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DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

ESTONIAN ACADEMY OF ARTS

FACULTY OF DESIGN

MSc. Design and Technology Futures

RETHINKING POSITIONING TO ADVOCATE AN ACTIVE LIFESTYLE AMONG BLIND AND VISUALLY IMPAIRED PEOPLE

POSITSIONEERIMISE ÜMBERMÕTESTAMINE, PROPAGEERIMAKS AKTIIVSET ELUSTIILI PIMEDATE JA VAEGNÄGIJATE SEAS

MASTER THESIS

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Department of Mechanical and Industrial Engineering

THESIS TASK

Student:	Helet Loodus
Study programme:	Design and Technology Futures
Supervisor:	Ruth-Helene Melioranski

Thesis topic:

English	**Rethinking positioning to advocate an active lifestyle among blind and visually impaired people**
Estonian	**Positsioneerimise ümbermõtestamine, propageerimaks aktiivset elustiili pimedate ja vaegnägijate seas**

Thesis main objectives:

1. Research, analyse and understand
2. Explore existing solutions and identify further development
3. Design solution

Thesis tasks and time schedule:

No.	Task description	Deadline
1.	Qualitative Research	03.02.2023
2.	Field research and exploration	24.02.2023
3.	Concept design finalization	27.04.2023
4.	Thesis finalization	18.05.2023

Language: English **Deadline for submission of thesis:** Date

Student	Helet Loodus	……	……
Supervisor	Ruth-Helene Melioranski	……	……
Head of Study programme	Kätlin Kangur	……	……

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ABSTRACT

For most people, daily life is manageable because we rely on our senses to complete tasks and reach goals. Our sense of sight is the most frequently used sense, allowing us to gather information about our environment and social interactions. This valuable gathered information can empower us to navigate various environments easily, irrespective of any visual limitations present in the environment.

Losing sight later in life can be a difficult adjustment for visually impaired individuals. The experience of the world through the eyes can be missed, which can impact their ability to gather information and perform daily tasks in the world that is designed by the people with sight to people with the ability to see. This adjustment can lead to feelings of grief and even depression. In addition, a large number of visually impaired people disappear between the walls of their homes in order to ensure their safety, which in turn leads to detachment from social life and leads to loneliness.

People with visual impairments often face challenges when leaving the safety of their homes and entering unfamiliar environments with potential obstacles that can cause anxiety and fear. While solutions like blind canes, smartphone apps designed for the visually impaired, and guide dogs exist to help them live independently, some individuals have lost faith in these services and given up on using them.

This master's thesis aims to provide a comprehensive solution for those with vision loss in their later years. The system proposal is specifically designed to track a person's location, generate a detailed map of the surroundings, and significantly improve awareness of the environment.

The basis of the concept is a technological platform that utilizes artificial intelligence to empower visually impaired individuals to move around with increased confidence. The device provides assistance in avoiding obstacles and maintaining balance, but it does not dictate the path. Instead, the support system closely monitors the user's journey, constantly adapting to their needs and learning from new situations.

The solution is designed to alleviate fear and anxiety related to detection while encouraging users to experience the positive emotions that come with physical activity. The solution is concentrated on promoting an active lifestyle that contributes to both physical and emotional well-being, ultimately leading to a higher quality of life.

KOKKUVÕTE

Toimetulek ei valmista paljudele raskusi, kuna argiste tegevuste tarbeks kasutame kõiki oma meeli, saavutades suuremaid ja väiksemaid eesmärke. Nägemise, inimese ühe tähtsama sensoorse meele kaudu, omandatakse enamus välismaailmas toimuvast. See väärtuslik teave võimaldab meil hõlpsasti navigeerida erinevates keskkondades, olenemata selles esinevates visuaalsetest piirangutest.

Visuaalselt saadud informatsioon on olulise tähtsusega, toetades igapäevaseid tegevusi keskkonnas, mis on loodud nägijatele. Seega vähenenud nägemisvõimega inimene, kes on kogenud ümbritsevat läbi nägija pilgu, jääb ilma suurest osast teabe kogumise allikast. See omakorda võib põhjustada endasse sulgumist, samuti leina, millest võib omakorda välja kujuneda depressioon. Taandudes ühiskonnast oma kodu seinte vahele, kindlustamaks enda turvalisus, võib selline otsus viia sotsiaalsest elust irdumiseni ning rajada teed üksildusele.

Turvalisest keskkonnast on siiski ka vaja aeg-ajalt lahkuda ning ühineda liikluskeskkonnaga. See otsus võib mõnes tekitada ärevust ja hirmutunnet. Liiklemise toetamiseks on vaegnägijtele pakutud võimalusi kasutada pimekeppi, nutitelefoni koos teekonnarakendustega, kõneseadeid ja ka juhtkoera. Olenemata võimalustest kasutada abivahendeid, mis toetavad iseseisvust, on nii mõnigi loobunud pakutud lahendustest.

Magistritöö on koostatud eesmärgiga pakkuda lahendus hilisemas eluetapis nägemise kaotanud isikutele. Disainilahenduse raames luuakse süsteem, mitte ainult enda asukoha positsioneerimiseks, vaid ka ümbruse kaardistamiseks, suurendades teadlikkust ümbritsevast keskkonnast, milles viibitakse.

Kontseptsiooni aluseks on tehnoloogiline platvorm, mis hõlmab endas tehisintellekti võimekust, toetades vaegnägijate aktiivsemat elustiili ja suurendades nende enesekindlust liikumisel väljaspool kodu. Seade ei vali ise marsruuti, vaid abistab kasutajat sellel teekonnal, vältides takistusi ning pakkudes tuge, juhuks kui peaks kaduma tasakaal. Toetussüsteem jälgib kasutajat ja teekonda, ning õpib uutest olukordadest, kohandudes vastavalt kasutaja vajadustele.

Lahenduse eesmärk on vähendada hirmu ja ärevust avastamise ees ning suunata kasutajat kogema liikumisest saadud positiivset emotsiooni. Disainilahendus propageerib liikuvat elustiili, aidates kaasa nii füüsilisele kui ka emotsionaalsele heaolule, soodustades paremat elukvaliteeti.

1 INTRODUCTION

According to the World Health Organization (WHO), around 2.2 billion people worldwide have been diagnosed with near or distant vision impairment in the world that is built on sight (World Health Organization, 2019). Societies are designed and operated by vision. Cities and towns, economies, education systems, sports, media, and many other facets of contemporary life are designed for people who can see. Thus, vision contributes to daily operations and assists individuals at all stages of development.

When it comes to assessing the environment, sight is the most dominant and complex of the five human senses - hearing, touch, smell, taste, and sight. Although studies vary on how much information is received through vision, it is generally believed that sighted people receive between 75% - 90% of information through sight. Vision also helps us move around by locating our surroundings and space in ways other sensors cannot. As a result, blindness can significantly impact everyday activities and coping. In addition, when asked which sense people would be willing to give up, the answer is almost always anything but their vision.

Visual-related quality of life is a multifaceted attribute that includes vision functionality such as visual acuity, contrast sensitivity, colour, depth, and motion perception, which are functions related to the vision-specific quality of life to execute tasks dependent on sight. Thanks to sight, being able to execute tasks more conveniently affects our emotional well-being and social connections. (Lamoureux & Pedudovs, 2011) For example, loss of eyesight can impair one's ability to work or care for themselves and limit recreational activities, interactions, and independence. A number of research have revealed that vision loss has a bigger influence on reliance in instrumental daily living tasks than in basic daily living activities (The National Academis of Science, Engineering, and Medicine, 2016). In other cases, people with vision loss will experience a pattern of grief that can be compared to someone diagnosed with a terminal illness. They will mourn the loss of their vision and related losses, including their jobs, hobbies, and independence. They can go through various stages of grief, including denial, anger, depression, negotiation, and acceptance (Kübler-Ross, 1969).

In Estonia, according to the Estonian Social Insurance Board Statistics 2022, the number of visually impaired people is around 2,000, including people with mild, moderate, and profound disabilities. While many people with visual impairment often have a concomitant disability, the number is probably even higher. (Estonian Social Insurance Board, 2022) The provided statistics do not cover the people who have lost their vision temporarily and the elderly whose vision has decreased. Therefore, the number can

reach almost 15,000 individuals, according to Jakob Rosin, the Chairman of the board of the Estonian Association of the Blind (Rosin, 2021).

The number of visually impaired in Estonia is almost as much as in the small Estonian town of Kuressaare. However, regardless of the relatively high number of persons with visual impairment, the author has not observed anyone with visual impairment moving around or anything indicating the person is blind or visually impaired.

After the author learned that close family members had to deal with visual impairment, the author decided to investigate the field. While in one case, the person's sight was corrected with the operation after almost ten years, and the sight was restored, then the sight loss in the other case has been gradual, and the emergence has been relatively long-term. Due to a medical condition, the vision will be lost entirely. Nevertheless, in the latter case, no preparations have been made. The person is alienated from the usual activities, does not go out much, does not communicate with people, and several health disorders have appeared, including depression. Therefore, the author was keen to investigate the realm of visually impaired people and the situation and problems people encounter daily basis.

The paper focuses on learning about the people who have lost their vision later in life, how it affects their everyday living, and what improvements can be made. In addition, the author wants to know how people see themselves, how society sees them, and what society has done so that people with vision loss can maintain their living standards and have opportunities for independent living.

1.1 Terminology

Several concepts defined by the author are to explain the variety of visually impaired and, in addition, terminology of the approach of solutions that are considered for visually impaired people. Since not all people with visual impairments are entirely blind, their vision cannot be restored to normal without extra help. Therefore, a glossary of terminology is provided to help clarify what people with visual impairments may see compared to normal-sighted people.

Visual impairment

A vision impairment is described as a restriction of one or more visual system or eye functions. This can range from mild vision loss to total blindness. Normal vision cannot be achieved through prescription lenses or surgery. According to WHO (World Health Organization, 2022), it can be divided into:

- **Temporary loss of vision**

This condition is not permanent and can result in loss of vision in one or both eyes due to health problems, or due medical procedures. Vision recovers over time.

- **Permanent loss of vision** (irreversible)

The permanent vision loss may be congenital blindness (present from birth). In contrast, others have degenerative or traumatic eye conditions that likely retain visual experiences and retain memories of visual images.

- **Legally blind**

The person who has less than 6/60 vision (a person who cannot see at six meters what a normally sighted person can see at 60 meters) or who has restricted vision to 20 degrees (normal field of vision is 180 degrees) or combination of both. According to WHO (World Health Organization, 2022) , it can be divided into:

- **Mild vision**

Visual acuity worse than 6/12 to 6/18

- **Moderate vision**

Visual acuity worse than 6/18 to 6/60

- **Severe visual impairment**

Visual acuity worse than 6/60 to 3/60

- **Blindness**

Visual acuity worse than 3/60

- **Total blindness**

Complete lack of light prescriptions.

2 METHODOLOGY

In this thesis, the author explores the challenges faced by visually impaired individuals who have experienced vision loss later in life. Drawing on personal experiences with people in this situation, the author investigates ways to enhance their ability to lead more active and fulfilling lives.

Regardless of the circumstance, the sight loss can be result from medical conditions – degenerative or congenital condition, trauma, or disease; the vision loss significantly limits the visual capability to carry out daily activities adequately in the world built on sight. Activities, such as eating, dressing, cooking, doing house chores, shopping, and working, which are previously taken by nature, now need a new way to manage. Therefore, lack of vision is one of the most recognizable barriers to coping with independent living.

The research was conducted in Estonia to learn about possible societal barriers and accessibility issues. Therefore, people who have participated in the study have been ones who are blind congenitally and lost their vision adventitiously in Estonia and have experience with the system of how society has invested to include people with visual impairment. Ongoing research, including the author's self-experimentation, by executing the daily task of the blind and visually impaired blindfolded and observing the person who has lost their eyesight late in life, will provide input for further design elaboration and concept testing. Currently, the design proposal is provided for Estonian people due to reasons based on the problems that emerged during the fieldwork with the locals, even though the design concept can be implemented abroad.

To ensure inclusion for individuals with visual impairments and medical conditions, the focus is on accessibility, but how to provide a comprehensive information flow that is accessible to people with vision loss? Accessibility means removing barriers and embracing inclusivity rather than exclusion. The author delves into this field and identifies key factors for independent living, such as increased knowledge about one's environment and access to information. These factors can potentially lead to a more active life. Can enhanced awareness of one's surroundings and access to information lead to a more active lifestyle?

2.1 Accessibility

The term "accessibility" refers to the ability of people with disabilities to use buildings, services, or information. Everyone has an equal chance to engage in social life, regardless of age or health. The effects of vision impairment on an individual vary based on a wide range of variables. This covers, for instance, the accessibility of preventative and therapeutic measures, access to vision rehabilitation (including aids like eyeglasses or white canes), and whether the person has issues with inaccessible structures, modes of transportation, and information (World Health Organization, 2022). Accessibility can be considered a property of available information, services, and physical space. Considering the needs of persons who have mobility issues is the component of accessibility that is most frequently mentioned. Moving independently in various locations, participating in various activities, and using services are still crucial for people with visual, hearing, and intellectual disabilities.

Simultaneously, universal design seeks to accommodate as many user groups as possible. In designing the living environment, the inclusive design incorporates the best-offered user experience for various target groups (Riigikantselei Riikliku korralduse töögrupp, 2021). Although accessibility is considered in the creation of the spatial environment, it does not include a broader spectrum but a narrower one, where a single object or service is evaluated from the point of view of accessibility. Access is not ensured for everyone when transportation and street area do not support it. It includes real-time information flow for individuals collecting information with other senses, except for vision. (Riigikantselei Ligipääsetavuse Rakkerühm, 2021)

According to the general plan, accessibility can be divided into two categories: the physical environment, which includes structures, transportation infrastructure, and roads, and information and services, which includes media and e-environments. The accessibility of education, tourism, culture, sports, and emergency services are exposed in addition to the physical environment, information, and services.

Accessibility is essential for the four main types of disabilities—mobility, hearing, vision, and intellectual disabilities. Structured environment and services with the target group in mind to benefit everyone, including children, the elderly, and, in addition, individuals who have had temporary trauma. Not everybody thinks about accessibility, but the value is much higher once the solution is implemented. For example, the lowered curbed stone was initially designed for people in wheelchairs. Later it became clear that almost everybody profited from the solution, including mothers with baby strollers, cyclists, and the elderly. Aids for persons with special needs, which allow them to move and

engage in social life, have a significant place in addition to the physical and information environment. The assistance is meant to compensate for decreased bodily function brought on by a physical or mental impairment. The symbiotic relationship between people's requirements, the nature of aids, and the physical and informational environment give rise to accessibility, providing partial independence and breeding confidence. (Ühtekuuluvuspoliitika fondide võrdõiguslikkuse kompetentsikeskus, 2022) Furthermore, it should not be forgotten that tens of thousands of medical interventions or accidents (traffic accidents, poisonings, and several other incidents) cause the average person to become temporarily disabled every year. (Parts, 2020).

2.2 Design methods

The double diamond model developed by the Design Council in 2005 was used during the process (Figure 1). It aided the author in organising the thoughts and provided a clearer, more comprehensive, and more structured approach. It is the method that helps to understand the problems and explore them in the step in a better way to iterate the process.

