BSc Thesis Creative Technology

COMMUNITY-BASED DESIGN TO HELP OLDER ADULTS TO INCREASE THEIR PHYSICAL ACTIVITY

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JULY 2022

UNIVERSITY OF TWENTE.

ACKNOWLEDGEMENTS

Firstly, I would like to express my special thanks of gratitude to my supervisor Dr Femke Nijboer for providing me with the opportunity to work on this graduation project and for having faith in my abilities to finish it successfully. Her expertise and support played a crucial role in helping me complete this project and develop as a designer and researcher. Secondly, I would also like to thank my critical observer Lara Siering for her constant input and regular feedback moments. She was an inexhaustible source of ideas and an incredible critic who always knew how to direct my thoughts and show me how to turn them into reality. This project would not be possible without them.

Lastly, I would like to thank all the older adults who actively or passively participated in this research. Their experience and insights were the most valuable for this project. Through our interactions, I was able to not only complete the project but also gain a greater understanding of the world around me and because of that become a better designer.

ABSTRACT

Even though it is anticipated that the number of older adults will double over the next 30 years, not much is being done to protect their health and well-being as they age. The younger generations and among them, designers of new technologies, frequently overlook them and dismiss them as unimportant. According to research in the field of older adults' health and well-being, older person's social connections and interactions—rather than their socioeconomic standing, gender, or race—are the strongest predictors of their health. Furthermore, it has been established that a person's level of physical activity is strongly influenced by their social environment. The goal of this study is to develop a system that motivates older adults to increase their physical activity through socialization.

The process used for this purpose is based on two design methods—the Double Diamond model and the Creative Technology design process. In order to get first-hand information about the target demographic of Serbian older adults, I closely collaborated with older adults themselves through observations, interviews, and brainstorming sessions. The research took place in suburban neighbourhoods of Belgrade, the capital of Serbia. Five older adults were actively involved in this study, while the number of older people observed sums up to approximately 40 individuals. This resulted in the formulation of user and developer requirements that were the base for product development. The reoccurring topics that the older adults emphasized as the most important were related to ease of use, unobtrusiveness and getting information about their friends and other people of their age. Based on this data, a system consisting of a network of 24 benches was created in a neighbourhood in Belgrade. The system informs those sitting on a bench where other people are and encourages them to move to another bench. Additionally, an application was designed to provide extra features, including the ability to connect to other users, see where they are in the area, and compete with them to be the most physically active, as well as the ability to save data and track user's progress.

The prototype built was tested with five older adults through a round of observations, interviews and usability testing. The evaluation revealed that the participants were positive about the system. The prototype was experienced as straightforward, easy to use and motivating by the participants. There were no significant criticisms made by the participants, except the suggestions of possible additions to the features and product overall. A prototype received an excellent System Usability Scale score of 84,4. Therefore, there are strong reasons to believe that the smart bench system could have a positive impact on the social and physical activities of older adults. However, the homogeneity of the context in which the study

took place needs to be taken into account in future research work, since it may have affected the results' applicability to different contexts.

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1. INTRODUCTION

Given the rapidly increasing number of older adults in the world and our ageing population (Tinker, 2002), it is no secret that the health and well-being of society's older members are becoming increasingly important. According to the United Nations (2020), the world's population of individuals aged 65 years and up is 727 million. In 2050, the number of older adults is expected to increase to 1.5 billion. In Serbia, the number of citizens over 65 drastically increased in the last ten years. In 2011 older adults accounted for around 17,3% of the population, while in 2021 it has risen to little more than 21% (*Procene Stanovništva | Republički Zavod Za Statistiku Srbije*, n.d.). Despite this number, older adults in society are often overlooked when it comes to healthy and active lifestyles since younger people have a tendency to believe that older adults are past the point when they can begin or maintain healthy habits. While it is true that older adults may have a few physical limitations, this does not mean that they cannot participate in any activity. It is even necessary for older adults to have a healthy lifestyle in order to keep their independence and live longer lives free of preventable diseases (Gabriel & Bowling, 2004).

Even though it is not impossible, it is also not easy for older adults to start and maintain healthy habits. The majority of them find it extremely difficult to adopt new behaviours, especially in their later years. There are various reasons for this, but the most recognized ones among older adults are related to external social motivators more than to physical limitations (Gouveia et al., 2016). Social relationships are a fundamental part of life since humans are inherently social beings and their relationships shape and influence the way they live and their quality of life (Sayer, 2011). This social connectedness is especially important for older adults since they are more likely to experience loneliness, depression, and other psychological problems due to the nature of their changing social relationships and life circumstances (Alipour et al., 2009; Seyfzadeh et al., 2019). In fact, studies have shown that the existence or absence of social support is a better predictor of health than socioeconomic status, gender, or ethnicity (Tremethick, 1997). This implies that a well-organized and developed support network could be a powerful stimulus when considering behavioural changes. There are several pieces of evidence proving this. According to Major et al. (1990), social support can encourage changes in behaviour by boosting self-efficacy. Furthermore, it may also help people cope with high-stress life situations and relapse is commonly associated with elevated levels of distress (Cohen & McKay, 2020; Dwyer & Cummings, 2001). A well-developed support network may give emotional and esteem support, as well as feedback, knowledge, reinforcement, and physical help, which people going through a change usually need (Bucci et al., 2015). Additionally, making public pledges and having a “buddy” who shares attempted change may

also be effective change strategies, since it transforms a change into a shared experience (Burbank et al., 2000). Several “buddy programs” proved to be effective in keeping the individuals motivated and encouraged to reach their goals (Barlow et al., 2005; Grant, 2008). Regarding older adults, in particular, their social networks frequently consist of a small circle of close relatives and friends, indicating that individuals in their social networks might also be powerful motivators of change (Fiori et al., 2007).

There are many ways in which this issue can be approached. The most popular answer for these sorts of issues is a variety of technologies, which offer a great deal of creative freedom and opportunity. However, the design approach should take into account the older people as the target group and their strengths, weaknesses, and limitations. As a result, the project will utilize technology to the extent that it is deemed appropriate.

1.1 RESEARCH QUESTION

Based on the study conducted as a part of the introduction of the project, the research question was formulated in order to specify the main goal of the research. It covers three main things: technology, community and health and well-being of older adults. The research question is presented below.

RQ: How to design a technology-supported service to build a community and help older adults create and maintain healthy lifestyle habits?

Sub-questions:

1. What is the role of social support in the well-being and health of older adults?

2. What kind of social support has the most impact on older adults?

3. What role does the community play in changing and maintaining habits?

2. BACKGROUND

2.1 SOCIAL EFFECTS ON THE WELL-BEING OF OLDER ADULTS

Having strong positive social connections later in life has many psychological and mental health benefits. According to several studies in this field (Chen & Feeley, 2014; Everard et al., 2000; Kahn et al., 2003), encouraging social interactions have significant effects on reducing loneliness and feelings of isolation among older adults. To illustrate, Kahn et al. (2003) state that people who are socially engaged in their later years are considerably less likely to be diagnosed with depression than those who are not. Seeman (2000) indicates that a positive social influence enhances an individual's self-esteem and sense of belonging and security. Ashida and Heaney (2008) elaborate on this stating that socially active older adults can maintain their independence and remain in community settings much longer than those who are socially isolated. Seeman (2000) adds that relatives, friends and other social connections of older adults are greater motivators to engage in healthy behaviours, encouraging the individuals to start and maintain healthy lifestyle habits. Therefore, there is strong evidence that a healthy social network can help older adults reduce negative feelings while also encouraging positive ones.

In addition to several psychological benefits, maintaining an active social life as an older person has a variety of physical health implications. Kahn et al. (2003) found that older adults, who had meaningful social connections, scored higher overall in terms of physical health when compared to the ones who were deprived of social life. Similarly, Seeman (2000) suggests that social support can be associated with reduced mortality risks in older adults. Particularly, Everard et al. (2000) imply that the individuals who participate in social activities have a slower functional decline, thus they can preserve physical functions for longer. They also add that if friends, family members, or a spouse identify indicators of prospective physical health problems in older adults, early intervention may be possible before a disability occurs, minimizing the likelihood of disability and, eventually, poor physical health overall. Ashida and Heaney (2008) argue that, in the long term, increased neuroendocrine and immunological processes are linked to a positive psychological state of older persons caused by social connections. Seeman (2000) discovers that those who are socially involved have a considerably lower number of instances of cardiovascular illnesses, including coronary heart disease (CHD) and stroke. In brief, a strong social support network can be a significant factor in prolonging older adults' life and hindering preventable physical illnesses.

The feeling of being excluded and socially isolated has several severe consequences on the mental health of older adults. According to various studies (Chen & Feeley, 2014; Everard et al., 2000; Kahn et al., 2003), it has the potential to elicit mental issues or aggravate already existing ones. Specifically, Kahn et al. (2003) argue that one of the most common mental illnesses that appear among older adults, who are deprived of meaningful social connections, is depression. They imply that this is also the most significant one since it leads to poor mental health overall and a lower quality of life. Several other studies reported that the lack of social relationships is negatively associated with the perceived health-related quality of life and subjective well-being among older adults (Ashida & Heaney, 2008; Chen & Feeley, 2014; Everard et al., 2000). Furthermore, Ashida and Heaney (2008) indicate that the increasing levels of cognitive impairment and dementia can be a result of inconsistency and unreliability of social interactions. Seeman (2000) adds that a low level of social connectedness is one of the biggest and more distressing sources of daily stress for older adults. As a result, social isolation is recognized as one of the determining elements impacting older adults' mental health.

The consequences of isolation are also detrimental and harmful to the physical health of older adults. To illustrate, Seeman (2000) reported that the number of physical illnesses is greater among older adults who are socially isolated than those who are socially active and experience consistent positive social interactions. Chen and Feeley (2014) argue that social isolation is associated with more frequent somatic complaints and ailments in general. Even though they are the polar opposite of psychological issues, they can be severely amplified by poor mental health. Seeman (2000) adds that, over time, these somatic symptoms contribute to poorer immune function and the ability of the body to fight external pathogens, which is especially harmful to older individuals whose bodies are already weaker than those of younger people. Chen and Feeley (2014) and Ashida and Heaney (2008) imply that low social connections can also be related to higher systolic blood pressure and cholesterol levels in the blood. They state that this can ultimately cause a wide range of chronic diseases such as lung diseases, angina, and arthritis. Overall, deprivation of meaningful social interactions among older adults can lead to impairments of physical health and significantly contribute to the development of chronic illnesses.

2.2 THE MOST MEANINGFUL RELATIONSHIPS FOR OLDER ADULTS

There is a significant difference between the actual/received social support that is available to an older individual and their perception of it. Kahn et al. (2003) state that the

disparity between the older person's understanding that social assistance will be available when required (perceived support) and the actual received social support when faced with a stressor (actual/received social support) is the cause of this. Many studies (Ashida & Heaney, 2008; Chen & Feeley, 2014; Everard et al., 2000; Kahn et al., 2003) state that perceived social support is more meaningful to older adults than actual support. Ashida & Heaney (2008) claim that perceived social support is a substantial predictor of better mental and physical health in older adults, while actual social support has a minor influence. In short, in the case of older adults, perceived social support has been shown to be significantly more impactful than the actual support they receive.

Regarding the types of social support, two main factors can potentially influence older adults' well-being and health. Everard et al. (2000) define instrumental support as support that covers providing material and/or physical aid to an individual. This can include financial assistance, cooking a meal for someone, or doing grocery shopping for them. On the other hand, according to Chen and Feeley (2014), emotional support refers to the verbal and nonverbal methods through which one expresses care and concern for another by providing reassurance, empathy, comfort, and acceptance. This can include listening and offering sympathy to the older individual after they have received bad news. Even though instrumental support seems more practical, several studies (Ashida & Heaney, 2008; Chen & Feeley, 2014; Everard et al., 2000) have proven that older adults find emotional support more valuable than instrumental one. Everard et al. (2000) show that higher scores of emotional support have been shown to greatly improve the overall health-related condition of older adults. They also add that emotional support contributes more to an individual's perception of support, as mentioned in the preceding paragraph, which magnifies its value for the well-being of older persons. On the whole, older individuals tend to prioritize emotional support above instrumental support.

Even with emotional support being the most meaningful one, various people can offer different emotional relationships to older adults. Chen and Feeley (2014) argue that spousal relationships or partnerships are the most influential among older individuals. Similarly, Seeman (2000) states that children, other relatives and close friends are also seen as an important source of emotional support for older adults. Rather than having frequent contact with one another, these relationships are supposed to include high-quality interactions and interpersonal closeness, which explains why a social network with people close to the older individual is important (Ashida & Heaney, 2008; Chen & Feeley, 2014). After all, it has been shown that the deep and emotional connections that older adults have with those closest to them are the ones that have the most influence on them.

2.3 THE MEANING OF WELL-BEING

2.3.1 Definition of well-being

According to the Oxford English Dictionary (*Well-Being, n.*, n.d.), well-being is defined as “the state of being comfortable, healthy, or happy”. However, scholars do not agree on a clear definition of well-being. Crisp (2021) defines well-being as something that is “good for” a person. Pollard and Lee (2003) use individual features of an intrinsically positive condition and happiness as a mean to describe well-being. Helliwell and Putnam (2004) also argue that people's well-being is heavily dependent on and defined by themselves. Since the term well-being is broad and subjective, it is hard for the researchers to agree on one definition.

Objectively, the term "well-being" is most usually associated with health. And, while it is not the only factor that influences well-being, it is one of the most essential (Crisp, 2021). As seen in Figure 1, Friedman & Kern (2014) highlight the link between health and subjective well-being as one of the most notable. They claim that, while the relationship between well-being and health is neither linear nor straightforward, there is little question that well-being is connected with better health, reduced morbidity, less pain, and longevity.

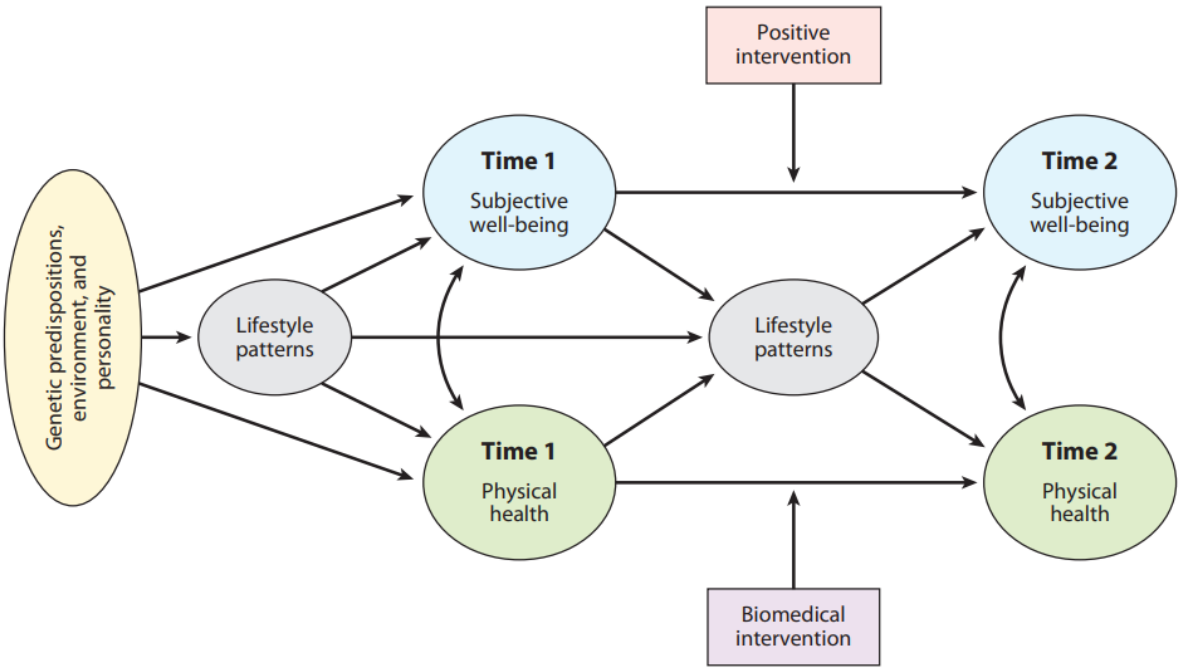

Figure 1. A causal model of relationships including health and well-being (Friedman & Kern, 2014)

2.3.2 Physical well-being in older adults

The most commonly identified physical problems that older adults face include hearing loss, cataracts and refractive errors, back and neck pain and osteoarthritis, chronic obstructive pulmonary disease, and diabetes. Most of them are caused by functional decline, the decrement in physical and cognitive functioning (Quinn et al., 2011). According to several studies (Crombie et al., 2004; Harwood et al., 2006; Satariano et al., 2000), leisure physical activity is pointed out to be of the biggest importance for the prevention of functional decline and improvement of physical health and well-being of older adults. Sun et al. (2013) state that older adults are less likely to be regularly active than people of other ages, especially when talking about leisure-time physical activity. As a result, there is a need for older adults to engage in more frequent leisure physical exercise.

2.3.3 Mental well-being in older adults

Concerning the psychological health and well-being of older adults, there are several potentially detrimental mental illnesses that older adults often experience. They include depression, affective and anxiety disorders, dementia, and psychosis. Many older adults also have sleep and behavioural issues, as well as cognitive decline or confusion (Yaffe et al., 2014). The majority of them are related to social isolation and loneliness. In fact, Luanaigh and Lawlor (2008) find loneliness to be an independent risk factor for depression, one of the most common mental issues among older adults. Because of that, there needs to be a greater emphasis on launching intervention strategies aimed at reducing loneliness in order to improve the quality of life and psychological functioning of older adults.

2.4 CONCLUSION

There is evidence showing that social interactions have a powerful influence on the health of older adults, both physical and mental. A strong social support network is crucial for older adults' overall well-being, where family and close friends are seen as most influential. Those relationships must be deep and constant throughout time in order to provide the care, attention, and support that older adults require. Even though the mental health of all individuals is equally important as physical, the majority of psychological problems that older adults face are influenced by their physical health, condition and activity. Therefore, the first step in addressing the issue of poor overall health in older individuals is to enhance their physical condition. The greatest barrier to older adults' physical health has been identified as a lack of

physical activity. Since older adults may not be able to participate in physically strenuous activities, this refers to undemanding leisure-time physical activity. This includes any additional type of movement that an older individual can introduce into their everyday life. As a result, this project will focus on motivating older individuals to be more physically active throughout the day.

2.5 RESEARCH SCOPE REFINEMENT

Because of the information from the literature, the research goal and scope altered after the background literature review. The most impactful connections for older individuals are the constant ones, as discussed in earlier chapters. Due to the scope of this project, it will concentrate on existing communities rather than creating new ones. This will assist to develop a more realistic effect, as existing ties are stronger than those that can be formed during the project's duration. Furthermore, because the most crucial step in addressing older adults' overall health is to improve their physical condition, this project will encourage older adults to participate in leisure-time physical activities more. This does not necessarily indicate the formation of new habits, although it can be a result in some instances. Due to these changes, the research question is adjusted as well.

RQ: How can a technology-assisted service be designed to benefit from the strength of relationships in older adults' communities to encourage them to be more physically active throughout the day?

3. STATE OF THE ART

3.1 TECHNOLOGIES FOR THE WELL-BEING OF OLDER ADULTS

Given the importance of supporting vulnerable people, of which older adults make up a substantial share, much study has been devoted to the use of information and communication technologies in everyday life to encourage activity, physical health, and independence in recent decades (Grossi et al., 2020).

3.1.1 Wearables

Smart wearable healthcare gadgets are being increasingly used to help older adults monitor their health, well-being, and independence. The development of innovative solutions to efficiently help, monitor, and track the health of older adults has been aided by the use of low-cost wearable devices (Stavropoulos et al., 2020). Wearable healthcare devices range from activity and fitness trackers such as Fitbit, Apple Watch, and Galaxy Fit that collect data on physiological parameters such as sleep duration, heart rate, number of steps walked, and calories burned to more sophisticated devices that collect advanced clinical data such as blood pressure, glucose, and oxygen levels (Poon et al., 2011). Healthcare wearable devices are self-contained, non-invasive devices for older adults that capture a variety of physiological health data (Wang et al., 2017).

Older adults can benefit from wearable healthcare gadgets in a variety of ways. Firstly, these devices can enable continuous remote monitoring of older adults, alert caregivers/physicians to irregular changes, and help in the early discovery and management of health problems (Poon et al., 2011). Secondly, wearables can measure physical activity, send alerts, and assist in the avoidance of falls. Thirdly, by offering reminders, promoting physical activity, and assisting older individuals in making necessary alterations to their daily routines or behaviour, wearables can aid in the self-management of health. Fourthly, regular monitoring of clinical parameters by wearable technologies can let older adults get home-based telecare, lowering provider visits and expenses (Teixeira et al., 2021). Examples of Fitbit smartwatches can be seen in Figure 2.

Figure 2. Fitbit smartwatches (*Smartwatches* | *Fitbit*, n.d.)

3.1.2 Smart home services

Smart home services are another way to monitor and modify older adults' level of well-being and quality of life. Smart homes are specially built living places with interactive technology and unobtrusive support systems that allow individuals to have more independence, activity, and involvement than they would otherwise have. They promote ageing-in-place by allowing individuals to live safely and independently in their own homes by leveraging smart technology (Creaney et al., 2021). This has the potential to improve people's quality of life while also reducing the strain on healthcare facilities and other resources.

A good example of a smart home system targeting older adults is the Gator Tech Smart House made by the Rehabilitation Engineering Research Center on Technology for Successful Aging at the University of Florida, USA in 2004 (Tomita et al., 2010). Environmental sensors for comfort, energy efficiency, safety, security, activity/motion tracking, fall detection with the emergency warning, and reminder/prompting technologies are some of the features included in this system. A picture of this system is shown in Figure 3.