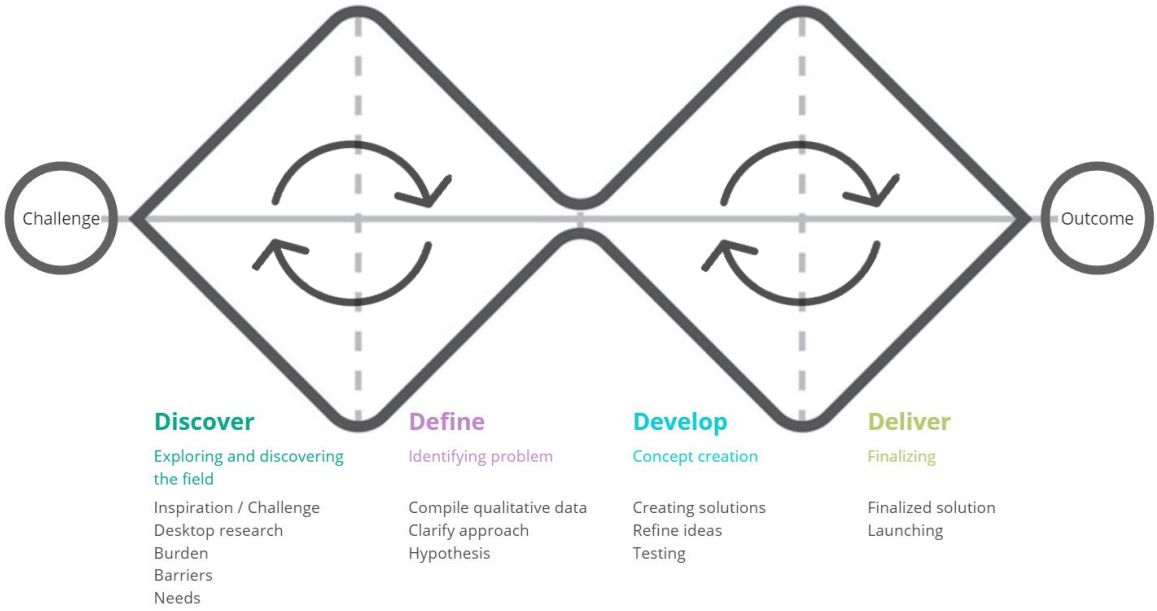

Figure 1 The Double diamond model generated by the author, based on (Design Council, 2019)

Discover the problem – At the beginning of the project, learning about the field and gaining knowledge through interviews, observation, and other means. The goal of the stage is to explore novel angles on the subject.

Define the problem – The second half of the problem diamond represents the defining stage, during this stage, designers analyse the options gathered in the Discover phase to determine their importance and feasibility. The goal is to develop a detailed creative brief that outlines the core design problem.

Develop potential solutions for the problem – During the first half of the solution diamond process, designers create, test, and refine their solutions or concepts through prototyping and iteration. This approach enables them to improve their ideas continually.

Deliver a feasible solution to the problem – The delivery stage of the double diamond model closes the diamond when the project is finished, and the outcome is completed, produced, and released to the market. (Design Council, 2019)

In addition, the constructive design research method is used to guide the investigation. Constructive design research can draw on insights based on the strengths and capabilities of the design field itself while maintaining methodological and theoretical flexibility. (Bang, et al., 2012) The hypothesis is interpreted in terms of how it relates to the ideas that spur research questions, experiments both in discovering phase and designing phase, evaluation, and information production (Figure 2). The tool for describing design research simplifies the process of framing and reframing the actual procedure. It involves gathering specific knowledge that aligns with the thesis and assessing information from stakeholders. This helps to view the hypothesis as an ongoing process carried out through continuous experiments.

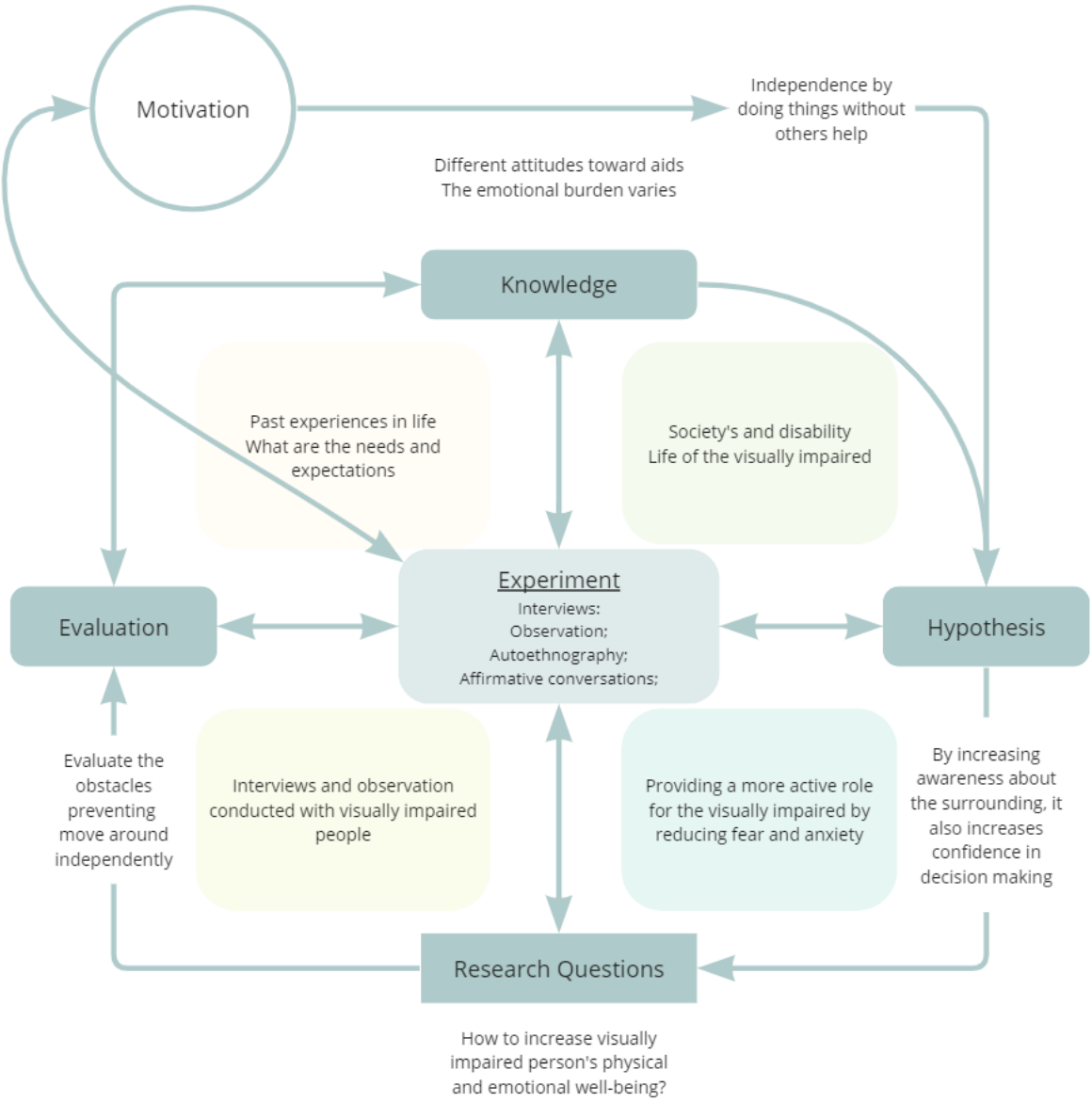

Figure 2 Constructive design research model made by the author, based on (Bang, et al., 2012)

2.2.1 Research methods

The author used research papers, books, journals, and websites to inquire insights of the realm and gain knowledge about the severity of vision loss and the limits imposed by the condition. The study examines how the situation has impacted independence and quality of life and how governmental institutions offer social support. The guidebook for young adults with visual impairment and others who have recently lost their vision served as the author's starting point for the overview. The guide " "My own life- a guidance material for young people with visual impairments and those who have recently lost their sight" (Estonian Association of the Blind; Finnish Association of Visually Impaired People, 2022) written by an active member of the Estonian Association of the Blind and the Northern Estonian Association of the Blind. The guidebook helps the author comprehend the changes the new condition is bringing about, and the actions people need to take to receive support and assistance to feel confident and carry out things independently. Additionally, the guide included a list of services to provide awareness of the possibilities and how to use them.

The research is based on the social model of disability and the following methods have been used in a field study to examine how society includes or excludes visually impaired people. For the research author applied several approaches to learn more about the person with visual impairment. The following methods were used:

- Qualitative interviews.
- Direct observation of the familiar route and unfamiliar route.
- Direct observation of taking into use a new device.
- Autoethnography.

Interviews

Interviews were one of the methods the author used for gathering data and learning about the attitudes and values of focus groups. The information acquired is typically qualitative or quantitative in character. As Beck and Manuel suggested, that the interviews are a suitable option for data collection if you want to comprehend or explore finely nuanced human concerns, the query is best answered in prose rather than with figures, and if wanted to be studied a pattern or an experience looking for trends (Manuel & Beck, 2008). In order to make the interview flow like a natural conversation, the author employed an unstructured interview, Unstructured interviews are

characterized by a lack of control over the subjects' replies, although based on a clear strategy that is kept in mind. (Harvey, 2006)

In conducted interviews the author asked open-ended questions about the impact of vision loss on life and the difficulties of coping with the emerging situation. In addition, the author asked questions about society, how people with decreased vision feel their part in society, and how they find the motivation to learn new approaches to receive surrounding information.

Observation

The author used comprehensive observation, specifically naturalistic observation, to collect insight directly from the field. The author did not interact with the observable, only a little if they asked something. The observation data collection includes watching, listening, and recording on the spot to study the natural behaviour and characteristic of phenomena. The author used a naturalistic approach to learn about real-world challenges and assess whether deviations are from normal behaviour. Instead, the objective is to learn about the behaviour in natural settings and the factors influenced during the observation period. In agreement with the observed, two observations were carried out. The aim was not to interact with the observable, although the approach is reactive – the participant was aware that the author was observing (Harvey, 2006). The first was carried out in a familiar environment, with learned pathways. For example, a person can navigate thanks to known landmarks. The other was carried out in an unfamiliar environment to see the changes in attitude.

Autoethnography

The author uses the self-experimentation research method to get close to the research phenomena. The research method helps the author to gather qualitative information through a deeper reflection of the experience of blind people and sense the surrounding as the target group feels it. The method provides a collection of personal experiences to open a viewpoint between the researcher's relationship with society and interaction challenges in parts of the daily tasks. This approach challenges the authors' beliefs and prejudices.

According to Adams (Adams, et al., 2014): "*autoethnography is a qualitative research method that: 1) uses a researcher's personal experience to describe and critique cultural beliefs, practices, and experiences; 2) acknowledges and values a researcher's*

relationships with others; 3) uses deep and careful self-reflection—typically referred to as "reflexivity"—to name and interrogate the intersections between self and society, the particular and the general, the personal and the political; 4) Shows people in the process of figuring out what to do, how to live, and the meaning of their struggles; 5) balances intellectual and methodological rigor, emotion, and creativity; and 6) strives for social justice and to make life better."

Personas

To compile and present the collected qualitative data author used personas, the fictional characters, to humanize the topic and build empathy with the target group. In terms of design thinking, using personas gives a better understanding of the user groups, their experience, behaviour, needs, and desires. Furthermore, persona supports interpreting research by allowing the individuals to be recognized and by assisting the target group in the phase of the concept creation process in achieving a satisfactory result in user experience. This is due to the varied experiences and needs of the people (Engineering Design Centre, 2019).

3 THEORETICAL FRAMEWORK

Hereby, the paragraph will provide a literature view of the vision impairment and the challenging circumstance of having to relearn how to interact with the outside world. In addition, the formulation of a hypothesis and the collection of data for problem space mapping will be aided by the theoretical framework.

3.1 What is visual impairment?

The WHO has adopted the definition of impairment, which is "loss or abnormality of a psychological, physiological, or anatomical structure or function that is considered an impairment in the context of health experience" (World Health Organization Geneva, 1976). A visual impairment can be divided into visually impaired and blind. The person can be congenitally blind, people who are born with it, or adventitious blind. The last category includes those who develop vision impairment later in life due to an accident or an incremental health problem. A person is visually impaired if their diminished visual abilities make it impossible to function independently. While glasses or lenses are expected to correct the hindrance of weakened vision in standard cases, visual aids do not improve the vision of impaired people. The bias is that visually impaired people are totally blind, which is true in some cases. Loss of visual acuity, tunnel vision, central vision loss, and total blindness are all categorized under legal blindness, and the scope of the condition may vary (Figure 3).

Depending on the severity of the condition and the necessity of the person, the visual impairment can aggravate the restriction of:

- Movements and orientation regarding to the surroundings.
- Receiving and transmitting the information, while visual information is not visible or can be seen only very close range with the help of aids.
- Performing activities of daily living, which includes problems in self-hygiene, preparation of food, cleaning, doing groceries and delivery, and so forth.
- Recreation and leisure.
- Self- determination.
- Participating in social life, including creating and maintaining social relationships.

It can be concluded that all aspects of life are affected by impairment which relates to the quality of life. Therefore, visual function is essential to maintain optimal self-independence.