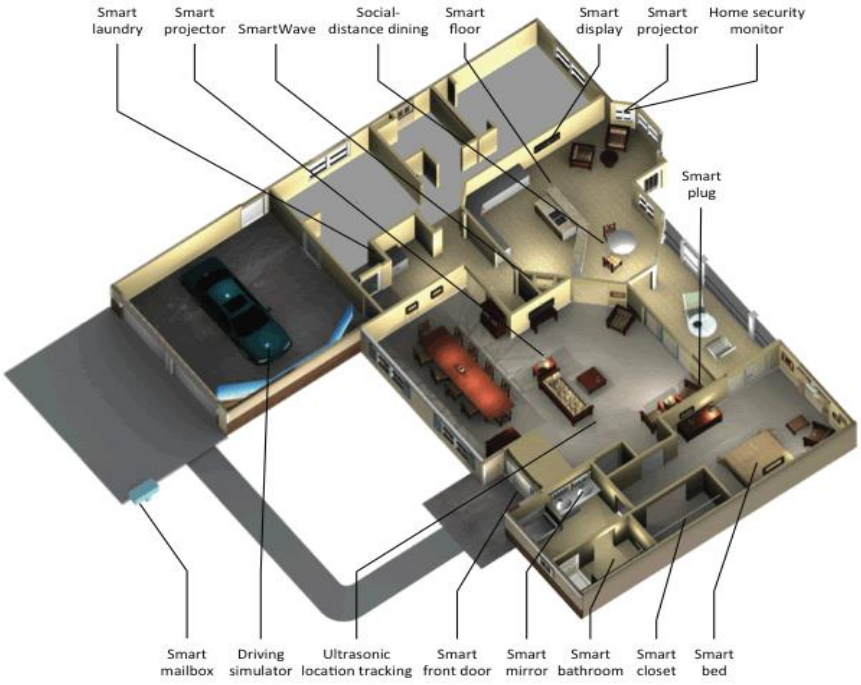

Figure 3. Gator Tech Smart House (*Mobile & Pervasive Computing at the University of Florida*, n.d.)

3.1.3 Laptop and smartphone software

Numerous applications and software aim to improve the health and well-being of older adults. It is now rather simple to use wireless communications to give comfort through m-Health applications, allowing patients to take a more active part in their own health management (Szinay et al., 2020). This may be the most accessible option, as an increasing number of older adults now own a smart device such as a smartphone. Not many of those applications are exclusively targeting older adults, but some of them can easily be used but older individuals. These can be Calm, Headspace: Meditation & Sleep, Yoga: Down Dog, or MyFitnessPal (Banskota et al., 2020). Many of these apps are proven to be useful for older adults but are not specifically meeting all of their needs and concerns. Applications that perform effectively for younger people may need to be revisited to see which aspects of the technology or therapies are successful for older adults. Reduced costs for continuous monitoring and improvement in hardware and software are required in order to meet older adults' needs and actively encourage them to use m-health. (Paschou & Sakkopoulos, 2019). Several screens of the MyFitnessPal application are presented in Figure 4.

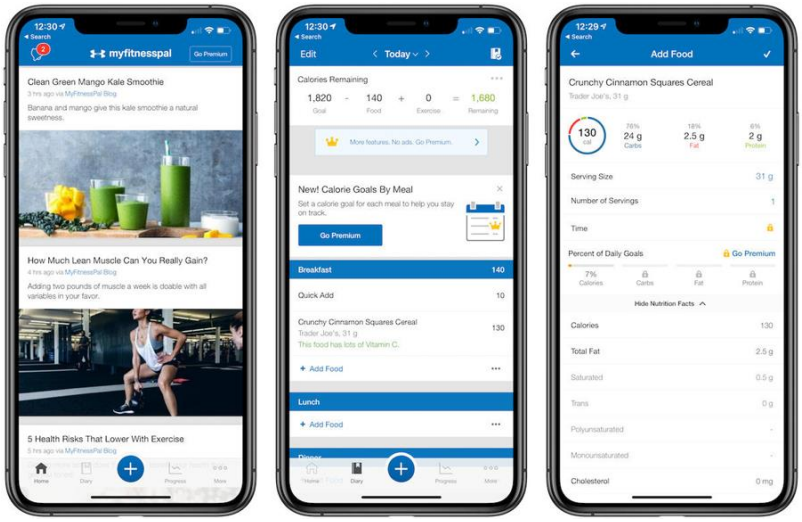

Figure 4. MyFitnessPal (*MyFitnessPal*, n.d.)

3.1.4 Virtual and augmented reality

Virtual reality (VR) and augmented reality (AR) provide several advantages for older adults, including encouraging a healthy lifestyle through health-related games, preserving social contact through digital interfaces, assisting with rehabilitation, and assisting with daily duties (Seifert & Schlomann, 2021). On a physical level, virtual and augmented reality applications can assist older adults with motion training by providing a difficult and stimulating environment in which they can practice balance, resulting in the minimization of the risks of harm from falls. VR and AR can also be beneficial tools for providing cognitive training and

rehabilitation. On a more holistic level, VR and AR have a range of good benefits for the mental, emotional, and social health of older individuals (Wiederhold, 2018). One example of VR technology exclusively targeting older adults is MyndVR. This company aims at improving the quality of life for older adults through its devices and services. It covers a wide range of health issues, from psychological to physical in nature (*Virtual Reality for Older adults*, n.d.). Their device can be seen in Figure 5.

Figure 5. MyndVR devices (*Virtual Reality for Older adults*, n.d.)

However, besides all the benefits, VR and AR tools are still seen as more innovative and expensive ones on the market, which hinders many older adults from using them. Only a few older individuals have had the opportunity to interact with this type of technology, and the learning curve is greater than with smartphones or smartwatches, which are readily available.

3.2 COMMUNITY BUILDING SOLUTIONS FOR PROMOTING WELL-BEING

3.2.1 Social media

In today's day and age, social media platforms are critical for forming online communities in a variety of fields, including health, fitness, and well-being. These communities on social media serve as providers of valuable information and encouragement for their members, but they also promote different health-related and fitness-related products and services (Dessart & Duclou, 2019). These kinds of networks, however, are not regulated and inaccurate information can be spread. Furthermore, social media mostly appeal to teenagers and younger adults, therefore, it is not the best medium for targeting older adults (Dessart & Duclou, 2019).

3.2.2 Samsung health (Together feature)

Samsung health is one of the most used fitness applications. Its Together feature enabled the users to connect with other people through the application and compare each

other's progress. Users may partake in walking competitions with their friends, or join Global challenges and compete in other fitness contests with individuals from all around the world (*Use the Together Feature in Samsung Health*, n.d.). According to Samsung's study, people who use the Together features and engage in challenges in the Samsung Health application walk 22% more than other Samsung Health users (*Achieve Your New Year's Resolution With New Group Challenge Feature in Samsung Health*, n.d.). Despite its many advantages, this software is not well suited to the needs of older adults. Samsung health, let alone its Together feature, is not often used by older adults. This application is presented on the screens in Figure 6.

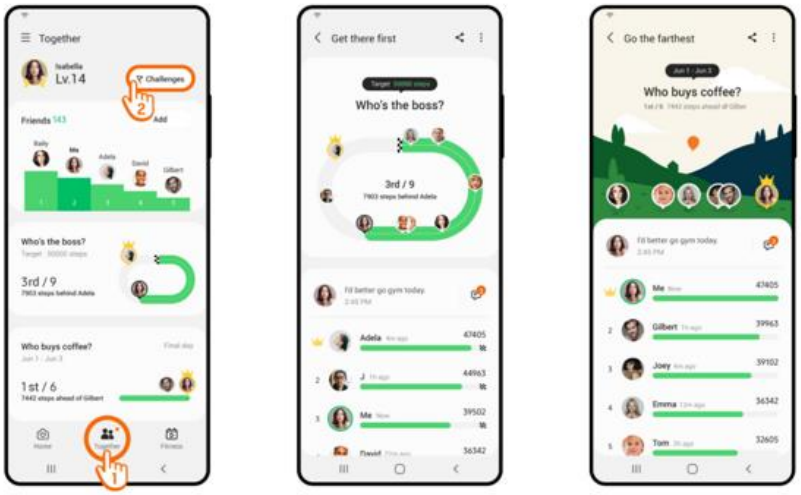

Figure 6. Samsung health - Together (*Together Feature in Samsung Health*, n.d.)

3.2.3 Smart public spaces

Smart public spaces are becoming more popular in recent years and are a part of the urbanization and development of smart environments and cities (Bašová & Štefancová, 2017). They have a great potential in getting people involved in various activities. Their potential for community development is equally significant. Even regular public areas, such as parks, offer an appealing environment for people to gather and spend time together (Radwan & Morsy, 2018). Recently, Active Public Space emerged as a new term and concept basing itself on the foundations of smart public spaces. Such space aims to encourage social interactions and foster various activities in which citizens can freely participate. One example of an Active Public Space is The Smart Carpet project designed by McGregor Coxall. This product can be seen in Figure 7.

Figure 7. The Smart Carpet (*Smart Carpet* | *Projects*, n.d.)

This smart environment represents a flexible street whose parts can be separated for various purposes based on the demand. The idea behind this is to make spaces that can be used at all times in the right way. This smart base is supposed to be placed on the streets with busy traffic during peak hours but can serve as a popular social space during off-peak hours (Figure 8). The tiles of which this “carpet” is made can mimic pavements, roadways and even pedestrian crossings (*Smart Carpet* | *Smart Cities and Public Realm*, n.d.). This ensures the maximal utilization of the urban spaces promotes social activities even in busy metropolises.

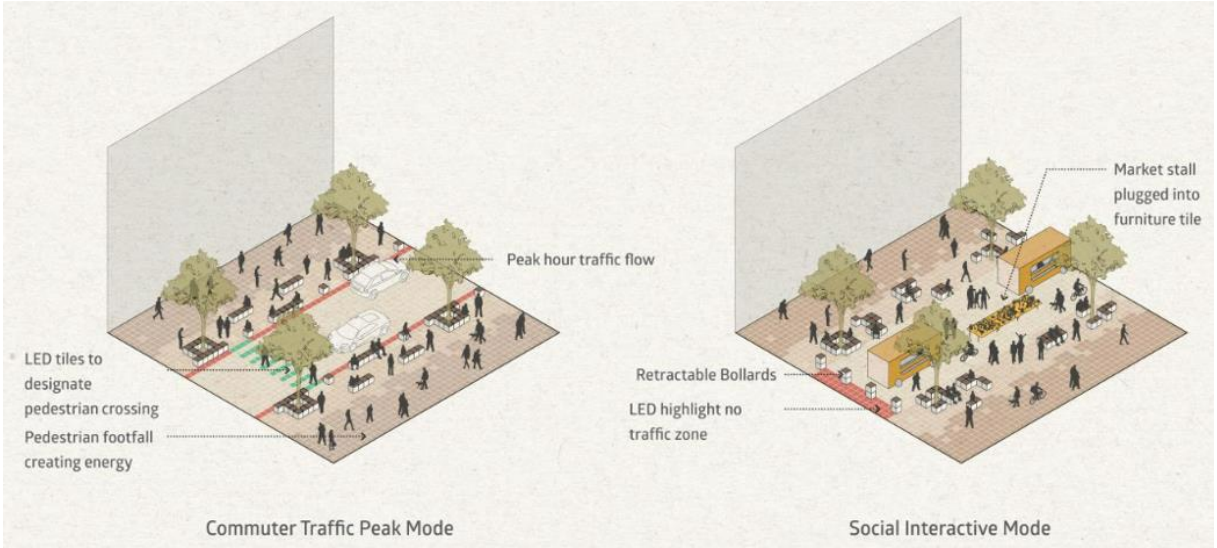

Figure 8. The Smart Carpet modes (*Smart Carpet* | *Projects*, n.d.)

3.2.4 Buddy programs

There are various online and offline “buddy programs” aiming at connecting two or three interested people to engage in fitness activities together and encourage each other along the way. This can have many benefits for the participants on the physical and psychological levels (Fyffe & Raskin, 2015). It can promote healthy competition and prevent harm and injuries (*Keeping Up With the Fitness Buddy*, n.d.). However, while this system connects people, it does not create a community. The pair who works out together is completely reliant on one other and their availability which can slow down the progress.

3.3 CONCLUSION

Several solutions exist that only partially address the problem described in the introduction. On one side, numerous technologies attempt to assist older adults in developing and maintaining healthy lifestyle habits using a variety of approaches, ranging from the more traditional, such as mobile applications, to the more inventive, such as smart home and VR systems. On the other side, there are a few tools for building a community with an aim to encourage and motivate people to live a healthy lifestyle. There are, however, no solutions that combine the community-building aspect with the target consumers being older adults. While some of the community-building tools can be used by older adults, they are not designed for their specific requirements, needs and limitations.

4. METHODOLOGY

The solution for the problem that this project is addressing will be designed utilizing the Double Diamond design model (*What Is the Framework for Innovation?*, 2015) in the combination with the Creative Technology design process (Mader & Eggink, 2014). Two methods are explained below.

4.1 DOUBLE DIAMOND DESIGN PROCESS

The Double Diamond design model is divided into four stages, beginning with an original concept and concluding with the delivery of a product or service. Those stages are discover, define, develop, and deliver, where discover and develop are diverging stages, while define and deliver are converging ones (*What Is the Framework for Innovation?*, 2015). Even though it appears to be linear, the entire process is rather circular and involves multiple iterations, as suggested by the dashed lines in Figure 9.

The first phase of the Double Diamond process is *discovering* which aims at deeply understanding the problem and the target users (Gustafsson, 2019). In this phase, the majority of the data will be gathered from various sources, literature, potential users and expert. The second phase, also known as *defining*, aims at sorting the data gathered at the previous stage and filtering it (West et al., 2017). In this phase, the user requirements and the outcome of the project will be defined. The following phase is the second diverging phase – *developing*. According to Design Council (*What Is the Framework for Innovation?*, 2015), this phase is for generating different ideas and solutions to the problem that was identified in the previous stage, as well as getting inspiration from target consumers. Lastly, the concluding phase is *delivering*. This phase involves selecting the most promising solutions found in the developing phase and testing them in order to decide on the optimal one (Gustafsson, 2019). The Double Diamond design process is structured in phases as presented in Figure 10.

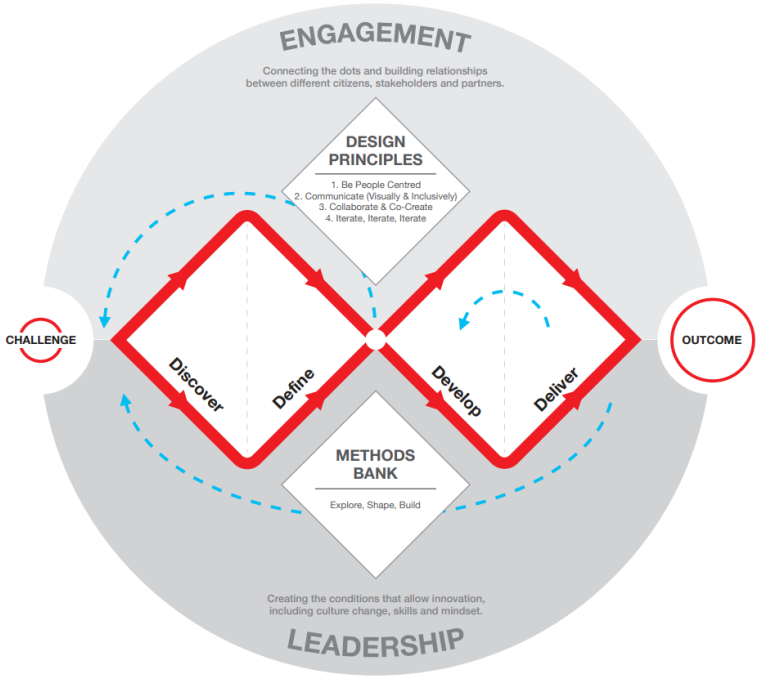

Figure 9. Double Diamond model (*What Is the Framework for Innovation?*, 2015)

4.2 CREATIVE TECHNOLOGY DESIGN PROCESS

This method consists of four phases as presented in Figure 10. These are *ideation*, *specification, realisation* and *evaluation* phases. This process is similarly nonlinear, exactly like the Double Diamond, as indicated in Figure 10 with the arrows. The *ideation* phase aims as generating different ideas for the design to answer the design research question. The *specification* phase consists of defining several concepts and developing a specification list for the final product. In the *realisation* phase, the prototype is built and later tested in the *evaluation* phase (Mader & Eggink, 2014).

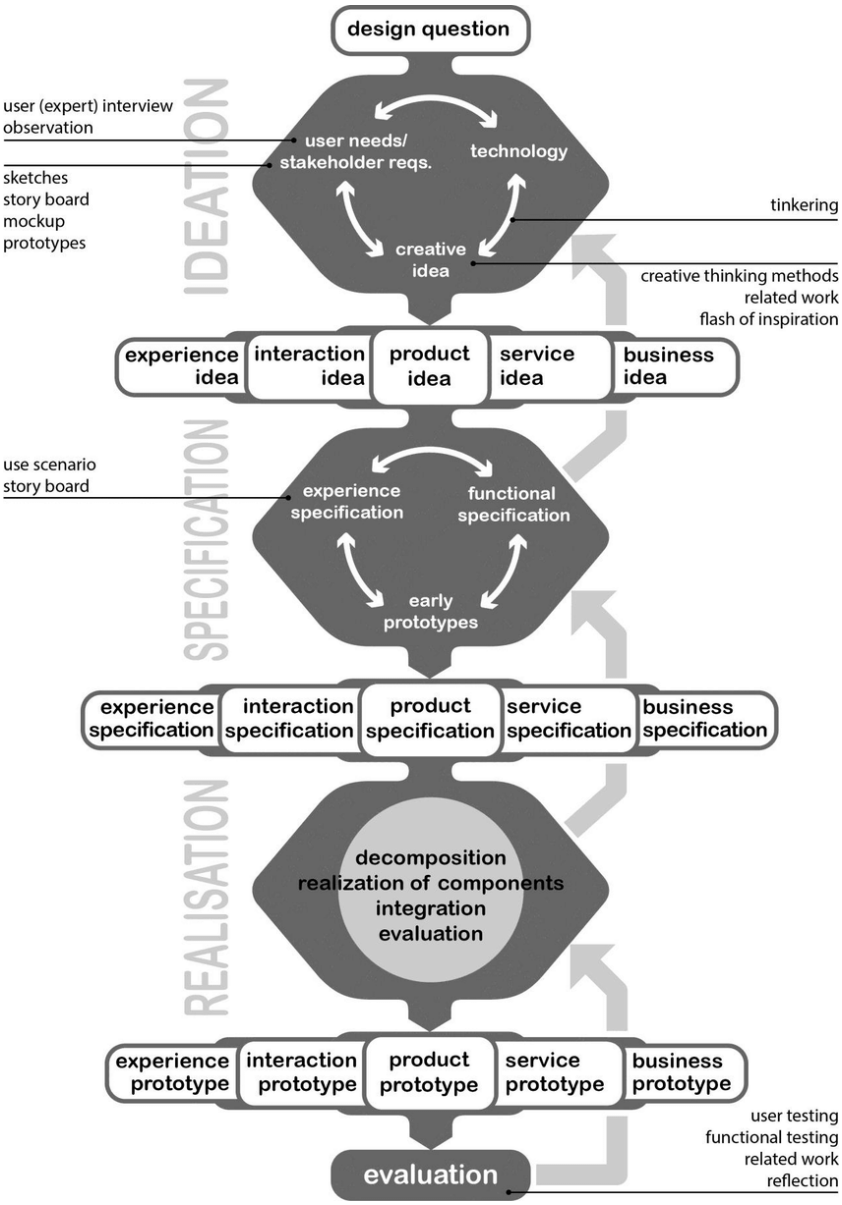

Figure 10. Creative Technology design process (Mader & Eggink, 2014)

4.3 INCORPORATING THE TWO METHODS

These methods overlap even though they appear to be different. On the one hand, the phases of discover, define, develop, and deliver make up the Double Diamond design process. On the other hand, the ideation, specification, realization, and evaluation phases make up the Creative Technology design process. I will adhere to the language of the Creative Technology design process for this project while incorporating some of the Double Diamond approach's core ideas. The ideation and realisation phases are the diverging ones, while the specification and evaluation phases are the converging ones. The whole process with its objectives for this project is presented in Figure 11.

Figure 11. Design process phases

4.4 IDEATION METHODOLOGY

4.4.1 Observations

The first stage of idea generation includes naturalistic observations. This approach entails monitoring and analyzing individuals' spontaneous behaviour in a natural setting without directly interfering with the observed individuals or setting (Angrosino, 2016). The data will be collected through note-taking by the researcher. These observations will be used to gather information about the current state of the older adults' physical activity and social life. Since the observations are not participatory, they will help in obtaining insight into the natural and realistic behaviours of older adults.

The observations will be done in two southern suburban neighbourhoods in Belgrade, the capital of Serbia, in two streets Serdara Janka Vukotića and Ljubomira Ivkovića Šuce. These two neighbourhoods are former military settlements, which means that people working in the military got the apartments in these complexes 20-30 years ago. As a result, these areas currently have a large number of older citizens residing in them. However, as more young families move into these areas, inhabitants of Serbia consider them to be family-friendly neighbourhoods. As seen in Figures 12 and 13, these neighbourhoods are characterized by a lot of greenery and buildings that are deliberately situated to allow for a large number of walking paths, parks, and other social public spaces. This makes them a convenient space attracting older adults to spend more time outside in public.