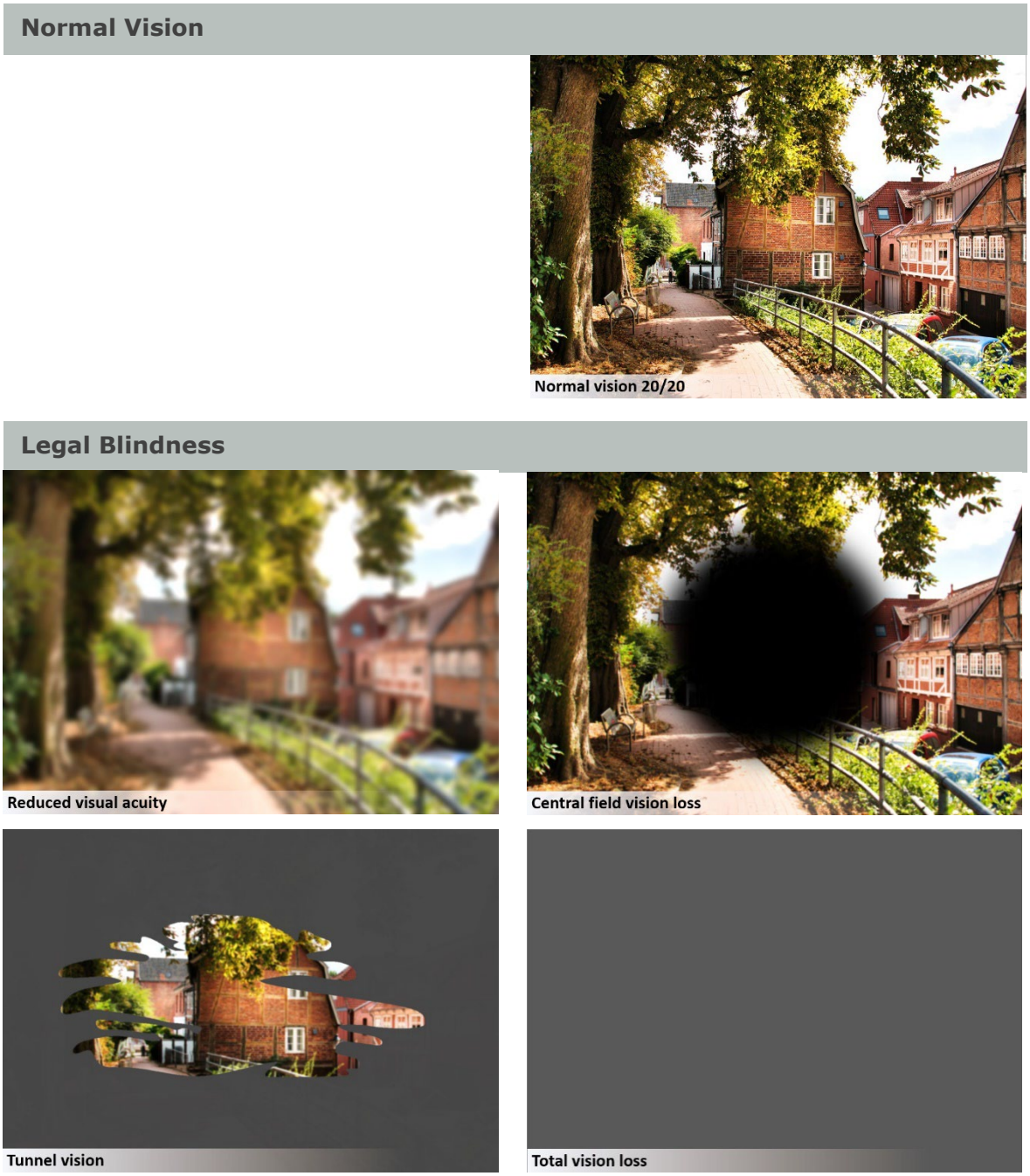

Figure 3 Type of vision loss made by the author, based on (Elliott, et al., 2017)

The loss of eyesight can have a significant impact not only on the individual but also on their family, friends, and society. Losing eyesight can be extremely daunting. It has the power to compromise a person's independence, income, career, and ability to provide for themselves and their loved ones. In addition, once-simple tasks may suddenly require the help of others or additional devices, even when it comes to leisure activities such as reading or spending time outdoors. (The National Academis of Science, Engineering, and Medicine, 2016)

Irrespective of a person's vision loss background, everyday tasks need adjustments and new ways to execute. Not only do people who undergo vision loss have to adjust to the new reality, but their close ones and suppliers of support services, such as governments, are significantly impacted. Furthermore, losing one's sight can be worrisome because it impairs mobility and independence, which makes it harder for people to maintain their standard of living. So, how does society support people who have lost their vision and lack knowledge of keeping standards of life?

3.2 Social model of disability

The concept of the social model of disability was created by Union of the Physically Impaired Against Segregation (UPIAS) activists in 1976. Academic creditability was imposed via the work of Vic Frankenstein (1980,1981), Colin Barnes (1991) and Mike Oliver (1990,1996). The UPIAS aims to have all impaired people with physical disabilities separated from society by the arrangements to allow them to engage in social life fully. The inclusion to social life encompasses comprehensive assistance by the state so that the people with the impairment can achieve the most significant possible independence in their daily lives, achieve mobility, work productively, and live fully – the goal is to give impaired people control over their lives.

"… *in our view, it is society which disables physically impaired people. Disability is something imposed on top of our impairments by the way we are unnecessarily isolated and excluded from full participation in society. Disabled people are therefore an oppressed group in society. To understand this, it is necessary to grasp the distinction between the physical impairment and the social situation, called 'disability', of people with such impairment. Thus, we define impairment as lacking all or part of a limb, or having a detective limb, organism or mechanism of the body and disability as the disadvantage or restriction of activity caused by a contemporary social organisation*

which takes little or no account of people who have physical impairments and thus excluded them from participating in the mainstream of social activities." M. Oliver (Oliver, 1996).

Oliver's statement provides a fundamental explanation of the British social model, which includes many essential components. Meanwhile, Northern American theorists have only adopted the first two:

- People with disabilities are often marginalized in society.
- People are divided according to their disabilities.
- The term "disability" refers to the social condition that distinguishes individuals.
- Disability is defined as a form of social oppression rather than a specific type of disability.

The social model had a significant impact on the British disability movement by introducing a powerful political strategy known as "barrier elimination." This approach seeks to eliminate the obstacles that prevent people with disabilities from being fully included in society. The model is based on the understanding that society labels individuals with impairments as disabled, thus creating a barrier to their inclusion. (Oliver, 1996)

The medical approach to disability, which solely focused on the health problems of individuals and perceived impairment as the primary issue, is no longer utilized as per the definition outlined by the United Nations Convention and Estonian law. The definition of disability has been significantly broadened by the social approach to disability. (Eesti Puuetega Inimeste Koda, 2013) The disability issue cannot be viewed as a personal health matter of an individual. Rather, it's a consequence of the interactions between the individual, their environment, and societal barriers, beliefs, and prejudices that create discrimination against disabled people. The social approach is the only approach that can tackle this issue, and it must be adopted with immediate effect.

3.2.1 Social barriers

According to the Social Model of Disability, the discrimination and exclusion of individuals with disabilities are caused by how society is structured and organized. In addition to pointing out that society is the root cause of disability, the social model also offers an explanation of how society attempts to disable those who are disabled (Figure 4).

The paradigm, sometimes referred to as a "barrier approach," offers advice that identifies both the hurdles that prevent persons with impairments from achieving their goals and how these barriers might be eliminated, reduced, or countered by other forms of support. These barriers raise the question, while the barriers exist, what is perceived as the role of the impaired people in society? Impairment often excludes people from doing beloved activities. The barrier exists in several areas, from the physical architecture and environment to the inaccessible digital world (Inclusion London, 2015).

Figure 4 The Social Model of Disability exclusive factors made by the author, based on (Inclusion London, 2015)

Physical/ Architectural barriers

Barriers to physical access for people with disabilities, such as those with sensory, environmental, or intellectual challenges, are present in constructed environments and physical structures. For instance, places that lack lifts or a ramp are inaccessible due to their staircases or places without tactile signs indicating the route. In addition, pathways are congested with obstructions, making them difficult for wheelchair users or those pushing strollers to navigate. Furthermore, entrances in different venues are not always considered for people with different needs. The cityscape and public buildings implement different solutions but mainly indoors; the overall environment does not support finding the correct path to the building. In addition, many establishments still lack accessible features like automatic doors or have not replaced any broken or removed signs that aid in providing information to visitors. (Sau, 2019)

Attitudinal barriers

Attitudinal barriers occur when people act and think based on false assumptions and only see impairment rather than the person with a disability. Prejudices and assumptions lead to discrimination that prevents people from being as productive and successful as possible. Unfortunately, bullying, isolation, and violence can come from the stigmas associated with disability. For example, the stereotype questions people's talents and that those with disabilities are intellectually incapable of accomplishing jobs; hence many do not think that people with disabilities would not make a good employee. In addition, utilizing people with impairment as the source of inspiration and constantly putting them on a pedestal to celebrate their everyday actions as if they have managed something impossible and objectifying them by reducing their ability as if they are incapable of accomplishing more. With this, people demean the human nature of the disabled person by expressing that it is exceptional for a person to live with a disability, and it is a barrier to living. (Young, 2014)

Technology barriers

People with disabilities can benefit significantly from technology when it comes to everyday tasks. However, limited access to technology can create barriers for those who need it the most. The complexity of interfaces can make it difficult for some to use technology, turning it into an obstacle instead of a solution. It is essential to design technology with different approaches to ensure accessibility for everyone. Unfortunately, failing to consider broader requirements can make specific devices inaccessible. (Fuglerud, 2011)

3.2.2 Consequences of inequality

By the year 2030 United Nations declares to meet Sustainable Development Goal No 10, which states the following: "empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status" (United Nations, 2016)

Coping with the changes on a personal level in society makes visually impaired people more dependent on others due to barriers in various realms. The lack of accessibility reminds people daily that it is not ordinary to have a disability or impairment since almost everything is designed for people with sight. This, in turn, alienates them from society and social life, making people with impairment more introverted. The left-out

feeling is no exception. Sadness can lock people down, and over time, depression may develop, and people disappear from the public.

People who do not want to stand out by using the equipment meant for the visually impaired might feel stigmatized when out in public with an aid amplifying that the person is disabled and unable to communicate or understand people around them, creating an emotional burden. These actions lead to the exclusion of the blind and visually impaired people.

3.3 Stigmas

People who are stigmatized often struggle to gain full acceptance in society and may feel the need to modify their identities or behaviours to fit in. The term "stigma" comes from the Greek word for piercing or marking, historically used to indicate the status of enslaved people and criminals. Essentially, stigma involves the labelling and shaming of individuals. Sociologist Goffman identifies three categories of stigma: character, physical, and group identity. Character stigma relates to mental or behavioural traits, while physical stigma refers to visible physical traits that deviate from societal norms and are considered undesirable.

Belonging to a certain group, whether it's based on race, nationality, religion, age, or any other factor, often comes with a negative label of group identity. These labels, which are often passed down through families, can harm every member of the group. Stigma is a dynamic phenomenon that changes over time, influenced by social progress and the emergence and disappearance of ideas, behaviours, and principles. Discrimination, also known as "enacted stigma," is a type of stigma that can be physical, mental, visible, or felt. Discrimination leads to the restriction and denial of rights, which ultimately reduces the quality of life.

Stigmas can affect people in different ways. Some may feel dismissed and stigmatized, prompting them to take extreme measures to counteract it. This may include altering their appearance, seeking approval through unconventional means or improving their skill set to gain acceptance. Alternatively, some individuals may use stigmas as an excuse for their lack of performance and learning. This can lead to social withdrawal, increasing feelings of loneliness, melancholy, and anxiety. Even when they re-join society, those who feel stigmatized may become more self-conscious and afraid to express themselves.

When encountering someone new, the initial impressions are often formed through visual symbols that can indicate a person's status or situation. For instance, in many cultures, a ring on the fourth finger of the left or right hand is commonly associated with marriage. However, it's important to be aware that certain symbols, such as a white cane, may signify that an individual requires assistance or tools to perform daily tasks. Unfortunately, these symbols can lead to stigmatization and negative assumptions. It's crucial to avoid discriminatory or prejudiced attitudes towards those who display them. (Goffman, 1963)

3.4 Aids

Persons whose sight cannot be corrected to normal vision with glasses or lenses are considered legally blind. The government has supported purchasing assistive products meant to do daily activities. Various devices have been developed to use indoors and outdoors, and the process continues. With improving technology, new possibilities emerge in functional capabilities, which help to improve the independent living of people with impairment.

Aids meant to support a person with visual impairment are divided into optical and non-optical products. While the optical device helps to increase the vision to maximum and enlarge elements observed through the device, the non-optical tends to rely on other senses than seeing. (Kaur & Gurnani, 2022) In addition, the devices people use depend greatly on the severity of the vision loss, awareness of the device, use of the device, frequency of usage, training available learning to use the device, need for it and accessibility (Senjam, et al., 2019).

The most common non-optical assistive device for the blind and visually impaired is a white cane. This helps the user to manually monitor the ground in front of the user the notice obstacles when approaching. The solution for a white cane varies between technical and non-technical. Technically improved solutions monitor surrounding and inform users earlier if there are some obstacles in front by vibrating or sending out a sound alarm. Regardless of improvement, only a small amount of visually impaired use the white cane, and one possible reason could be the stigmatization that comes with it.

Currently, many devices have been equipped with talk-back solutions, which give the users an instant overview, for example, the information provided on cell phones or computer screens. For many who have lost vision later in life, it is the most convenient solution to have voice-over feedback, describing steps in devices and providing more accessible information.

3.5 Inclusive design

According to the British Standards Institute (2005), inclusive design is defined as: "The design of mainstream products and/or services accessible to, and usable by, as many people as reasonably possible ... without the need for special adaptation or specialised design." The concept of inclusive design does not imply designing the entire market. Designing one product for a whole population with diverse needs and interests is impossible. Nevertheless, inclusive design has a distinct approach in which designers consider a wide range of user groups' needs and interests, regardless of user abilities. As a result, the design's outcome encompasses as many people as possibly reasonable, while the design itself remains without adaptations.

Inclusive design meets the accessibility requirements by eliminating existing obstacles and preventing emerging of new ones, removing barriers and seeing that each individual has unique needs and talents. A strategy that considers diversity makes finished goods or services more accessible. Even when a design is specially tailored to people with particular needs, the outcome, including the user, often benefits everyone. All people, regardless of age or health condition, are provided equal possibilities and inclusion in society to fulfil the potential when the whole human population is included in the living and information environment (Waller, et al., 2005).

Inclusive design is a must, as it requires the author to consider the perspectives and needs of individuals with varying abilities. It is essential to identify the basic requirements and challenges faced by those who feel excluded from their environment to meet the needs of as many users as possible. The solution must consider possibilities of how individuals can participate in different aspects of society and overcome any obstacles their surroundings pose. This thesis focuses on a specific group, but the solution is intended for broader usage among individuals with visual impairments and other groups who may require it at some point.

3.6 Quality of life

The paper discusses the definition of Quality of Life, which is not universally agreed upon. However, it uses the definition provided by the World Health Organization, which states that Quality of Life is "an individual's perception of their place in society, taking into account their culture, values, goals, expectations, standards, and concerns". (World Health Organization, 1993).

Not everyone's essential needs have been provided accessibility; therefore, the visually impaired person's life may not be as effortless as that of sighted persons. The providers of services or goods do not always consider people with different needs. Sighted people can distinguish the products or services with ease. At the same time, there is no accessibility for visually impaired people who need other approaches to understand the differences and be able to execute everything by themselves. Due to inaccessibility, many people need assistance, which can burden the person who needs help. Lack of personalized approaches, many might feel unwelcoming and feel uncomfortable when visiting places that are not accessible for visually impaired or blind people who are not getting the necessary information they are hoping for and feel excluded.

The inaccessibility is causing the problem of visually impaired and blind people feeling dependent on others. Therefore, a lack of specialized approaches to meet the need of the person with a vision may increase the feeling of insecurity, inadequacy, unhappiness, shyness, anger, and depression, leading to isolation and turning the person into an introverted individual. (İlayda, 2022) While introversion can certainly provide a positive experience, it's important to recognize that it can also become a burden. When individuals withdraw from their former selves and the people who have brought them happiness, it can create feelings of exclusion and hinder positive self-exploration. Therefore, it's crucial to strike a healthy balance between introspection and social interaction.

Achieving a good quality of life requires measuring the positivity of one's emotions. Therefore, meeting emotional, materialistic, and social needs to foster this subjective feeling is essential. In addition, good quality of life equips individuals with the necessary tools to cope with stressful situations and become more self-aware. Despite the personal aids that people can currently use, the quality of life is affected by the environment, not providing enough solutions for people who need help. The environment can be unwelcoming and create excluded feelings for the people not being able to access, for example, leisure, preferred courses, or participate in different activities. It's crucial to find a common denominator that enables individuals with reduced vision to navigate and interact with their surroundings.

3.7 Pillars of independency

Many disabled including blind and people with visual impairment want to live independently like other people, having same opportunities as society provides for an average person. Living independently does not, however, entail doing everything on one's own, it means having a control over their own lives. Because of the combination of services that make people's lives easier today, not every skill and piece of knowledge is necessary.