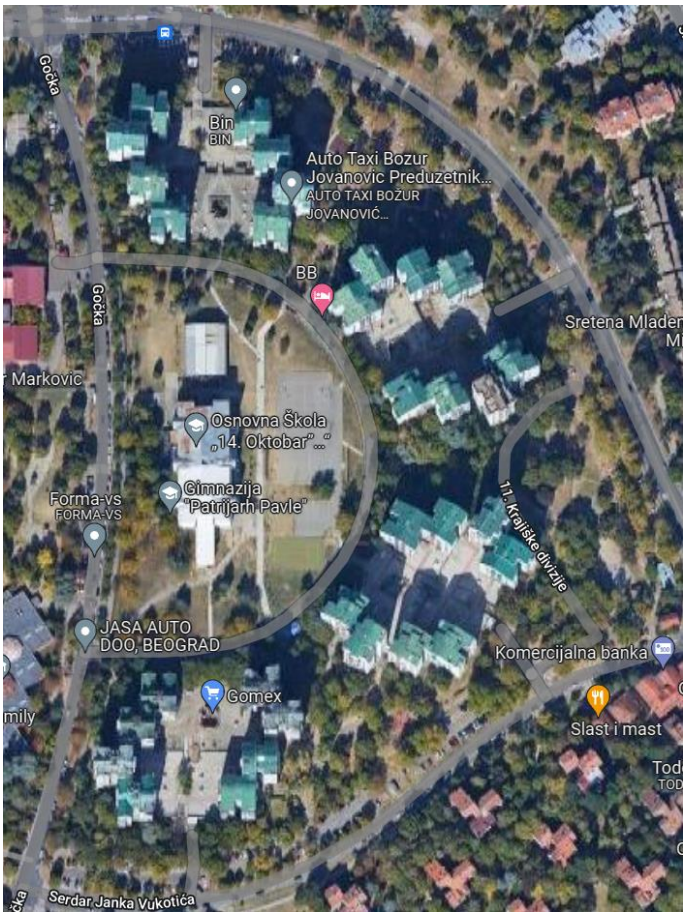

Figure 12. Neighbourhood Serdara Janka Vukotića

Figure 13. Neighbourhood Ljubomira Ivkovića Šuce

The observations will take place in three rounds, three days in a row. Each session will last around one hour. The researcher will keep a record of the behaviour patterns and any inconsistencies that may arise. Namely, the research will keep track of the aspects shown in Figure 14.

Figure 14. Observation objectives

4.4.2 Brainstorming session

Brainstorming is a design method used to generate a large number of diverse ideas (Wilson, 2013). For this project, the brainstorming session will include all the participants together discussing their ideas and building upon each other. The procedure of the brainstorming session will include the following stages:

1. Gathering older adults (the experts of everyday life)
2. Getting familiar with the research and signing the consent form
3. Initial discussion to promote idea generation
4. Proposing a topic for debate and idea generation
5. Inviting a group to develop ideas or solutions without providing feedback or attempting to limit the type or amount of ideas generated
6. Discussing, critiquing, and maybe prioritizing the contents of the brainstorming session for future activities (converging phases)

The group of participants includes 5 older adults, men and women, ranging in age from 69 to 84. They are the residents of the neighbourhoods mentioned and observed in the previous subchapter. Some of them were also observed during the observation rounds. The table with their demographics is presented in Figure 15.

Participant nr.	Age	Gender
Participant 1	84	Male
Participant 2	75	Female
Participant 3	69	Female
Participant 4	81	Female
Participant 5	73	Male

Figure 15. Participants' demographic

When all the participants are gathered they will be given the information brochure and the consent form both in English and Serbian. The information brochure and consent form in both languages can be found in Appendix A. The participants will be then given time to get introduced to the study by reading and signing the documents and will have time to ask any additional questions if needed.

The research will start with the initial discussion, in which the participants will be asked several questions on four main topics: social factors, physical activity, technologies, and public spaces, and will be invited to talk to each other and build upon each others' answers. The research will not interfere with their proposed ideas. The topics and the questions for this discussion are presented in Figure 16. The meaning of the colours in the table in Figure 16 will be explained in the next subsection. The goal of this stage is to get introduced to the topic and generate initial ideas.

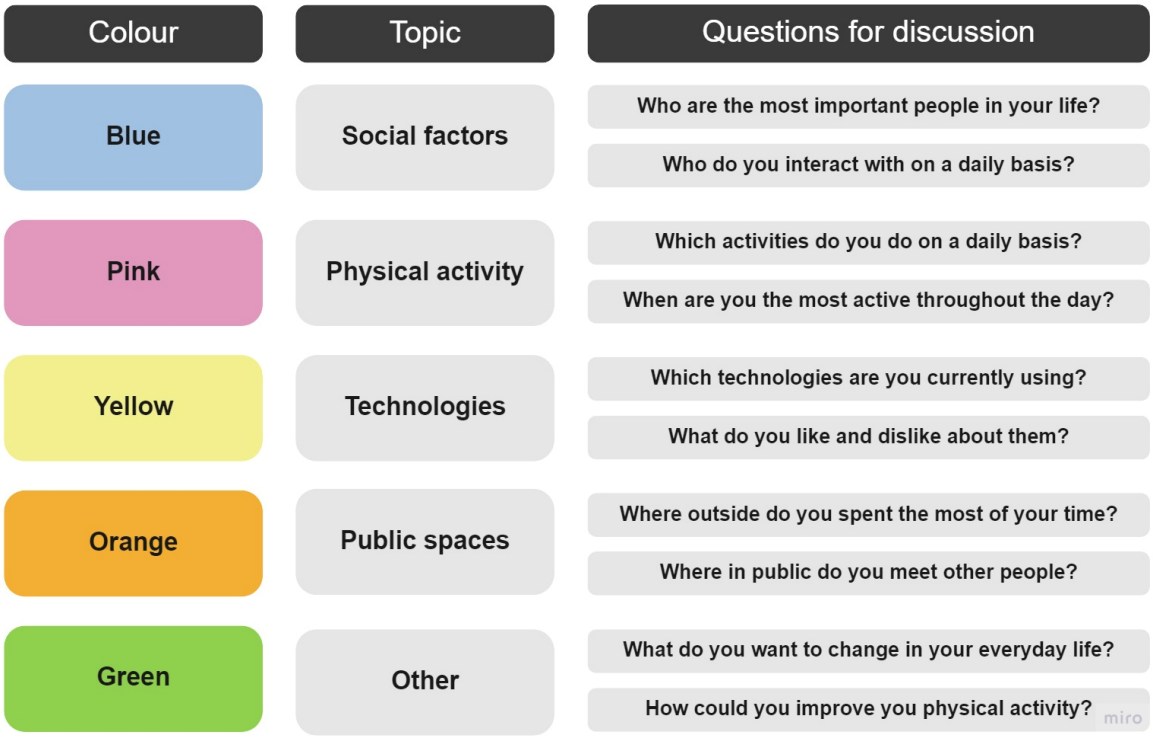

Figure 16. Discussion topics and related colours

After the initial discussion, the main part of the idea generation will start. The tool that will be used for this process is the bull's eye diagram, which is a strategic template designed in the shape of a bull's eye. It will be used to rank ideas from more to less important ones. This process will help in prioritizing ideas and the main requirements of this project. The ideas will be categorized into essential, important, and interesting ones, as shown in Figures 17 and 18, where each concentric circle radiating out from the centre corresponds to a different level of importance. Figure 17 represents a physical version of the bull's eye diagram in the Serbian language that will be used during the brainstorming session. Figure 18 shows a translated digital version of the template. Aside from categorization based on importance, the thoughts will be classified based on the theme. All of them will be written on sticky notes and placed anywhere around the circles, with the colour of the sticky note varying according to the theme of the concept. The topics and corresponding colours are show presented in Figure 16.

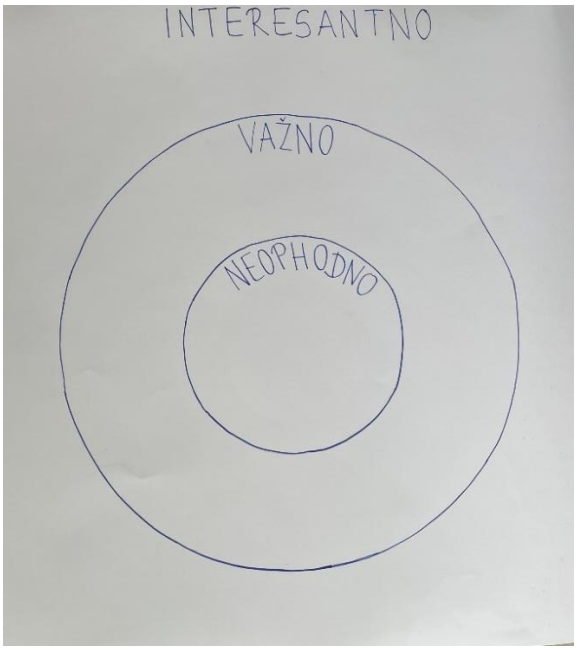

Figure 17. Bull's eye diagram in Serbian (physical)

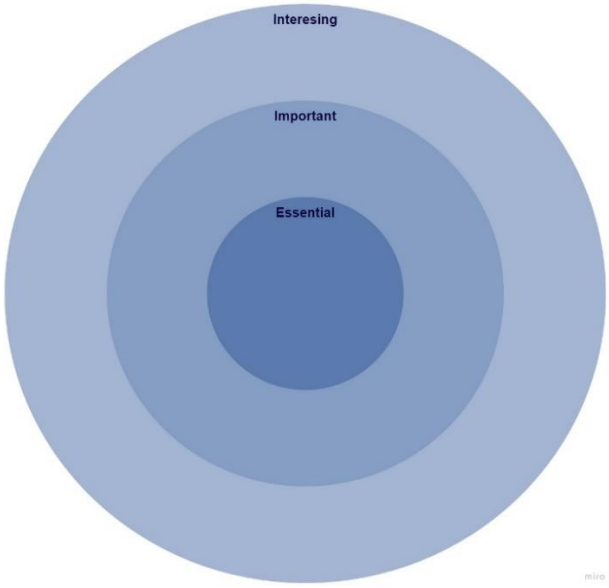

Figure 18. English translation of the bull's eye diagram (digital)

4.5 EVALUATION METHODOLOGY

4.5.1 User experience testing (observations and interviews)

In order to obtain data about the user experience while using a prototype, observations will be conducted. All the participants will get a chance to use a prototype and they will be

asked to verbally explain what are they doing. While doing that, their facial expressions and body language will be observed in order to understand the key advantages and disadvantages of the prototype. According to the Interaction Design Foundation (*How to Conduct User Observations*, n.d.), the observer should take note of the following:

1. What the user is actually doing (as opposed to what the observer expects)
2. What routines does the user have with the product and how does the user integrate this product into their life
3. All the verbal and nonverbal details
4. The actions as a whole, not just the product itself

Conclusions will be drawn from the reoccurring observation notes and user behaviours to simultaneously enhance the prototype and the final product.