- Appropriate and accessible Information.
- An adequate income.
- Appropriate and accessible health and social care provisions.
- A fully accessible transport system.
- Full access to the environment.
- Adequate provision of technical aids and equipment.
- Availability of accessible and adapted housing.
- Adequate provision of personal assistance.
- Availability of inclusive education and training.
- Equal opportunities for employment.
- Availability of independent advocacy and self-advocacy.
- Availability of peer counselling.

During the rapid development in technology, another pillar has to be added to the list, which increases enormously the ability to independent life and support the other pillars.

- Access to digital technology.

The pillars outlined should apply equally to all individuals. Every person with a disability has the fundamental right to live independently and be a part of their community. (European Network on Independent Living, 2022)

3.8 Conclusion

Through examining literature, it becomes apparent that society creates obstacles for individuals with disabilities by failing to provide access to necessary information and support their movement in public spaces. Even though inclusive design, as the name says, is to include all people despite their gender, age, ethnicity, orientation, religion, or disability by removing barriers, the barriers remain. What may seem like minor

barriers to sighted individuals can greatly impede the independence of those who are visually impaired. These obstacles exist in various areas, including physical and environmental spaces, technology, and unfortunate attitudes towards disabilities. This exclusion from different fields leads to inequality and fewer opportunities for individuals with impairments to achieve their goals.

Society's negative views can make individuals with visual impairments feel unworthy and excluded, leading to discrimination. These stigmas create an inaccurate perception of the person, and society may exclude them without understanding their true abilities. Unfortunately, some individuals avoid using aids out public for visual impairments to avoid stigmatization, even though these aids are meant to help with daily activities.

Therefore, the pillars of independence, the foundation that should ensure the visually impaired person's independency, are quite fragile, not fully meeting the requirement that a person needs for independent living. While not meeting the requirement, the excluded people can turn more introverted and withdraw from society. With the lack of communication and physical activities, the person's well-being can take a big hit, reducing the quality of life.

4 DESIGN RESEARCH

The design research contains expert interviews as well participatory involvement to investigate the challenges of the visually impaired people. In this chapter, the author gives an overview of the research result and points out the primary discoveries which are base for the following topic developments.

4.1 Interviews

Five interviews in total were conducted during the discovery phase to gain insights to rely on. The first interview was conducted with a person who has been blind congenitally; three interviews were conducted with people who have lost their sight gradually, and two of them have gone blind later in life; and finally, the interview was conducted with the person who has experience practising the accessibility and inclusive design.

The aim of interviewing the congenitally blind person who has not seen the world as normal-sighted people have seen it was to gather information on everyday tasks. To learn about the barriers and problems they encounter in their everyday tasks; furthermore, how they perceive the world in their own way. The interviews between the congenitally and adventitious blind were carried out to discover the differences in their attitude towards life.

Interviewee No. 1

Interviewee is congenitally blind, is married and lives in a city. Improvements in technology have increased independence and praises digitalized solutions in the city spaces, making moving around more accessible. Various aids are in use, computers, and smartphones, with programs meant for visually impaired people, walking with a white cane and sometimes using the help of an assistant. Is well aware that many solutions are designed for vision. In addition, person is an active traveller at home and in foreign countries. An active advocate for raising awareness of inaccessibility in society.

- "You have to have will, without will nothing going to change".
- "It is harder to socialize, and it is difficult to go somewhere by yourself".
- "If you don't make a sound, you do not exist for me".
- "It is my everyday life, and it is disturbing when someone is praising me crossing road by myself".
- "Sometimes it is beneficial, for example, giving advance notice when arriving to airport who provides an assistive service to execute many necessary activities from check-in to baggage drop-off, and quick escort to gate".
- "Excessive noise is disturbing".

Interviewee No. 2

The vision loss has been gradual since persons teenage years, lives alone in a city. Moves around independently and uses public transport. In addition, person uses a white cane and a guide dog. Rehabilitates the people with visual impairment, therefore has an overview of provided service and people using provided opportunities. For everyday work, the person uses a customized computer and phone with a talk-back function. Working in the name of the Northern-Estonian Association of Blind to continue even though the funding is almost non-existent. Does not go out voluntarily because many places are inaccessible, but luckily, almost everything can be solved by calling or via the internet.

- "It becomes clear how easy it was to be sighted".
- "Sometimes people use a white cane to let others know they are blind".
- "I do not always need to use the cane; I have memorized the path".
- "Hazardous situations occur when people do not mark the obstacles on the pathway – for example, open manholes".
- "Fast-moving electric scooters are so quiet and making me worried; it is difficult to distinguish the sound unless the scooters are next to you."
- "It is important to admit that the sight has gone, and it is ok to mourn, but the crises will pass, and you need to learn and acquire new coping skills".
- "Learning technologies is an ongoing process because it changes rapidly".
- "Needs emerge through obstacles".

Interviewee No. 3

The vision loss was gradual, and the person became blind after middle age. Currently living with a family member in the settlement in Harju County, and is a freelancer, writing opinions and articles in newspapers and periodicals. Uses the municipality's support services and attends meetings in Tondi and Astangu Centres. Visits theatres as often as possible and organizes visits for other visually impaired people. Swimming has been a hobby for a long time, and visiting a familiar swimming pool where a person can get around without others' help and accept help from a white cane. Various technology devices are used, like a computer, a smartphone, and a device for listening to an audiobook, podcasts, and radio. However, needs help with inaccessible design. Travels often to Haapsalu alone to participate in events and stays overnight in hostels.

- "I like to communicate with people I know; as for strangers, I will talk to them if I need help".
- "English is a problem, everything is in English, and I cannot understand what the speech synthesizer tells me".
- "Knowing Braille gives an enormous advantage".
- "It is a drawback that the working hours are from 9AM to 5PM; after that, I cannot use municipality transport and need to take a taxi from the city if the theatre ends after working hours".
- "I do not move around much by myself; even though we have a pedestrian road, I still might get insured when using it - in that sense, I am very timid".
- "If I want to use the help of an attendant, I have to get to them on my own first – one lives in Saaremaa and the other in Tallinn".
- "I can now order groceries to my front door has made many things easier".
- "I need to touch to locate my location; I cannot position myself well by hearing".
- "Virtual stores are meant for people who can see – sometimes it is difficult to execute the payment because everybody does not use the same approach".

Interviewee No. 4

The vision loss was gradual, and the person became visually impaired after middle age, living alone in a Järva County. Do not use municipality's provided social service. Communicated with family and old friend almost every day. Struggles with emotional well-being and lacking motivation to try out new things. Also experiences other health problems. Does not go out much, only when grocery shopping or something to do around the house. Do not use aids for running daily tasks, except cell phone with a talk-back function. Not feeling comfortable with technological improvement and do not like to learn, even though many things that brake do not have exact same replacement. Have not been in a contact with the unions or people with the same condition. Often uses phrase "Well, you know I cannot see".

- "I can do it by myself".
- "Chord needed to be done in the household keeping me active".
- "If I need to repair something I will ask help from the neighbours".
- "If I need to see the doctor and run some errand, I rely on my kids to help me out".
- "Daily I listen to radio and watching TV".
- "There not much to do around the house, except in summer when I need to mover lawn".
- "When it is too sunny outside, I cannot see anything, and due that I have lost my sense of direction and got lost in the garden".
- "I do not need to use white cane; I am not blind".

Interviewee No 5.

Expert in accessibility assessment and practitioner of inclusive design. Designer in the Innovation Team of the Estonian State Office, whose goal is to improve public services to be more user centric. As a member of the Rakkerühm, pointing out shortcomings in society and providing knowledge to overcome them led to changes in the building code. Interested in the diversity of people and solving social problems.

- "The whole world is built on sight".
- "Universal design is a matter of mindset".
- "Designers do not have to design for everyone - the target groups are different".
- "Intergenerational interaction - designing public space based on different needs".

Conclusion of interviews

Based on the results of the interviews, it is evident that individuals face similar challenges, irrespective of the extent of their visual impairment. These include difficulties navigating unfamiliar routes and heightened anxiety in public spaces due to noise, vehicles, and other obstacles. However, much depends on a person's nature, vitality and will to learn. While the whole world is built on sight, visually impaired people are looking for ways to participate in it. The problem that occurs through interviews is the lack of information and how it is presented. Many have found aids to improve the accessibility to information, while others, on the other hand, rely on their memories and try to execute daily tasks based on these. People are more likely to be more active and socialise when connected to organisations and have active memberships in various centres. It seems that connecting with people in the same condition increases the sense of belonging and reinforces inclusion in a community by sharing experiences.

Customised PCs, smartphones, and audio-playing devices are the most valuable gadgets. Many rely on their senses of hearing and touch; some people can discern objects better with sound than with touch and vice versa. Despite providing aid for the visually impaired to ease getting around, only a small per cent of people use aid for navigating, like a white cane or guide dog. Thanks to technological development, many use GPS to get around. Still, people are reluctant to move around for fear of getting injured or lost.

4.2 Observation

The observation took place in a small village in Estonia and in a bigger settlement, where the author observed one of the most common daily routine tasks, grocery shopping - being carried out in familiar and unfamiliar surroundings. The observable visited a small local grocery store independently and a larger one with an attendant. In addition, the author observed the deployment of a new device.

The observable has gradually lost vision after middle age and has lived in the exact location for almost 30 years.

Overview of observation

Grocery shopping

For the observable, a home is a fortress where every corner is known, and moving around is no problem. The well know place without external distractions can make a person more relaxed. However, even though the place is, well known the movements and walking around is still controlled and slow. Assessing information about things takes much longer.

When moving outside diversity of the surface materials of the walking is an excellent indicator of receiving information about the location. The walking is slow and concrete to balance the body after every step; steps were executed in the full sole. One of the most disturbing things was the loud noise when transport vehicles approached. To secure safety, by ensuring balance and ruling out danger, it was most reasonable to stay input to let the potential danger pass. The observer did not notice differences between movements regardless of walking in familiar places or unfamiliar with attendant help. However, the person who will attend visually impaired needs to know basic approaches how to do to it and how to express themselves in words – the observable did not receive the necessary information about the situation and what to do, and the attendant did not know how to guide.

Lack light makes it difficult for people who can perceive some light or shadow to navigate indoors. However, clerks are more eager to notice and help people in smaller stores. In addition, a large number of people in the store can mean long queues and unintentional touches that lead to increased anxiety and irritation. Accessibility is not always guaranteed, for example, common-use devices like payment terminals. In some cases, identifying touched elements is inadequate due to a person's insensitive fingertips. In addition, the weight in hand changes the balance of the body, and the person can deviate in the direction where the bag weight is held.

Adopting a new device

Several accessibility issues, starting from the case package to the device itself. Opening the package on a flat and wide surface secures stability. Confusion when opening the case package – no distinguishable identifications of where to open the packages. In addition, separately packed pieces are not identifiable at first. Finally, assembling the

device took a long time due to the issue of locating the connection point between the cable and the device, and the gable and wall connection.

Instructions on paper are a standard approach but useless for someone who cannot see, not other possibilities to learn about the new device. Locating buttons on the device was tricky, while the buttons were on the same level as the casing—no other signifiers on the surface. The person memorized the button's location by measuring the distance from the side. The person seemed upset that everything took a long time, and observing made the observant more anxious, and he was afraid not to meet the expectation when executing simple tasks.

4.3 Autoethnography

To gather more qualitative data about experiencing the surrounding without sight, the author conducted an experiment by repeating the task of observable grocery shopping. The task was executed in a small village in Estonia to minimize the risk of getting injured. The location was picked due to the fact that the place was familiar to the author and a good comparison of how clearly the path is stored in memory after removing the ability to see. The author used the attendant's help, who kept an eye on and took additional notes of the movement the author did not observe.

"How difficult can it be to use a path I have used countless times?" the author's prejudice before the experiment took place.

Conclusion:

Despite the short distance, the experiment of grocery shopping was exhausting. Everything the author knew before vanished when the feet touched the ground outside. The road that seemed very common and understandable turned into an unknown place. The walking pace seemed too fast; however, the speed was low– the heightened anxiety and fear made the author think that everything was moving uncontrollably fast. In addition, anxiety was heightened due to fact that keeping stable balance was difficult, when not leaning on attendant. It seemed like the landmark was constantly changing and brain could not explain this change without vision.

Irrespective of using the attendant's help, the author did not trust the guidance. Constant fear took a toll, and lots of questions later from the author towards the attendant, the attendant was tired. Moreover, in the grocery store, the information on goods was inaccessible, and there was no indication to recognize the needed product except fruits and vegetables.

As it turns out, even when the path is walked numerous times, increasing awareness about the surrounding based on memory is challenging without instant valuable information.

4.4 Conclusion of design research

Engaging in social activities has a significant impact on an individual's character. Some of those who have lost their eyesight later in life are confronted with the bias that some people may have towards them. Unfortunately, prejudice still surrounds the use of the white cane, which is a symbol of visual impairment. This prejudice has caused some individuals to abandon this important walking aid. People try to mask the condition by walking themselves without any aid that references to blindness, relying on a memorized path. However, even when a person has seen the surroundings, in the absence of vision, the usual route acquires an entirely different sense of meaning and knowledge of how much the brain does not memorize when eyes wander around when walking.

Overcoming obstacles is a sign of resilience, and it is crucial to stay active. Going out and putting oneself in a vulnerable position can affect one's emotional well-being. Sometimes, unfamiliar surroundings can lead to uncertainty and fear of getting injured or lost, resulting in an unsettling and distressed demeanour. This, in turn, has led people away from the more active life and made people more passive, which has led to isolation and loneliness. Regardless of the major changes in life, some have found opportunities to participate in social life.

The use of technology has proven to be immensely helpful for individuals with visual impairments in carrying out their daily tasks. Devices such as computers and smartphones equipped with screen readers have made information easily accessible, while GPS and other applications on smartphones have made navigating easier. Additionally, some products have incorporated audio notifications to present information to users. Acquiring new knowledge can be a daunting task, particularly for those who struggle with technology such as computers, smartphones, or other devices. Consequently, some individuals may become overwhelmed and abandon the learning process altogether.

5 REFRAMING

The research initially aimed to explore ways to enhance the physical and emotional well-being of visually impaired individuals. After conducting theoretical and practical research, it has been determined that individuals who have experienced vision loss later in life have a decreased quality of life and often feel isolated. To promote social interactions and improve mental wellness, it is crucial to encourage and support outdoor activities. One significant impediment to mobility is the fear of injury or becoming lost. Additionally, the stigmatization of visually impaired individuals can be a heavy burden, preventing them from venturing outside.

Therefore, based on the described above, the author supplemented the research question as follows:

“How to reduce fear and anxiety of the people with visual impairment who have lost their sight later in life to discover the path by themselves without obstacles?”

In addition, not all visually impaired people use aids to support daily tasks. While some do not have access to it, others do not want to feel blind on the streets, not wanting to attract attention. Furthermore, not all visually impaired people are completely blind, and many have a reception of light and shadows; therefore, they can move around by themselves without outside help. Nevertheless, the restriction remains, like recognizing indications and rearrangement of traffic or temporary obstacles. Despite increasing awareness of visually impaired people, people with eye conditions still encounter discrimination and prejudices.

Considering the findings conducted for research, it is vital to enable mobility for the visually impaired, not only purposeful but also for outdoor adventures, which would support their emotional and physical well-being.

The hypothesis as it follows:

"By not only locating the person's position but locating the surrounding by the person, using the descriptive, contextual method, allowing a person to make the final decision, calculated or spontaneous, which gives a person the opportunity for a more active life and thereby increase the well-being. "

6 DESIGN APPROACH

Research on design has shown that individuals with visual impairments tend to avoid spending time outside their homes or taking unfamiliar paths due to fear of getting lost or hurt. Through the interviews conducted, it was found that two out of four interviewees rely on white canes or guide dogs for navigation. It is important to note that there may be a larger number of individuals who do not use any aids, as the total number of people with any degree of sight loss is currently unknown, whether temporary or permanent and due to age or health condition. If possible, people are more agreeable to using help from the attendant. Based on observations, interviews, desktop research, and personal experiments, it is hypothesized that people face difficulties in understanding their surroundings due to a lack of easily accessible information.

Visually impaired individuals face significant challenges in accessing information, as different services often employ varying approaches, making it difficult to understand. Moreover, most services are designed with sighted individuals in mind, exacerbating the problem. While the government does provide some support for the visually impaired, many individuals lack motivation to access these services. Furthermore, the learning curve for new technologies can be steep, making it an insurmountable obstacle for some.

The main ideas gathered from the interviews were sorted and grouped into clusters, supported by the insights from interviews, that will serve as the foundation for the design approach (Figure 5). After analysing the clusters, the main themes appear to be fear and anxiety, the importance of freedom of movement, and the need for heightened awareness. The purpose of design proposal is to create a design concept that enables individuals to have more power over their environment, thus decreasing any negative emotions such as fear and anxiety.

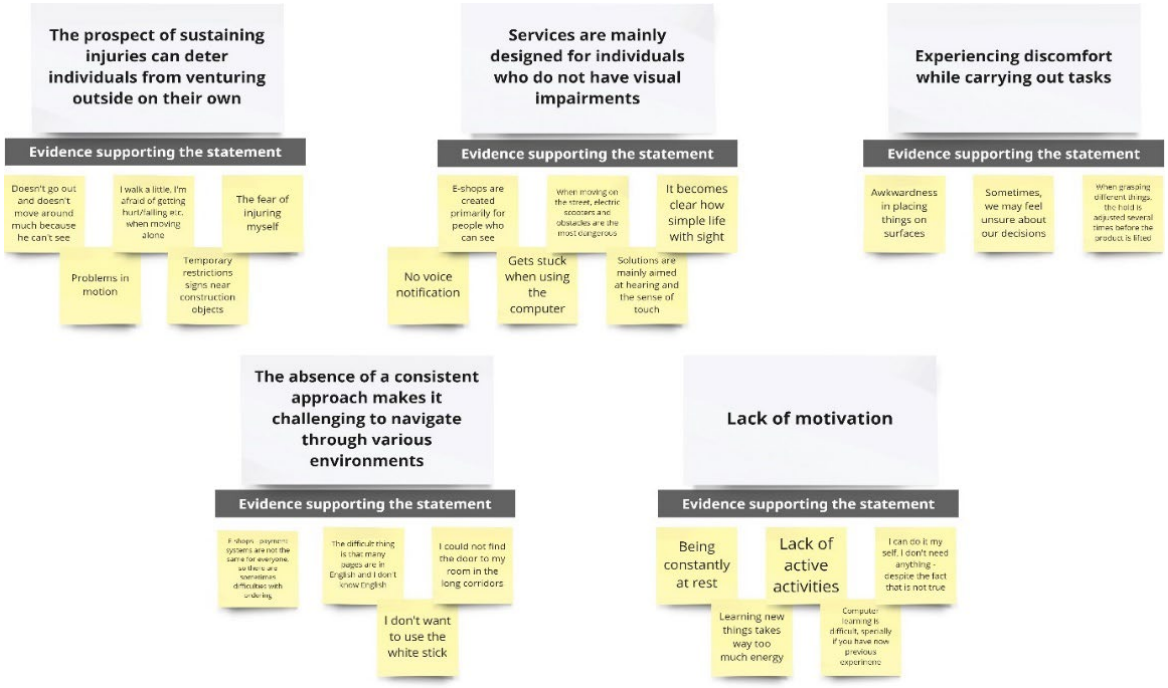

Figure 5 Insights clustering by the author.

Personas

In order to identify the target audience for the solution, two personas were created based on interviews, observations, and autoethnography results. The solution is aimed at individuals who enjoy being active and independent. The first group consists of individuals who, while interested in going out, tend to be more passive and have more free time. They may struggle with technology and require additional time to learn new devices. For getting around, they do not like to use aids that refer to them as blind people. The second group, on the other hand, comprises active individuals who spend more time outside their homes. They have adapted using a white cane and guide dog; however, even they can encounter difficulties when poorly marked temporary obstacles obstruct their usual paths. This group is generally more receptive to learning new technologies and adapting to change.

Creating personas by understanding how they differ in nature and actions also creates a deeper understanding of potential users. Created personas are the foundation of the creative process.

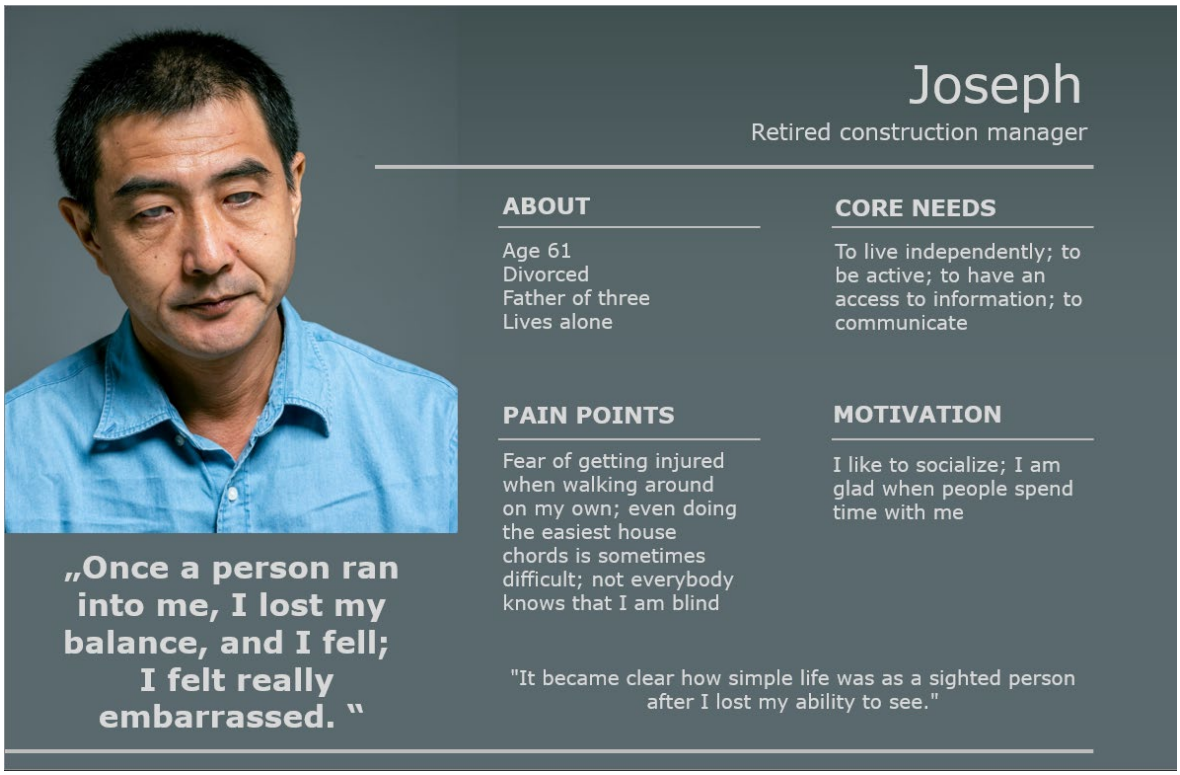

Figure 6 Persona "Joseph" made by the author.

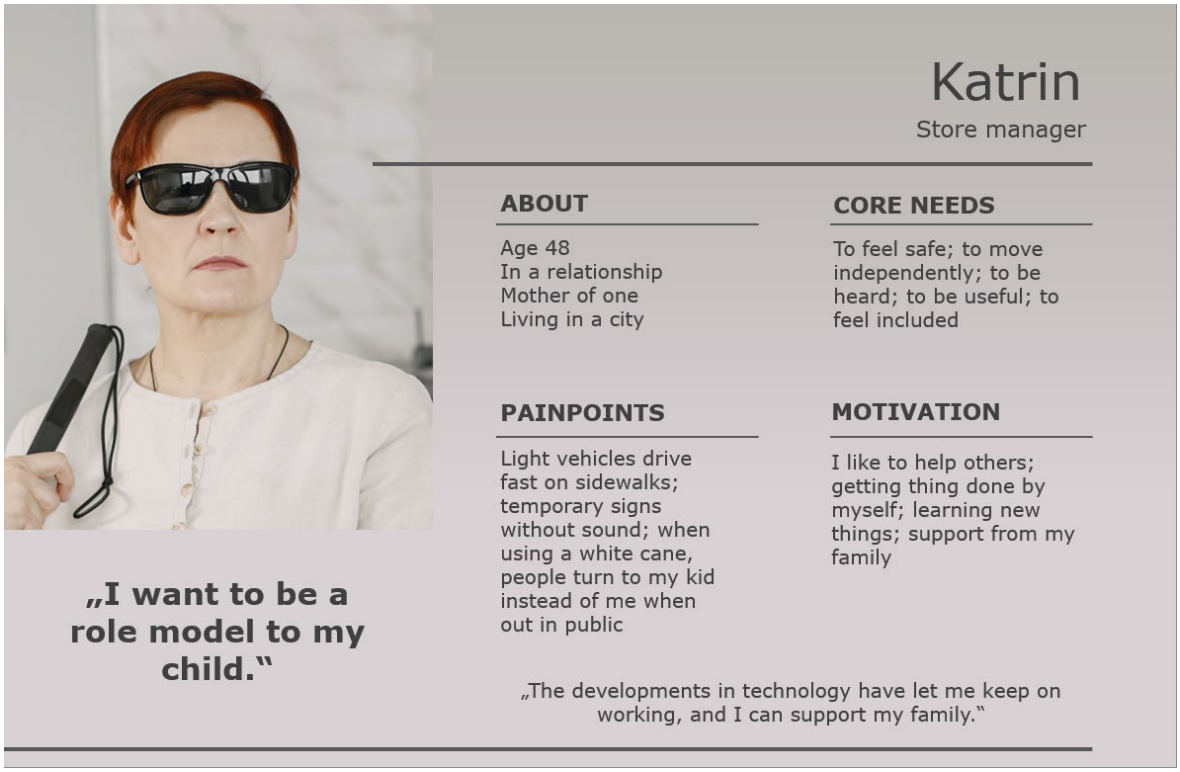

Figure 7 Persona "Katrin" made by the author.

6.1 Design Brief

Depending on person's degree of education, social position, way of life, and age at which they lost their vision, visually impaired people have a variety of backgrounds. There are variations in the experiences among the target group because each person is affected differently. For people who have lost their sight, society has offered aid. The assistance offered includes devices and services that should aid and teach them to adapt to the new environment through rehabilitation facilities and social benefits that encourage people to remain active. Regardless of the aid and rehabilitation offered to people with visual impairment, the obstacles remain, be it remote locations from the services offered, accessibility to the aids, or inability to use technological solutions.

The discovery and definition phase concludes with the design briefing, which outlines the objectives and anticipated outcomes for the following stage of development. Stating what the solution should and should not accomplish provides a foundation and scope for future concept development. The conducted interviews and observation have shown that the biggest challenge that is considerable base for activities is fright of getting insured and losing the sense of direction. The fear has shoved visually impaired people into closed room, where they feel comfortable and safe.

People without vision who have lost their sight in their formative years or whose vision loss has been gradual and whose loss of sight has occurred later in life share the difficulties of daily living. Vision loss has been related to loneliness, social isolation, worry, anxiety, and fear, as well as impacting one's mental health. While older people have established strong coping and management skills, younger people have a five-fold higher risk of major anxiety, which can lead to depression. People who lose their vision later in life have less risk of developing severe depression, but the risk is not lost (Lundeen, et al., 2021).

To increase blind and visually impaired well-being the intention is to cover the one of the basic human rights, which is freedom of movement. Even though, the aim of the movement is from getting point A to point B, the purpose of doing it is to pass the journey as fast as possible, as smoothly as possible, and with the least effort as possible. Moving around is comprehensive and constant activity, which departure and arrival locations are in general indoors of the buildings, nevertheless the journey contains variety of outdoor elements to pass (Falkenberg, et al., 2012).

The following table (Table 1) is a summary of the design research, which presents the primary deficits that visually impaired people experience on a daily basis. In addition, the author has proposed achievable goals to rely on in the different design processes to solve them. Furthermore, potential approaches are outlined at the bottom to consider proposals in the design solution.

Table 1 Challenges for the people of visual impairment by author

Current pain points	
Fear of moving about on their own and getting hurt/wounded or lost.	Limited working hours for social workers and disabled transportation.
Being connected requires learning new tools and techniques.	The information about obstacles located and appearing on the street are not immediately available.
Achievable goals	
Facilitating independent movement while receiving assistance from a secure environment.	Adaptable service that considers specific needs.
Clear and understandable paths without obstacles.	Quick access to information on the current situation is available with ease.
Approach	
Beacons that use lidar technology receiving and spreading information.	Assistive solution available for all the time if needed.
Increasing awareness by including people in community activities.	Community support by noticing and sharing obstacles on the pathways.

Based on the previous, the design concept should rely on three primary pillars to support:

- Increasing physical well-being by getting out and moving around
- Social interaction
- Reducing anxiety by providing information about the surrounding

The design proposal must provide solutions for visually impaired people to move around independently and get instant information about their surroundings through other senses. In addition, the solution should nourish a more active lifestyle and improve overall physical and emotional well-being.

Instant information about the surroundings should reduce anxiety and fear of moving around. In addition, locating the surrounding makes the user more confident to make an additional decision, learn about the community, and be more social. Being more active and social will help to increase awareness in the communities of the challenges the visually impaired face and improve accessibility with community support.

Social interactions should lead to social inclusion, creating opportunities for visually impaired individuals to participate in social activities, events, and sports. In addition, advocacy for the different abilities of visually impaired people promotes equality.

6.2 Design challenges

In order to achieve the goal, the author took into account factors that impact the movement of visually impaired individuals. Understanding how people perceive information about their surroundings through other senses and how it affects their decision-making was deemed particularly crucial. Additionally, the available technologies and opportunities for improvement were examined. Another important consideration was outdoor mobility and its underlying reasons, as well as the fear that may hinder individuals from taking action.