The interview that will be conducted after the session in which participants use a prototype is the second stage of the user experience evaluation. As the researcher, I will gather information throughout this stage and work to support any observation-based assumptions. The participants will be questioned about some of their decisions and their overall impressions of the prototype. This phase serves to confirm the usefulness of the product, if it would be beneficial in real life, and whether the potential users would utilize it in their daily lives in addition to identifying areas for improvement. This interview will be semi-structured meaning the prepared questions exist; however, if the researcher identifies interesting and useful topics throughout the interview, additional questions will be asked in order to obtain the most useful information. The initially prepared questions include:

1. What have you just done?
2. How were you feeling during this session?
3. How easy was it for you to use a prototype?
4. Would you use this or a similar product if it would be available in your neighbourhood?
5. What did you like the most about this concept?
6. What didn’t you like about this concept?
7. Would you change something (to make it better for yourself or other people that might be using it)?
8. Would you recommend this product to other people your age that you know?
9. How could this product change your everyday life?

The points for improvement will be identified based on the participants' responses and the conclusions made from the observations.

4.5.2 Usability testing

For the usability testing, the system usability scale (SUS) will be used (*System Usability Scale (SUS)*, 2013). After interacting with the prototype and finishing the interview, all the participants will obtain the evaluation form that includes SUS and will be asked to fill it in. This scale is shown in Figure 19.

	The System Usability Scale Standard Version		Strongly disagree				Strongly agree
			1	2	3	4	5
1	I think that I would like to use this system.		○	○	○	○	○
2	I found the system unnecessarily complex.		○	○	○	○	○
3	I thought the system was easy to use.		○	○	○	○	○
4	I think that I would need the support of a technical person to be able to use this system.		○	○	○	○	○
5	I found the various functions in the system were well integrated.		○	○	○	○	○
6	I thought there was too much inconsistency in this system.		○	○	○	○	○
7	I would imagine that most people would learn to use this system very quickly.		○	○	○	○	○
8	I found the system very cumbersome to use.		○	○	○	○	○
9	I felt very confident using the system.		○	○	○	○	○
10	I needed to learn a lot of things before I could get going with this system.		○	○	○	○	○

Figure 19. System usability scale (Lewis & Sauro, 2017)

Each participant's score for the questions with odd numbers will be deducted by one. The participant's score for the questions with even numbers will be deducted from five. All those values will be added up and multiplied by 2,5. This will result in a final grade of a participant that will be between 1 and 100. The average of all these grades will then be taken. That is the System Usability Scale score. SUS score above 68 is considered above average and anything below 68 is below average; however, the best result is above 80,3 (*System Usability Scale (SUS)*, 2013).

5. IDEATION

This chapter aims to generate, link and elaborate on the ideas for the solution to the problem of lack of leisure-time physical activity among older adults described in the first chapters. For this purpose, various methods will be applied, where the first ideas will be developed by the researchers, while the participants of the brainstorming session will have the biggest influence on the ideas and will help improve them by selecting and refining the best concepts. This will serve as the stage for obtaining general knowledge about the current behaviours of the older adults and their physical activity, the relationships with other people in their surroundings and the possible opportunities for improvement.

To gather all the necessary knowledge, this stage is divided into two parts. Firstly, the observations were executed by the researcher to develop the initial concepts. Secondly, the co-designing with older adults through a brainstorming session and mind-mapping were conducted through which the best ideas will be selected. This chapter will be finalized with the concluding remarks and the description of the following steps.

5.1 OBSERVATIONS

In this phase, I, the researcher, observed communities of approximately 40 older adults in Serbia to better understand their behaviour and habits.

5.1.1 Day 1 of observations

During the first day, I walked along the main walking paths in both neighbourhoods. This session occurred on a Thursday between 6 and 7 p.m. Many older adults were walking along the same routes, and some of them were sitting on the benches nearby. While several older adults were alone, the majority were accompanied by at least one other person, which can be seen in Figure 20. Furthermore, the older adults that I saw sitting were accompanied by more people than those who were actively moving. In some instances, more than five people were gathered at some spots.

Figure 20. Observation Picture 1

I also noted that older adults would frequently join each other on the route without prior agreement. They would often stop by, greet each other, and sit on the bench to converse. They would occasionally carry grocery bags with them, suggesting that they are coming back from everyday shopping. This can be seen in Figure 21.

Figure 21. Observation Picture 2

5.1.2 Day 2 of observations

A similar scenario was seen on the second day as on the first one. This session occurred on the following Friday between 6 and 7 p.m. Based on the observed behaviours

from the first day, this time I was situated near the "hotspots" (the most popular benches). People's interactions were given special consideration. While some groups were walking along the walking path, several older individuals were seen sitting. It was obvious from their appearance and body language that they generally knew each other, and those who were walking often exchanged greetings. They would occasionally join the people who were seated. Figure 23 shows a group of older women passing by the benches looking at the group of individuals sitting on the bench, with some of them even having a brief conversation with a member of the group seated. Figure 22 shows them before the other group approached.

Figure 22. Observation picture 3

Figure 23. Observation picture 4

A few hundred meters away from this occurrence, an identical phenomenon was noticed. When another senior person went by, five individuals sat on the benches in close proximity. Figure 24 depicts this arrangement. The lady walking exchanged greetings with the women on the centre bench before joining the single woman on the far left bench, as shown in Figure 25.

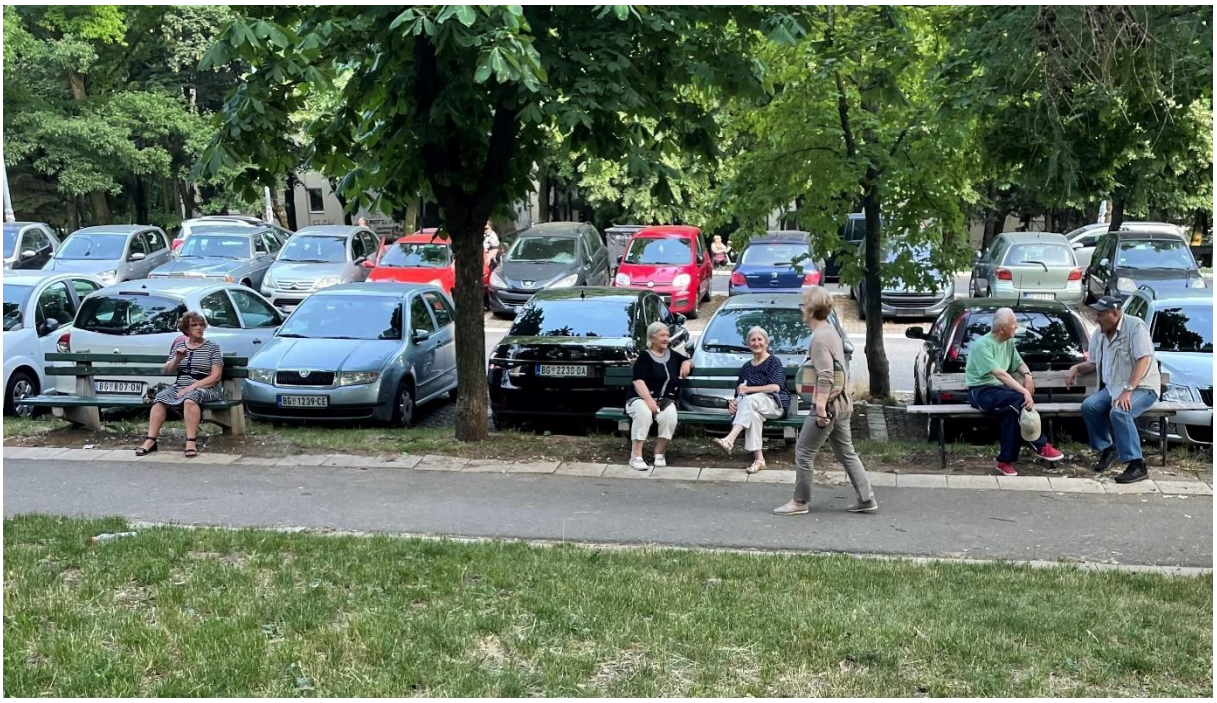

Figure 24. Observation picture 5

Figure 25. Observation picture 6

5.1.3 Day 3 of observations

On the third day, the session took place between 9 and 10 a.m. on Saturday. There were fewer people around in the morning than the previous two days. Around 9 a.m. three people were noticed conversing on one of the popular benches. They can be seen in Figure 26. What was particularly interesting was seeing a person with a walking aid which is a reoccurring theme noticed in Figure 22 as well. This could indicate the necessity of the benches to be close to one other and the walking to be shorter due to the need for a rest.

Figure 26. Observation picture 7

The second setting, which can be seen in Figure 27, occurred at approximately 10 a.m. Three persons were sat in the same spot as the last photograph was shot, although one lady was seated independently from the other two. She was seen using a smartphone, and numerous other older individuals were also seen using one. Figure 22 shows a woman with a walking cane as an example. This suggests that many older adults are familiar with smartphones and use them in their daily lives.

Figure 27. Observation picture 8

5.1.4 Conclusion

Based on the pictures taken and presented in this chapter, as well as the notes taken by me, the observer, reoccurring themes were noted and connected in order to form conclusions. Three main concepts emerged as a result and are explained below.

Busy location

The location in which the communities physically gather seems important. From what is observed, it is concluded that all the locations currently popular among older adults are busy spots which are familiar to the majority of people living in the neighbourhood. Furthermore, these locations are mostly visited by people living in near proximity and the members look like they already know and see each other on a daily basis. Those are mostly parks in between the buildings or the benches along the walking paths.

Non-obligation

The non-obligatory nature of the gatherings is a crucial concept noticed through observations. People are free to choose when and where they will join the gathering without prior agreement. It is noticed that people often join others for a short talk on their way to or from the supermarket. It looks like these socialization moments are seen as non-binding everyday occurring that are solely dependent on the mood and willingness of an individual. The time that each member is spending in these gatherings is also solely dependent on themselves and their willingness to participate, which makes these gatherings enjoyable and

completely voluntary experience. These non-committal, yet constant connections that older individuals develop with one another appear to be the most influential and desirable among the older members of society.

Familiar and comfortable environment

During the observations, it is noticed that the networks of people that are already formed are very strong and, in general, there is no need for forming new communities. All the people that gathered during these sessions seemed fairly familiar with each other. They communicated openly and discussed various topics which could compare this community to a close group of friends. The comfort that these people find in relationships with other people their age is one of the crucial concepts in making these communities the main motivators for change.

Sedentary community

The sedentary nature of these communities' gatherings is perhaps the most significant concept noted during the observation. Even though several persons were spotted moving in certain situations, this did not happen very often. Normally, individuals would prefer to sit rather than walk. Furthermore, groups of older adults walking would consist of no more than 2-3 people, with just one or two cases of more than 3, while groups seen sitting would be substantially bigger. This demonstrates that people prefer sitting, especially in the context of social gatherings. Consequentially, joint or social physical activity merely takes place.

After doing the observations, I concluded that the publicly placed design would be the best option for this project. The older adults in the observed neighbourhoods already formed strong communities that can be utilized to encourage each other to be more physically active outdoors. Furthermore, the already existing hotspots where older communities gather are a great place to start placing smart devices that can enhance the whole experience. This hypothesis will be developed into a concept in the next subchapter and then further elaborated on and modified during a brainstorming session with older adults.