Senses

People receive information about their surroundings through five senses: vision, hearing, touching, smelling, and tasting (Figure 8). Humans rely heavily on their vision, hearing, and sense of touch to learn about their surroundings. Vision allows people to perceive shape, size, colour, motion, and depth. Hearing helps individuals locate sound sources and assess volume and pitch. Touch provides information about surface texture, temperature, elasticity, and vibration. Sensory design aims to exclude vision and instead focus on utilizing hearing, touch, smell, and taste to convey information. To enhance the accessibility and usability of products, environments, and media, it is crucial to consider designing for bodily experiences. (Lipps & Lupton, 2018)

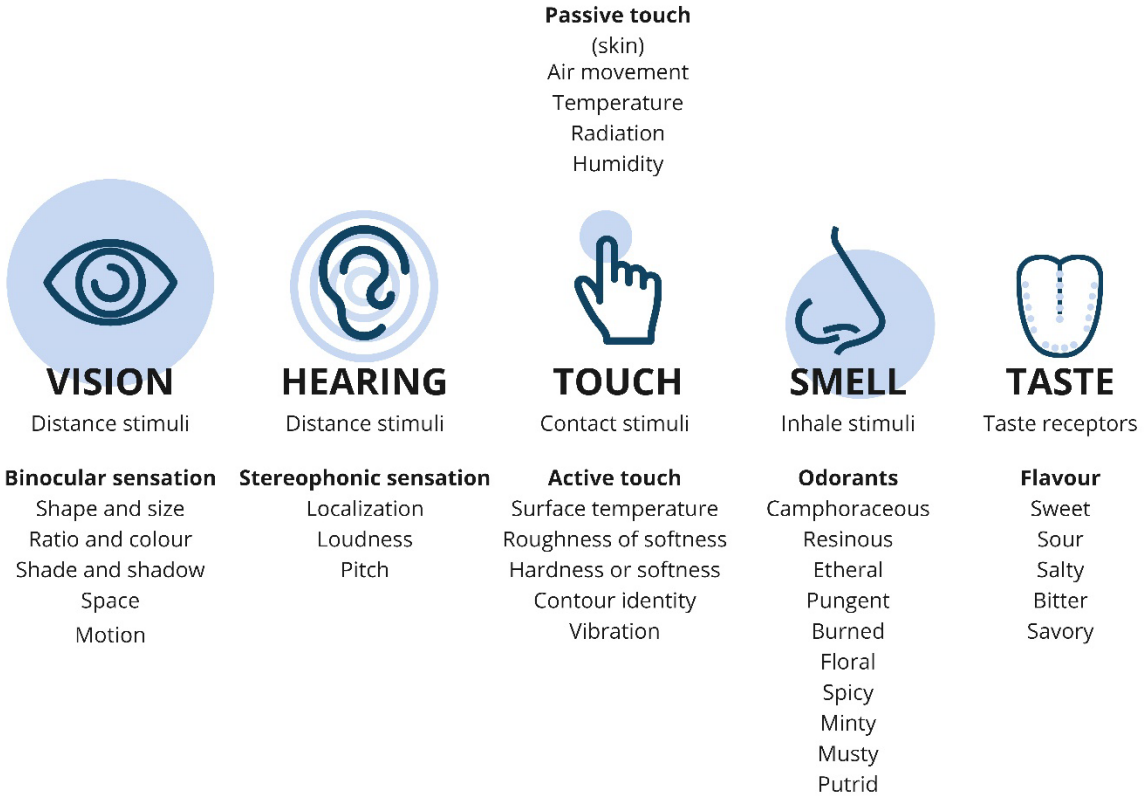

Figure 8 Senses made by the author, based on (Malnar & Vodvarka, 2004)

When the sighted person looks around, the seen elements the brain recognizes as familiar tell us what information is received through the eyes. Removing the eyesight, how the brain receives the information to interpret the experience? The goal is to find a solution, how the brain can narrate what it experiences and create a connection with the surroundings. By giving a chance to the description, the author also hopes through the solution to provide a visually impaired persons with the opportunity to evaluate their surroundings through hearing where they are at the moment and to find and connect points on their journey.

Technology

With the rapid development of technology, people are benefiting from more comfortable solutions for everyday living. These quick changes are impacting people's beliefs, behaviours, and ideals, as they look to technology for additions and improvements. One example is the smartphone, which has become an essential aid for the visually impaired. The application that is presented in smartphones can provide information about navigation, and with the help of the phone's camera, users can receive information about the surrounding and read texts. The most practical application has become "Be My Eyes" by connecting people who need sight to the volunteers through live video worldwide. Volunteers inform the visually impaired about the product, for example, by distinguishing colours, providing help with reading dates and instructions, and even helping to navigate. (Be My Eyes, 2021) It is worth noting that individuals who are proficient in technology in their daily lives are likely to adapt easily to new advancements. However, this advantage only applies to those who are well-versed in using smartphones, which unfortunately creates a barrier for the elderly generation who may not be as familiar with these devices and may struggle to access crucial information. With the current provided solutions, it seems that the improvement is made on devices that are expected to everyone already using – like smartphone, and assistive solutions are made as application that will be later compatible with phone to use it.

Outdoor mobility

The visually impaired and blind people consider opportunities for independent mobility challenging due to barriers occurring on public streets, like attributes of traffic participation, infrastructure characteristics, prejudices by other people, and additional health problems. Hence, performing daily necessary activities and spending time outside the home is difficult. Moreover, going out alone increases fear and anxiety, which in turn makes the visually impaired and blind more passive and alienates them from physical activities and socializing, reducing their quality of life.

The balance system of people is connected to their vision system, and if the vision is obstructed, it can affect the ability to balance the body effectively. The vestibular system is responsible for maintaining posture and balance, and the sensory system, including vision, assists it. However, the vestibular is ageing when people age, and it causes reduced functionality of several types of sensitivity. Hence, the system is disturbed when one of the senses does not work correctly. Therefore, losing sight can cause a sensory disturbance, which may cause falling, staggering when walking, also confusion, and disorientation. (National Institute on Deafness and Other Communication Disorders,

2017). It is imperative to guarantee the safety of individuals with vision loss by minimizing any potentially dangerous situation people can get into by not noticing the barrier that could lead to injury. Despite the visual impairment, people still desire the ability to move about, engage in social activities, and feel secure.

According to Kevin Lynch's theory of visual perception, a journey comprises two essential elements: orientation and mobility in physical space. The journey is composed of four critical components. The first component is to establish person's location through orientation. The second component involves making informed decisions about the route to take. The third component is to mentally map the surroundings to facilitate the next steps. The final component is to reach the intended destination. (Lynch, 1960)

Even though Lynch's theory focuses on visual perception, the experience for visually impaired individuals remains unchanged: locating position, collecting, and memorizing information from the surrounding, and arriving destination. The difference is that the vision goes far, and the decisions are made in time.

"*Very few people use the white cane when walking outside, and even fewer use the guide dog"* from the interview with J. Jerva.

State of fear

The brain reacts in a helpful manner when feeling afraid or anxious. Although these emotions can be uncomfortable, they serve as warning signals when people may face danger or a challenging situation, and work like instincts. Therefore, fear should not be perceived as a negative emotion as it is crucial in keeping people safe and alive. According to the Cambridge Dictionary, fear is defined as "an unpleasant emotion or thought that you have when you are frightened or worried by something dangerous, painful, or bad that is happening or might happen".

Fear of failure, disappointing others, and losing admiration can hinder people's progress. Primal fears such as rejection, exclusion, and change can impede the development (Zucker & Gotian, 2022). Many people are held back by their irrational fears, which result in unproductive behaviour and hinder their ability to move forward. This pattern of behaviour can make it challenging to accept life changes that are beyond their control. In addition, a lack of knowledge and understanding often contribute to these fears, causing individuals to give up before even starting.

6.3 Design approach testing

Considering the challenges of the previous chapter, the author executed a test with a visually impaired person who have lost sight later in life. Throughout the testing process, the author investigated ways to offer support, provide information about the environment, and help individuals increase their confidence in outdoor mobility. During testing, the author utilized sense base of voice descriptions to convey information about the surroundings. As hearing is a second sense after sight, providing instant information for humans, using voice descriptions was deemed relevant for the testing process. The following table (Table 2) describes the author's tasks during the walk and how actions affected the guided person.

The person was directed to go to the park near home, where the participant has not been for years now. Providing timely directions and a description of the surrounding, the author sought confirmation of whether the approach would offer additional support to the participator by reducing the fear of moving away from the familiar path. In addition, would the approach offer encouragement to undertake the journey alone?

Table 2 Concept testing tasks

Task	***Action***	***Changes in attitude***
Create awareness about the surrounding	Providing voice description about the surrounding and approaching objects, the author tried to use calm and soothing voice.	The person seemed more confident and asked more about the surrounding, like "Is the bench still there"; "What is written on the notice board?" – increased the curiosity about the surrounding.
Reducing fear	Describing the ground when something appeared on the path, describing bigger stones, holes, sticks, or the surface that was going to change	The pace increased while the person was confident where the foot had landed and was not concerned about the step if it was going to land on something unknown

Support to keep a balance	Letting the person find a comfortable way to lean on when walking	The person moved a half step behind the author and held onto a left shoulder and down elbow. The pace increased, and the person did not stumble after finding a correct rhythm with the attendant
Guiding	Guiding the person throughout the path and providing information about the direction of when to turn and where to turn	The person seemed more relaxed and started a conversation about past activities, and the mood elevated.

Guided person’s feedback:

“The attendant shared a lot of information about the surroundings, which was mostly helpful. Although, I wasn't particularly interested in detail like the direction of the stream's flow, I appreciated learning about seating options and how I was informed about approaching cars or people from a distance. The attendant's calm voice helped At first, I was hesitant and anxious about where to place my feet, but with each stride, I learned to rely on guidance and relax. The guide skilfully led me past the obstacles and instructed me on where to step near the curb. Gradually, I somehow developed confidence in my ability, and I felt like I was able to navigate independently. Overall, the experience was highly advantageous and enlightening.

As I walked with the attendant's assistance, I felt increasingly confident and secure. My usual struggles with stumbling and poor posture were alleviated by having something to lean on, which enabled me to walk at a faster pace. The attendant's description of my surroundings provided me with a new perspective on the environment that I remembered, but now saw in a different light. It was refreshing to leave the room and walk along a different path. While I would like to be more active and explore the area, I am hesitant to use a cane or any other aids that might draw attention to my condition. I prefer to keep it low-key, not because I don't need assistance, but because I don't want to use any signifiers that might make others aware of my condition.”

6.4 Conclusion

In the realm of design, it is imperative to take into account sensory factors, that helps people to get information about the surrounding. Hearing is the second swiftest means of receiving information after sight, which increases its importance when designing for the visually impaired. Moreover, for those with visual impairments, touch is vital for identifying nearby objects, physical obstacles, temperature, and other properties, whether in an active or passive capacity. Hence, it is essential to create solutions that can verbally describe the environment and assist users on their journey. In addition, verbal descriptions should be more considerate of how to express what is seen and how much is reasonable to describe.

To provide a more vivid description, the user can integrate into the surrounding through the memory flashes remaining from the past. To assist the visually impaired during their travels, it's important to consider not only their lack of awareness of their surroundings but also the potential for physical support and navigation assistance. Providing information about the surroundings is not enough; the solutions should also offer physical support. People with visual impairments may struggle with balance and need secure movement, especially when navigating uneven surfaces.

7 DESIGN CONCEPT

The concept proposal encourages people who have lost their sight later in life to continue an active lifestyle to maintain their emotional and physical health. Physical activity is highly valued and included in everyday life as part of the active life philosophy. The conceptual solution aims to increase people's well-being through physical activity, socialization, and reunification with the community. The feeling of belonging to a community is definitely a significant advantage for the elderly, who may need more help with day-to-day activities.

An attainable goal would be to enable people to wander around independently. Therefore, it is important to think about the positioning of the location. The existing system provides information about the user's location at a certain point in real time. In addition, it offers a way to get from point A to point B, taking into account and proposing a shorter route in most cases. By changing the positioning approach, not only by determining the user's location but also by determining the user's surroundings, thereby increasing the user's awareness of the surroundings, reducing possibilities of getting into difficult situations and increasing self-confidence in self-discovery.

Figure 9 Design concept with voice assistant made by the author.

The solution offer consists of two main elements: a device that the user can rely on and a technological platform that helps assess threats in the external environment and inform about them. The device is connected to a database that collects information, processes it, and transmits it to the user.

The device is intended for independent use by someone with visual impairment who feels unsafe walking around without knowing what is happening around them. Managing the device is easy for the user and does not require special skills to prepare the instrument for use and move around. Regardless of age, people can reduce the fear and anxiety of getting injured while walking around, and in addition, advocate an active lifestyle. The device's purpose is not to control a person but to provide enough adequate information about the surroundings so that every decision can be considered, and the user can avoid unsuitable situations.

7.1 Concept structure

The purpose of the solution concept is to gather, process and share essential information about the person's location and surroundings. While the vision for processing information is sometimes challenging, receiving information is visually solved through the camera that collects information about the surroundings. The device is connected to an AI database; the assessed information is presented to the visually impaired through description translation.

The extensive system is concentrated in a device. The user can exploit as an electronic companion, providing support to people, both in the form of introducing the surroundings and offering support to those who may get into tricky situations due to imbalance. For example, when moving around the lack of a sidewalk, vehicles that do not move at the speed of a pedestrian, noise, wet and slippery roads, various obstacles on the road, holes or street signs, or garden decorations set at the wrong height can cause significant danger.

The solution has taken into account the publicly available information about roads, and the basis of all the maps are the following special levels in city traffic:

Table 3 Definitions (Eesti Pimedate Liit, 2016)

Orientation	finding a route and arriving to desired location, avoiding hazardous obstacles.
Traffic	purposeful movement on a public road.
Light traffic	Traffic on foot, bicycle, roller skates, wheelchair, baby stroller.
Light traffic road	Road meant for light traffic.
Pedestrian road	A section of the road designated for pedestrians and mobility scooters is separated from the carriageway or cycling path by a curb or another feature, which may be indicated by pavement markings or the proper traffic signs.
Cycling road	A part of the road that is structurally separated or located separately from the carriageway intended for driving a bicycle, balance scooter, mini scooter or moped, or a separate road marked with an appropriate traffic sign.
Green area	An area in the city or other settlement covered with grass, flowers, trees, and bushes.
Embossed surface	Rising above the surface, protruding.
Separation strip	A strip of land with a standard width around certain facilities.

These are standard parts of the traffic space that each participant out in a public space must consider (Table 3). The so-called basis of the device is the road network, where the basic information of the traffic surfaces has been entered, which will gradually be supplemented during use.

Technological platform

When it comes to creating and managing digital products, a technological platform is essential. With the power of AI (Artificial Intelligence), machine learning, IoT (Internet of Things) and more, these platforms make it easy to communicate, complete tasks, and conduct transactions regardless of location. Specific hardware and software tools for managing data are necessary to get the most out of these platforms. Nevertheless, once the platform is up and running, it amazes how effortlessly access information is provided and the critical tasks are completed quickly and efficiently.

The design proposal offers a comprehensive solution that comprises a data management platform and a robotics platform. The data management platform is a software that efficiently gathers both structured and unstructured data from various internal and external sources. The collected data is then analysed and evaluated, and the results are shared with the source. On the other hand, the robotics platform is designed to help create an intelligent machine that can learn and adapt to users' predetermined commands to assist them.

Simultaneous locating, mapping, and information processing

The data management platform employs cutting-edge light detector and ranging (LIDAR) technology, acting as a bird's-eye camera like in state-of-the-art autonomous cars. This technology accurately and detailly detects 3D objects from above and surface measurements, generating a virtual spatial map of the surrounding. Through virtual spatial room, differences of the surrounding are detected and transferred to used device (Figure 10).

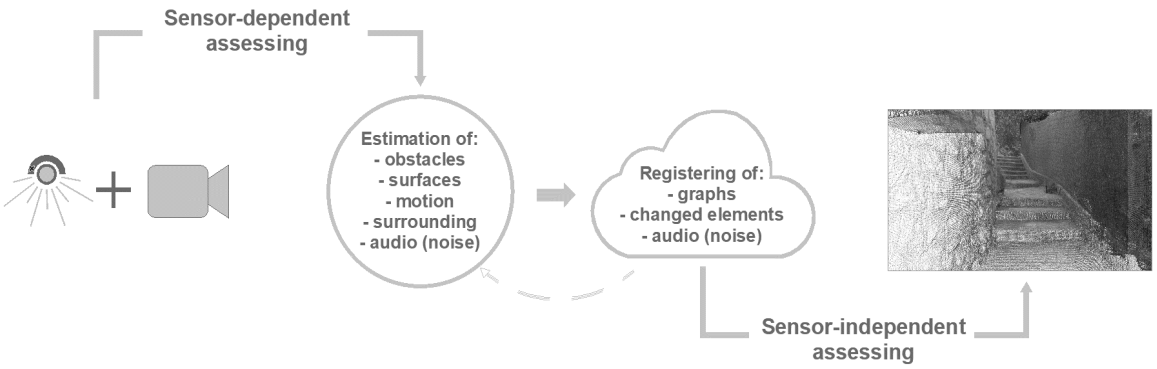

Figure 10 Information gathering, assessing, and transmitting made by the author.

The platform is equipped with a preloaded standard base map founded on publicly available road information, constantly updated with new information gathered during daily walks. The device provides instant updates on walking path conditions, thanks to its camera that identifies various stationary elements such as trees, architecture, or small holes during the mapping process. The updated map of the device solely consists of newly detected information that was previously unmapped. Any undetected data is forwarded to the cloud for assessment. The device's computer determines which initial data is sent to the cloud. Furthermore, the onboard computer can detect the movement of moving objects such as people, animals, and cars and so forth. Internet connectivity is necessary for assessing cloud information. In the absence of the internet, the device can utilize previous data and patterns to function. However, when it comes to encountering new obstacles, the device can only offer fundamental information and cannot provide any comprehensive insights regarding the obstacle.

User notification

Receiving notifications is an essential aspect of using digital products, and they are delivered through Voice AI technology that is integrated into the device (Figure 11). In order to use the device's notifications and virtual assistant, it must be connected to the internet through a smart device with internet access. This will enable it to provide information about the device and its surroundings. The user notifications alert the person in time about the obstacles in the walking way, for example, a walking group of people in front of the user and if there is a possibility of collision. The user will receive a notification that the device is detecting a collision possibility in the form of a group of people, resulting in a slowdown or change in direction. With the user's consent, the device will make the adjustments. Users have the option to choose their preferred notification package, which includes updates on changes to the walking path and its surroundings. They can also request descriptions of the surrounding areas if they so desire. In turn, the minimal package can only describe the direction recommendation. Notifications for users can be disabled, and the smart device can assist users in avoiding obstacles by subtly adjusting their walking direction without needing permission for minor adjustments. For those with visual impairments, there are various devices available, including options to modify the speed of the talk-back feature for more experienced users. It is important to tailor the pace of notifications to suit a wider range of users, as the notifications are not presented at a one-size-fits-all speed. Since people have different preferences, adjusting the pace of the talk-back feature is crucial.

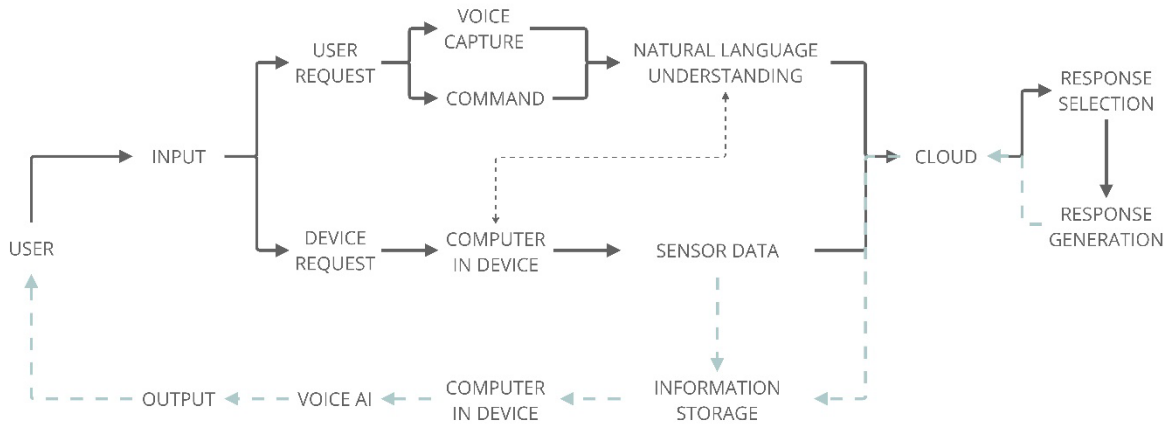

Figure 11 Virtual assistant system made by the author.

User Interface

Considering the user's needs, the equipment does not need a screen or other visual information presenters. Therefore, the system is created for two possible interfaces for voice and touch, creating a bridge between humans and machines (Figure 12). The voice user interface lets the user interact with the device with voice using audio commands and works as a way as a virtual assistant like Siri or Alexa. Before initiating any interaction, it is imperative that the device's operator use the wake-up word to activate the virtual assistant. This approach gets rid of the extensive need for users to become proficient in operating devices by manually pressing controls to execute commands. It is especially beneficial for people who struggle with comprehending technology.

However, targeting a more user groups additional interface would be through touch. Therefore, people who do not use voice for commands can insert commands through the controllers by tapping, crossing, and pressing their fingers. This approach needs learning to understand the different touches mean, using the pads more as a mixture of Morse code and a smartphone screen.

The information from the device is shared by audio based on short notifications to descriptive translation. To ensure privacy, it is advisable to use noise-cancelling headphones that enable the user to regulate the sounds they hear. This feature is especially useful in crowded areas where background noise can interfere with clear communication. However, for those who prefer not to use headphones, the device's voice output is integrated into the handle, which provides the closest connection to the user; however, the shared information flow by the voice assistant in high-traffic areas can be disrupted and unclear.

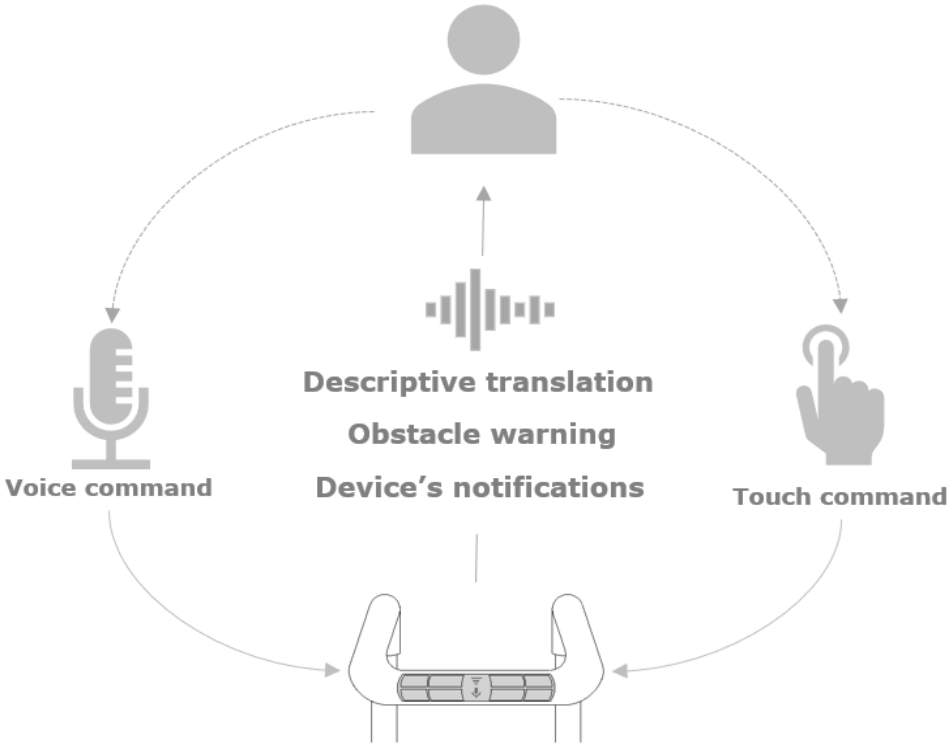

Figure 12 Voice interface, made by the author.

Through voice or touch commands, the device can be customized to how wide the area is to monitor, increase or decrease the speed and volume of the device's speech or how detailed a description the user wants.

Concept for a physical device

A personal assistive device with a description assistant or shortly ADDA is a system that aids its users on their journey. This device is equipped with a computer that enables it to gather and share information, provide voice assistance, and function as a robotics platform with a self-balancing solution. It is designed to assist individuals who have visual impairments by guiding them and describing the information in their surroundings. By using the device users can explore their surroundings independently without fear of getting lost, which can help reduce anxiety levels.

ADDA is activated as soon as the user grabs the handle. The device adapts to the user's height and finds the most comfortable height for usage. Equipped with a GPS, LIDAR system, bird-eye camera, and a talk-back solution, ADDA provides users with information in easily understood sentences. Users can interact with ADDA through touch and voice commands according to their preferences.

The device can adjust its position and enhance its system information with each use. Its physical form (Figure 13) is designed with the Ballbot solution in mind, featuring a omnidirectional wheel that can rotate 360° and move in any direction on the ground. In addition, the device balances itself by reducing fear of falling when unbalance state could occur. The handle can be customized by bending it or keeping it straight up, allowing the user to adjust the distance between themselves and the device to their liking. The device also features a voice and touch command board integrated into the handle for instant connectivity. For a more discreet connection, users can connect headphones to the device. The device is designed to run on battery power and comes equipped with a docking station for convenient recharging.

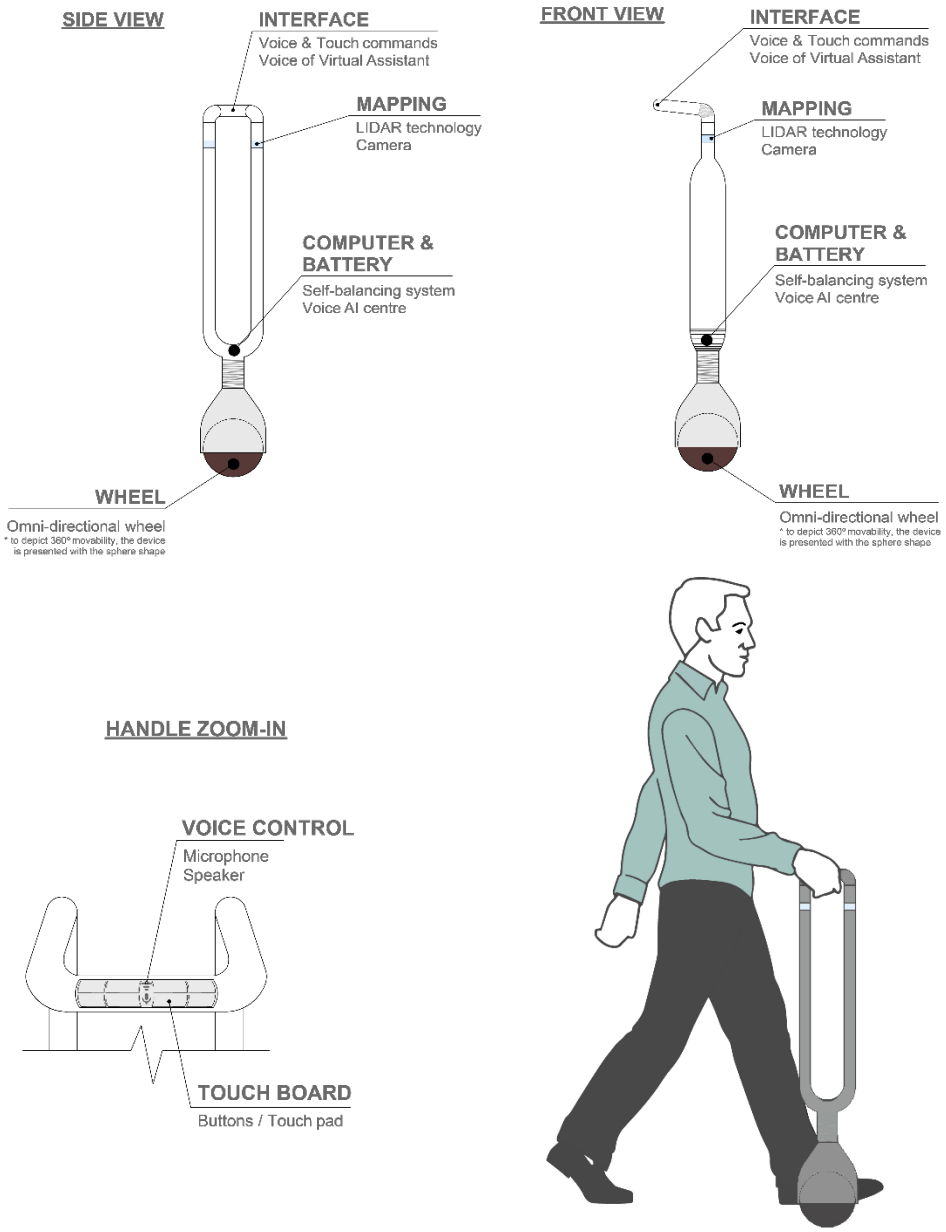

Figure 13 Solution proposal of ADDA, made by the author.

The device in use

1. **Set-up and personalise – starting the journey:**
    a) To activate the device, grab from the handle,
    b) removing the device from the bay,
    c) the device makes an adjustment to prepare for the user‘s height,
    d) placing on headphones (optional),
    e) connecting device with a smartphone, providing AI guidance, by tapping on the handle,
    f) taking the device outside,
    g) inserting command like location, pace of the speech, or level of description to the device by voice or touch.

2. **On the road:**
    a) holding a handle,
    b) the device keeps a half-step distance from the user and moves in front,
    c) device adjusting to the user’s pace, body balance, and the ground surface,
    d) user activating description by sliding on the handle or tapping on the headphone,
    e) by determining the amount of guidance, the user answers the audio AI,
    f) device describing the surrounding trough voice,
    g) the device directs the user away from obstacles by letting them know which way to go; if the voice is disabled, the device lightly pulls the user to the safer path.

3. **Standby when not in use:**
    a) After 15-second the device will lower itself – goes into battery-saving mode,
    b) device will go into stand mode after 30 second when the user’s hand is removed from the handle.

Concept system

An electronic device is fully capable of executing a multitude of tasks, such as receiving input, storing, retrieving, processing, and outputting data. The proposed solution combines systems that instantly provide information about changes in the path. Making the environment easier to understand with systems offering more support for the movement reduces fear of not knowing about the surrounding. Provided solution increases the likelihood of being more active and exploring unfamiliar areas and can lead to unexpected meetings with other people. Furthermore, the comprehensive system provides the user with important physical and location-based support. The accompanying figure illustrates the system's concept, which includes an overview of the individual and their location within the system (Figure 14).