5.2 INITIAL CONCEPT

The neighbourhood Serdara Janka Vukotića that was observed contains a walking path long around 1,3 km. Along that path, there are 24 benches. The walking path and the network of existing benches are presented in Figure 28. The idea is to utilize the existing benches that are already actively used by the older adults in this neighbourhood and place the device or the system of devices onto them. The bench is supposed to encourage older adults currently sitting on it to move along the walking path and change the bench. The next bench will have the same task and will encourage them to move again to the next one in line and so forth. The aim is to make a system of benches that will promote constant movement and increase the overall physical activity of older adults without it being forced.

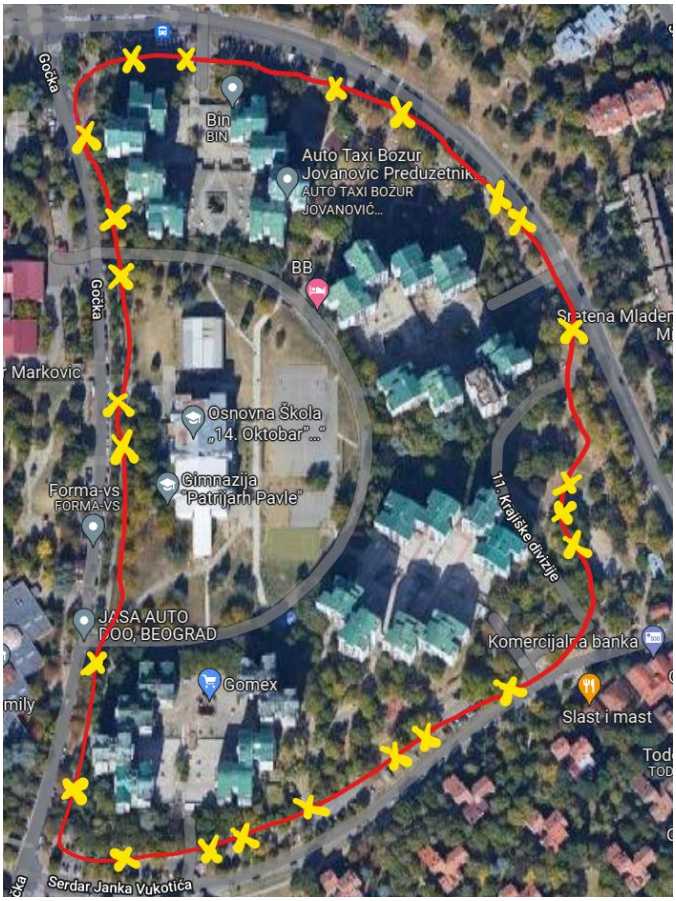

Figure 28. Walking path (red line) and bench placement (yellow crosses)

5.3 RELATED WORK (BENCH DESIGNS FOR DIFFERENT BEHAVIOURS)

The initial plan called for creating smart benches, therefore and additional state-of-the-art research was done to gather information on bench designs that presently exist and either force or promote particular actions. This supplementary research was conducted in order to create a foundation from which the ideation session could grow, allowing for the understanding of which existing designs function well and which do not. Several examples are presented below.

5.3.1 Buddy bench

The concept of the buddy bench is primarily used in children's playgrounds to avoid playground loneliness. They are used to communicate to others that the individual sitting on it is looking for company and that they want to be approached (Clarke, 2018). This approach has been proved to be useful for children and young people, but it also appears to have the potential for adults in some environments where it is needed.

Figure 29. Buddy bench (*Buddy Benches*, 2022)

5.3.2 Tilted bench

Tilted benches and other hostile public architecture aim at preventing people from spending a lot of time sitting on public benches. They are sometimes called anti-homelessness benches because they prevent homeless people from sleeping on them (O'Neill, 2019).

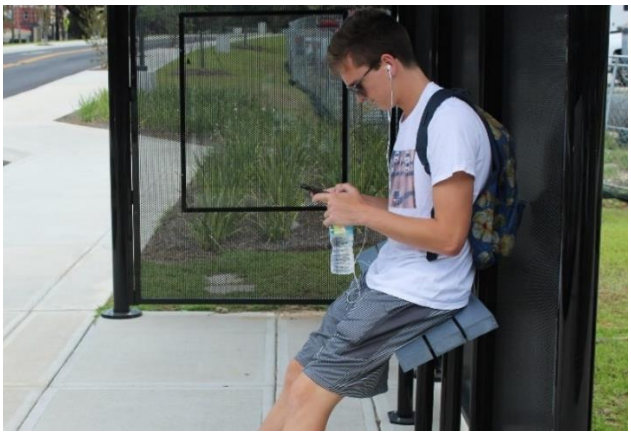

Figure 30. Tilted bench (*New, Slanted Bus Stop Benches Spark Outrage on Social Media*, n.d.)

5.3.3 Bicycle bench

Benches with pedals are commonly placed in outdoor fitness parks to promote physical activity. They may be utilized by individuals of all ages since they make it possible to participate in an exercise while sitting on a bench talking to other people or doing anything else.

Figure 31. Bicycle bench (*Pedals for Bench*, n.d.)

5.3.4 Benches places further than expected

One example of this method is the placement of benches near bus stops but not exactly at the bus stops. In this way people have to walk to the bus when it arrives, resulting in extra physical activity that would not have occurred otherwise.

Figure 32. Bench near the bus stop (*A Bench Near The Bus Stop With Trees*, n.d.)

5.3.5 Classification of related work

According to Tromp et al. (2011) and the fact that products can encourage and discourage different behaviours, there are several types of design influences based on the intended user experience. They depend on two dimensions: whether the influence is hidden or apparent and whether it is strong or weak. As a result, there are four major categories – seductive, which is hidden and weak; persuasive, which is apparent and weak; decisive which is hidden and strong; and coercive which is apparent and strong. All four types can be seen in Figure 33.

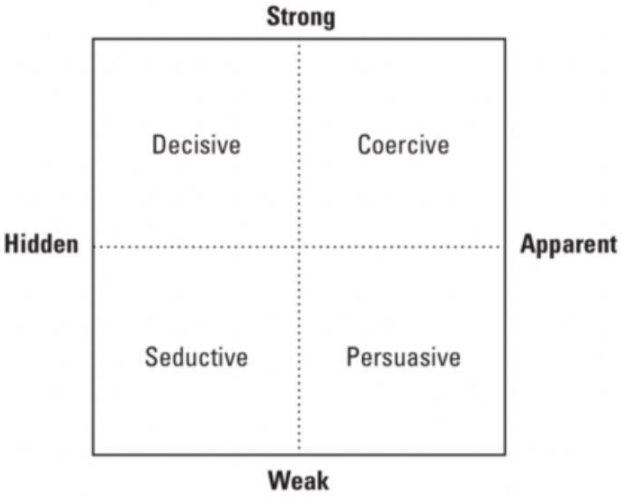

Figure 33. The classification of influence is based on intended user experience (Tromp et al., 2011)

Based on this categorization, related work mentioned in this chapter is placed on the template as in Figure 33 to better understand these designs and their intentions. This classification can be seen in Figure 34.

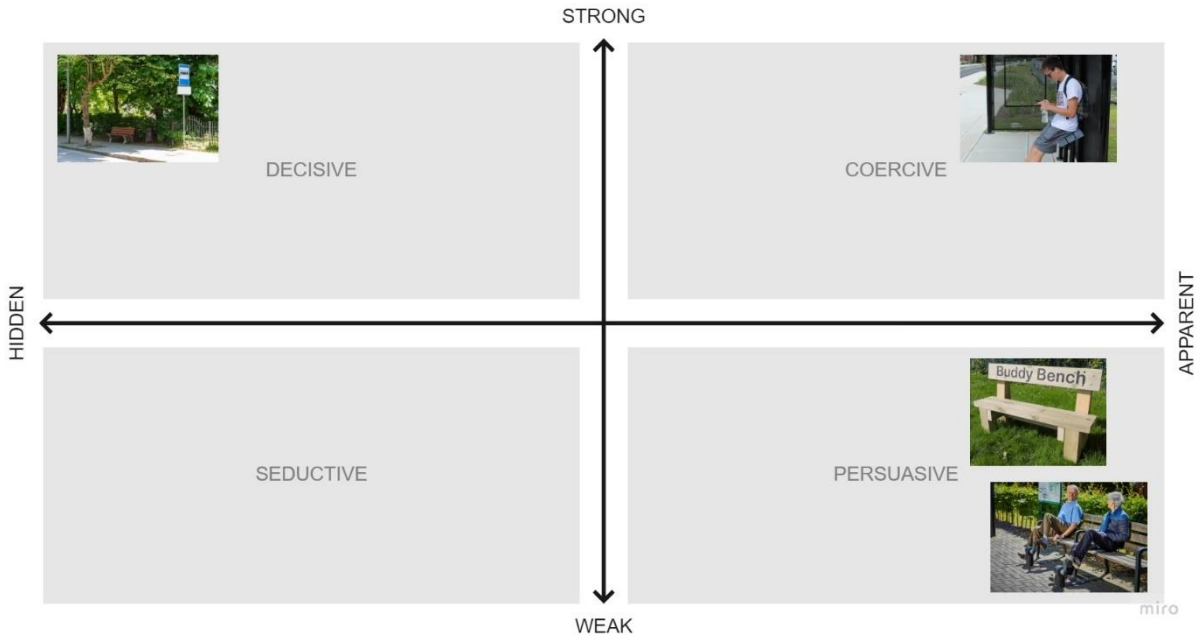

Figure 34. Classification of related work

The buddy bench and the bicycle bench have an apparent influence and their design is straightforward in terms of what it is designed to achieve; however, with those designs, there is the opportunity to deviate from the design and just ignore the activity. The goal of the tilted bench design is evident, even though it can have multiple meanings. However, with this design, it is not possible to avoid it and regularly sit, since it does not allow for that type of activity. When it comes to altered bench location, the goal of promoting physical activity is not as obvious as in the previous designs, but the impact of this design is comparable to that of the tilted bench, as they both do not allow for alternative behaviour. This classification will be shown to the participants of the brainstorming session at the end of the discussion to obtain additional information on the type of design they prioritize.

5.4 BRAINSTORMING SESSION

As explained in the methodology, five older adults participated in this brainstorming session. They were walked through the content of the session and everyone agreed on the purpose and objective of the brainstorming. There were no obvious outliers when it came to physical activity or technological skills. The information that they provided is presented in the following subchapters. It will be analysed by looking for reoccurring themes in the textual information given, the important quotes that will be cited and the diagrams made during the session.

5.4.1 Initial discussion

In the initial discussion, the participants were asked questions from Figure 15 as detailed in the methodology section. The participants mostly answered the questions individually, but in some cases, a conversation developed around a particular issue, and more participants became involved. Participants would occasionally modify or adjust their replies in these cases, rationalizing it as something "they were reminded of" or something they "would have forgotten if it had not been mentioned" by another participant of the session. The answers and their analysis will be categorized depending on the theme as shown in Figure 15.