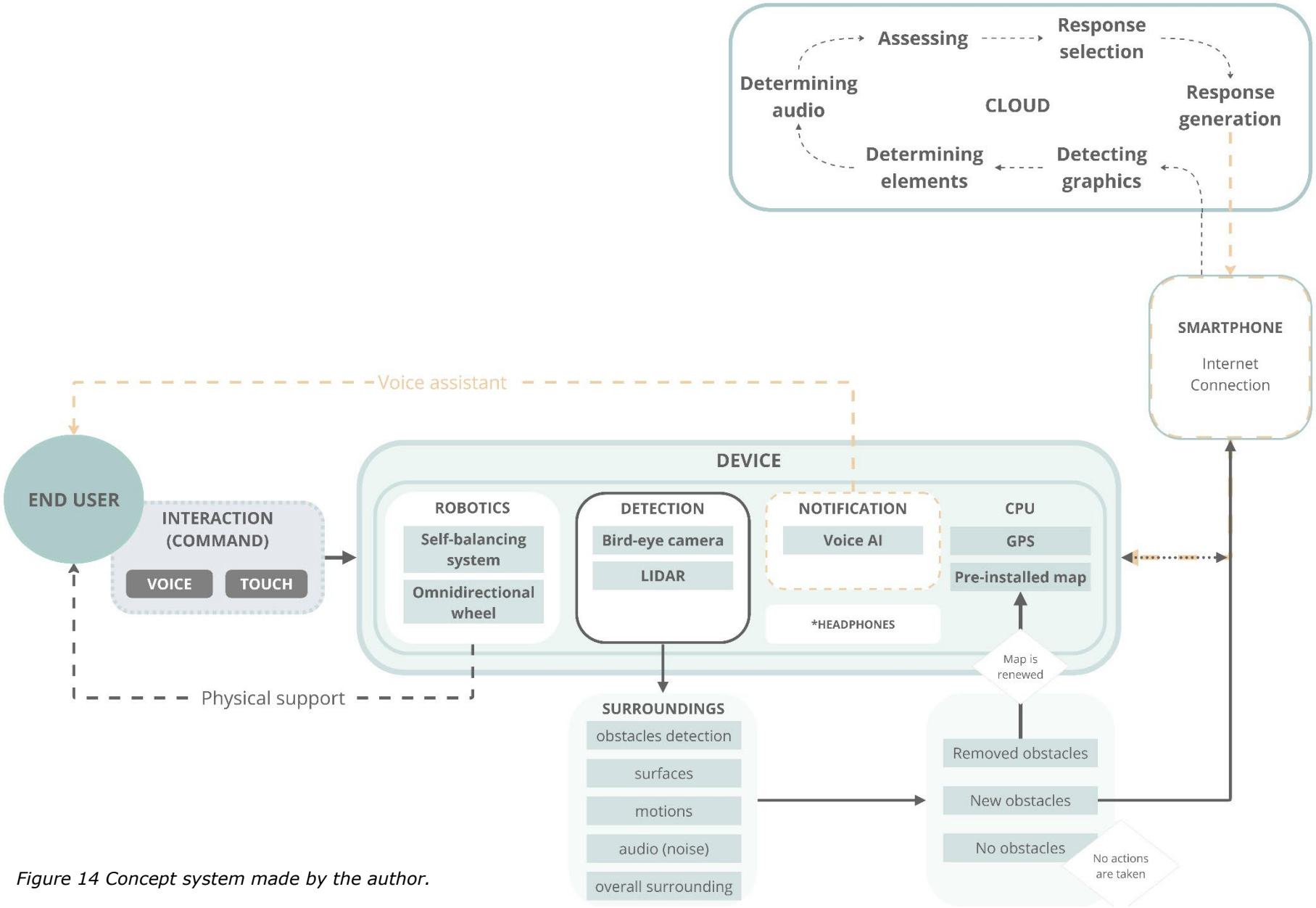

Figure 14 Concept system made by the author.

7.2 User Experience

The proposed design concept aims to create a technological platform that caters to the needs of visually impaired individuals. It helps them confidently navigate their paths and collect information about their surroundings. With the ability to upgrade and save routes, including habitual and new walking paths, users can access a more accessible street map, eliminating the fear of getting lost or encountering a lack of information that could hinder their decision-making during their journey. Equipped with Audio AI, the device also provides company for those who may feel lonely, serving as a comforting voice to interact with. The commands and descriptions are given through voice, simplifying the learning curve of using electronic devices. The audio is customizable. Therefore, the user can change the radius of the monitored area, the severity of the description, and the pace of the deliverable. While some prefer a slower pace to understand the words, more experienced ones can turn up the speed and listen at a comfortable pace. As the device is equipped with possibilities to change the frequency and pace of the Voice AI, the device never stops supporting the user during the walks. Even if the voice is silenced, the device softly directs the person away from hazardous obstacles, which may cause the user inconvenience. To illustrate the concept of user experience, the author has employed a case scenario that highlights the immense advantages that can be gained by individuals who are blind or visually impaired.

Use case scenario

Joseph's daughter has recently suffered an injury that has affected her ability to walk properly. She requires rest for approximately a week and is advised to avoid walking. Despite Joseph feeling more at ease at his own home, he decides to accompany his daughter's family during this period. He enjoys spending time with his daughter and grandchild and wishes to be of assistance. His daughter has made transportation arrangements to ensure Joseph's safe arrival from door to door. Although the surroundings are unfamiliar to him, and he feels a bit apprehensive during his visit, Joseph has brought along his new mobility device to assist him.

The weather is beautiful, and the grandchild is eager to play at the nearby playground.
Unfortunately, the mother is unable to walk. However, Joseph has kindly offered to accompany the child to the playground so they can enjoy their time together.

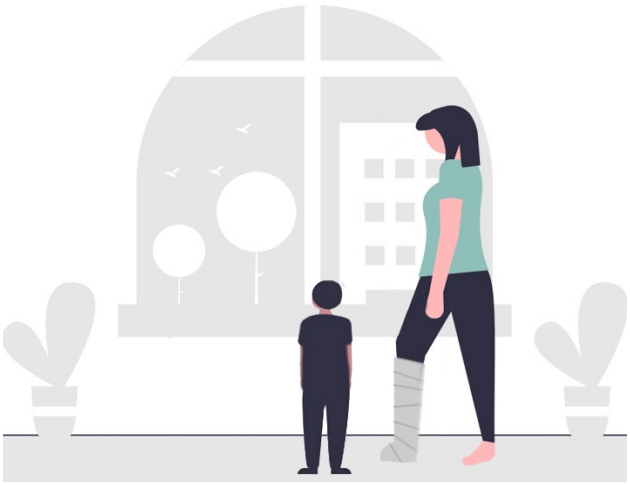

Figure 15 Use case scenario, made by the author

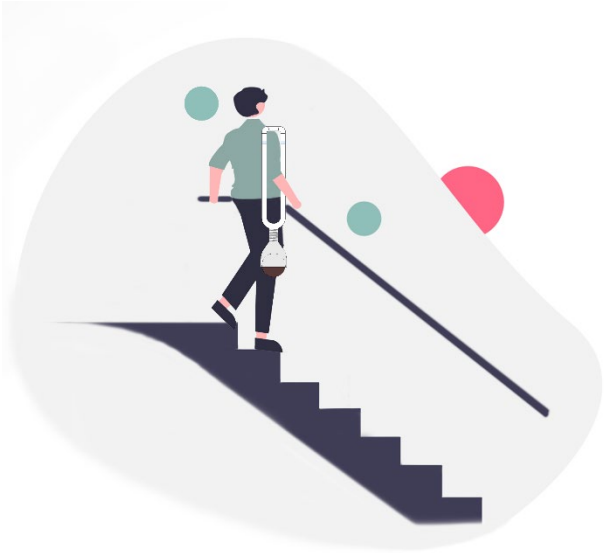

Figure 16 User carries the device, made by the author

Joseph needs to use stairs to get outside. He easily places the device on his shoulder, walks down the stairs and sets it down on the ground. The device automatically starts and balances itself. Joseph connects the device to his phone by tapping the left upper button twice, enabling voice commands and guidance. Now, the device is connected to the internet and ready for use.

Joseph utilized voice commands to inquire about the location of the nearest park. The device reiterated the request and informed Joseph that the park is located 350 meters at the end of the street and that it will provide directions to lead him there. Joseph grabs the handle on the device and lets the device guide him.

Figure 17 Interaction, made by the author.

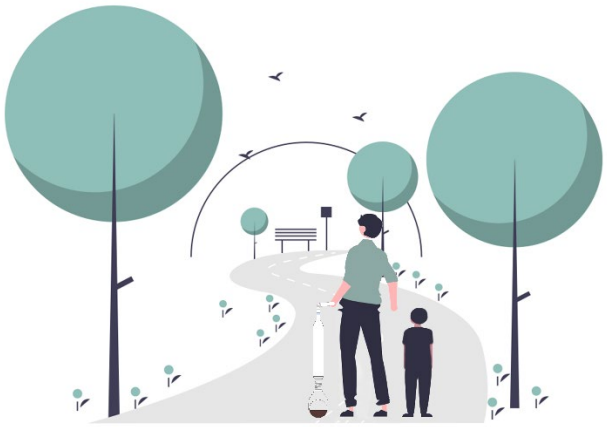

Figure 18 On the streets, made by the author.

Joseph adjusts his device to limit the incoming information by tapping on the combination on tabs to hear his grandchild's voice as they walk safely towards the park. As he holds the child's hand, their movements are unpredictable, but the device quickly adapts, syncing with Joseph's pace and guiding him without overwhelming him with extra details about the surroundings.

As Joseph approached the park, he requested his device to locate the nearest bench. The device listed the available bench locations, and Joseph expressed his preference to sit close to the playground. He confirmed his selection by instructing the device to choose the bench closest to the playground, and it directed him there. Joseph is able to take a break and enjoy the weather while his grandchild playing.

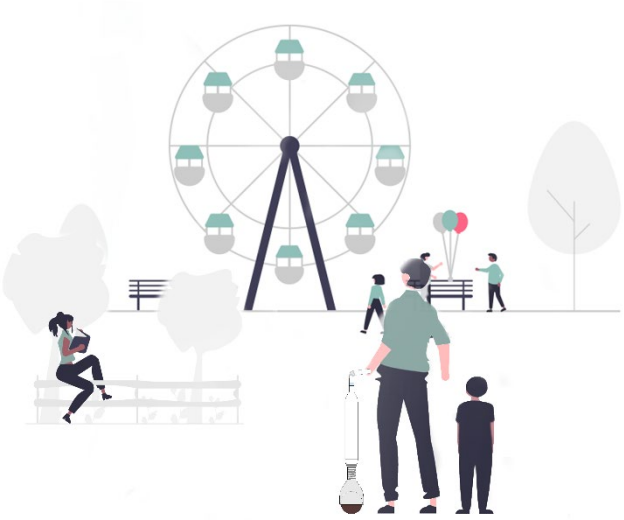

Figure 19 Arriving at the park, made by the author.

Figure 20 At the park, made by the author.

While sitting, he increases the level of the description to learn more about the surrounding and get more acquaint with the neighbourhood. He can relax listening the device describing him more accurate details about the surrounding of the park attributes, people in the park, and many more.

8 CONCLUSION

From the beginning, the thesis focused on exploring why individuals with visual impairments tend to remain indoors and the obstacles they encounter regarding autonomy. Next, the paper examines the obstacles that impede individuals from fully participating in society, including fear, stigma, and societal barriers. Finally, the proposed design aims to effect positive societal changes by empowering visually impaired individuals to be more engaged and assisted when venturing outdoors, allowing them to be more social and open to communication.

The proposed solution offers value by effectively combining data management and robotics to provide optimal assistance for the individuals who are blind or visually impaired. Specifically, the design aims to help those who have lost their sight later in life by enhancing navigational assurance and alleviating fear and anxiety. The system is developed with the needs of visually impaired individuals in mind, offering a range of solutions, including easy-to-understand information flow and self-balancing feature that can assist individuals who struggle with balance. The device's main purpose is to monitor the surroundings through visuals to gather information without overwhelming the user with too much data. The information is then transmitted to the user through a talk-back virtual assistant. Depending on the user's preference, the assistant can provide information through either a loudspeaker or headphones.

However, it is yet to be tested for its effectiveness. During the concept testing phase, the author was present, which may have influenced the collected data as the individual may have felt more secure with someone guiding them. It remains to be seen if users can rely on the device and the information it provides when navigating independently.

The goal of this thesis is to improve the physical and emotional well-being of individuals by providing them with a sense of security when leaving their homes. The solution focuses on enhancing the lives of those with visual impairments and promoting independence when navigating unfamiliar environments. However, it can also benefit other groups, such as the elderly, those with temporary vision loss, or individuals with injuries who require additional support during recovery. Furthermore, the device is designed to empower users by enabling them to acquire the necessary skills to use the proposed solution independently, without the need for specialist assistance.

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In this chapter, I would like to express my heartfelt appreciation to everyone who has shared their personal experiences and knowledge while I was preparing this thesis. I am grateful for all the valuable insights that I received, whether it's a short comment on blogs or videos, or a lengthy interview. I want to give a special shoutout to the concept testing participants for their contributions, which helped me understand how to provide assistance on unfamiliar paths and learn more about guiding and approaching people with vision impairments. I also appreciate the availability and willingness of my interviewees to answer my questions and describe their motivations and challenges in society.

My educational journey has been enriched by the incredible people I have met along the way. I have learned valuable insights from my classmates, who have taught me the beauty of simplicity. I am deeply grateful for the incredible ride and would like to express my heartfelt appreciation to Martin, Ruth, Janno, and Kätlin, who have played a pivotal role in guiding us through our courses and expanding our horizons.

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LIST OF FIGURES

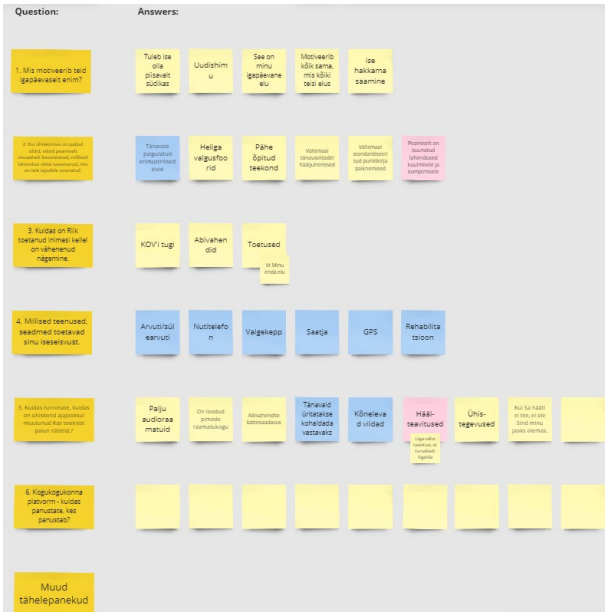
The author may include images and illustrations from sources such as pexels.com, pngegg.com, shape.so, undraw.co and Microsoft 365 Stock images in the work, but only for non-commercial purposes.

LIST OF TABLES

APPENDICES

Appendix 1 Interviews

Interview with J. Rosin



Interview with J. Jerva

Interview with P. Sissas

Interview with J. Riimets