Social factors

When questioned about their social lives, the participants commonly acknowledged that one of the most significant aspects of their lives is their social connectedness. All five participants said that their family and close friends are the most important to them; however, four out of five participants stated that they see their family members between once a week and once a month.

Participant 2: "My children live abroad and I don't get to see them that often, we usually video call every week, but I miss physical contact."

And:

Participant 4: "The majority of my old friends passed away and I don't have kids, but I am lucky that I am still in a happy marriage. I don't know what I would do without my husband."

Even the one participant that lives close to his loved ones stated that they do not see each other as often as he would want.

Participant 1: "My daughter lives in the same building as me, but you know how it is: she now has a family, children, and a lot of daily duties, and I, as a retiree, have a lot more free time than she does."

The participants pointed out the age difference to be an important factor when it comes to the relationship they have with their families. Younger people tend to have less free time as they still work. Furthermore, the participants stated that they enjoy conversations with people of their age a lot more since they share comparable experiences. Four out of five participants said that they see their neighbours more often than some of their close friends and family members.

Participant 5: "I see friends that live close to me almost every day. Since I have a lot of free time, I often go out for a walk and meet several people along the way. We usually have a chat or go to the supermarket together."

The other participants have similar experiences as well. They all emphasized the strength of the community in the area, stating that they know a significant number of older adults and see them on a daily basis. This appears to support the findings of the observations and demonstrates that even members of the community are aware of its importance.

Participant 5: "We all know each other (in the neighbourhood) and for me, personally, this sense of community is extremely important. I've been missing social interactions since my wife died, but this community is actually helping me deal with my loneliness."

Participants 3 and 4 also mentioned that one of their favourite parts of the day is spending time with other older adults. This in-person contact with people of their age keeps them informed about current events and activities that are popular among this age group.

Physical activity

Despite the fact that this age group may have greater physical limitations than younger individuals, the participants stated that their physical state and staying active were highly important to them. Taking a leisurely walk was mentioned by all the participants as their favourite physical exercise; however, they had a different understanding of what that meant to them. Participants 2 and 4 stated that due to their physical health they mostly walk up to one kilometre a day when doing errands, while Participant 1 walks a few kilometres every day.

Participant 1: "I think staying active is essential for people of my age. I still walk up to 5 kilometres per day and always take stairs instead of the elevator."

All five participants agreed that strenuous physical activities that require a lot of physical effort are not appealing to them, and they added that they believe this is also true for the vast majority of other older adults they know.

Participant 5: "Even though I believe that staying active is vital, it is not required, and it might be difficult for us to perform additional exercises. It is sufficient for me to go for a short walk once or twice a day."

The participants also referred to COVID-19 restrictions and the lockdown and the extent to which it affected their physical state. They stated that not being permitted to go outdoors

had a severe impact on their physical state and that it took a few months for them to regain physical strength and become comfortable with walking long distances. This implies that when it comes to older adults' habits, consistency is key.

Participant 1: "At the time, I was fortunate to be at my weekend cottage in the countryside rather than in the city, so I was able to keep myself busy by going for walks and performing tasks in my garden. That really saved me."

And:

Participant 4: "For someone who is in their 80s, the lockdown had a detrimental effect on me, especially since I had broken my hip a few years ago and was still recovering when the pandemic happened. I'm still dealing with the consequences, and restoring my vitality is considerably more difficult."

When asked about the time of the day they are most active, the participants said it varies depending on the season and weather. During winters, they move throughout the whole day when it is not snowing or there is no ice on the streets. However, since it gets very hot in the middle of the day during the summer, they prefer being out in the morning and afternoon.

Participant 2: "During summer, the temperature sometimes reaches 35 degrees, which is unbearable, so I prefer to go outside between 7 and 10 a.m. or late in the evening around 8 p.m."

The other participants agreed with Participant 2 and stated that their outside activities are mostly dependent on the weather.

Participant 1: "I'm becoming more sensitive to extreme weather as I get older, and it's having a huge impact on my overall health. When the temperatures are too high or too low, I try to spend more time walking inside my apartment rather than going outside."

Technologies

The extent to which the participants reported using technologies in their life varied. Three participants stated that they use different types of technologies several times a day, while one person said they use them several times a week and one reported using technological devices only occasionally. Nonetheless, all participants agreed that the smartphone is the most significant and preferred device. All five participants own some kind of

smartphone for at least three years and use them for various purposes. They stated that smartphones are mostly used for communication and staying in touch with other people, as well as for obtaining various types of information such as news and weather forecasts. Three respondents also mentioned that they have totally shifted from print to electronic newspapers.

Participant 1: "I completely got used to my smartphone. I use it to contact my grandchildren and I even have Facebook and Whatsapp. It was difficult in the beginning, but I mastered the basic functions and it made my life so much easier."

And:

Participant 2: "I used to spend so much money calling my children abroad, but the smartphone made it so much cheaper. I started using it mostly to stay in touch with them, but now I even look for recipes online or set reminders to take my medicine."

However, even with all the benefits, the participants pointed out some of their struggles with using smartphones. They are mostly related to the usability of the apps and the search engines and even the language barrier. Four people said that the fact that they do not speak English makes it significantly harder to use some applications or the internet. They mentioned the lack of intuitiveness as one of the major hurdles with regard to smartphone applications.

Participant 4: "I have various apps on my phone, but they rarely have an option to be translated to Serbian, so some younger relatives of mine have to translate the functions to me and then I have to learn it by heart. That's very hard for me."

And:

Participant 1: "The buttons and text are often too small and I struggle with using several functions because of that."

Concerning other technologies, the participants haven't pointed out any in particular. The majority of them use a wired phone as well, a TV or kitchen appliances. None of them uses any other type of new technology like a smartwatch or smart home devices. When asked about them, two participants pointed out price as the main reason for avoiding these products, while the other three said that they are too complicated or unnecessary.

Participant 1: "Smartphones are great, but I wouldn't go any further than that. Everything that I need right now, I can do with my smartphone. I could use some improvement with the features, but I don't think I would have the patience for learning something completely new."

Public spaces

The participants normally spend the majority of their time outside in the same public areas. They all stated that their neighbourhoods were the primary gathering place for public activities such as socializing with other people. Due to mobility or transportation issues, they frequently visit places within walking distance. Furthermore, they responded that the locations they are most comfortable with are the ones they are most familiar with. They also pointed out that the place in which they spend time is determined by the other people they are willing to meet rather than the quality of the particular place. These socializing places are already established in the majority of these communities, and residents are aware of where they may meet other individuals their age. Some respondents stated that they go outdoors intending to meet people, while others stated that they spontaneously meet people on a regular basis when they go outside for different reasons.

Participant 3: "I spend most of my time in the nearest park. A lot of people from the are meet there. We sometimes play chess, but mostly just chat."

And:

Participant 2: "When I first moved to this area, I noticed a few older adults frequently sitting on a bench in front of the building where I live. I began talking to them on my walk home from the grocery store, and it has now become a habit."

These statements from the participants are in line with what was noticed during the observation sessions. They all agreed that the social factor is the deciding one when deciding on where to spend time outside. However, they acknowledged the fact that some places are more convenient than others.

Participant 1: "There are many spots to choose from, but as older adults, we prefer those with plenty of sitting room and shade created by the trees."

And:

Participant 5: "The most popular resting spots are those near walking paths since they don't require major rerouting and deviation from the original track."

5.4.2 Ideas generation

The last discussion topic from Figure 35 is used as a starting point for this subchapter. The participants were presented with the initial idea explained in Chapter 5.4.1. The participants were then asked to give ideas on how they would improve the idea or modify it.

Several ideas emerged as a result and they are categorized by the topic and colour as presented in Figure 16 and are placed on the bull eye's diagram. The final diagram is in Figure 35, while Figure 36 represents the digital version in English.

Figure 35. Filled in bull's eye diagram in Serbian

Figure 36. Filled in bull eye's diagram In English

5.4.3 Influence type discussion

Following the brainstorming session's ideation phase, the participants were shown relevant work examples and a diagram from Figure 34 and asked for their thoughts on the topic. They all liked the concepts given in Figures 29 and 31, and they characterized them as non-obtrusive. What they enjoyed most about them was the ability to choose whether or not to engage. The majority of them emphasized that, due to various physical constraints, the amount of physical activity varies greatly among different people, particularly among older adults, and that a design that forces them to leave the bench would be unfavourable. That is, at the same time, why they all disliked the tilted bench depicted in Figure 30 and said that it may even cause physical injury to some people with mobility difficulties. The participants thought the idea in section 5.3.4 about the placement of the benches was an interesting one and agreed that it would not be as invasive as the tilted bench; however, it could also prevent certain people from using it, if, for example, the benches were placed far away from the walking path in their case. They also responded that they prefer an apparent influence over a hidden one.

5.4.4 Readability ideation

The readability ideation phase was the last step in the brainstorming process. The goal of this phase is to talk to older adults about the best interface options and get a better knowledge of their reading abilities. As a result, a few options in terms of font size and colour combination were offered. Figure 37 illustrates this. The text was given in font sizes 11, 13, 15, 18, 21, 25 and 30 px, and regular and bold options were presented on the laptop screen. The colour combinations were strong contrast, with a darker background and lighter writing on one side and vice versa on the other.

Figure 37. Interface ideas, font sizes and colour combinations

To begin, participants were asked which colour combinations are the easiest to read and which ones they like. They all agreed that the first one, in black and white, is simple to read but dull and uninteresting. In addition, four out of five participants said the second and third combinations aren't really appealing, but the last two are. They all favoured the latter two options, particularly those with a darker background and yellow or grey writing.

When it comes to the font size and type, the participants agreed that whether the text is bold or not makes little difference in terms of readability, and that bold text is even somewhat more difficult to read; however, they found the size of the font to make the most difference. When asked what is the smallest font they feel comfortable reading, four participants said 15

px, while one said 18 px. They all agreed that 11 px is far too small and difficult to read. On the other hand, they believe that 30 px is excessively large and distracting. It was decided that any size between 18 and 25 px would be acceptable.

6. SPECIFICATION

In order to start the development of the product and the device itself, it is necessary to specify the important characteristics and functions the system should have. This will be done by specifying the requirements for the project. These requirements will be based on the background research, observations, and brainstorming session, but also on the feasibility and the time available. The requirements will be categorized into two subcategories: user requirements, which are based on the ideas given by the participants of the research, and developer requirements, which are based on the available time and resources.

6.1 USER REQUIREMENTS

Through the analysis of the answers from the previous Ideation chapter, and more particularly, the brainstorming session with the participants and potential users, some reoccurring themes are first noticed in the observation sessions and then confirmed by the participants themselves. Those are, for example, their everyday physical activities or social habits and behaviours. Those reoccurring topics were the base for developing the list of user requirements. Furthermore, the discussion about the type of design influence and the usability of the product were also taken into consideration when putting together the list. However, not all the ideas had the same frequency of occurring and level of importance, therefore, the requirements are categorized into three: must, should and could, indicating their level of significance. The final product of this process is presented in the form of a list in Figure 38.

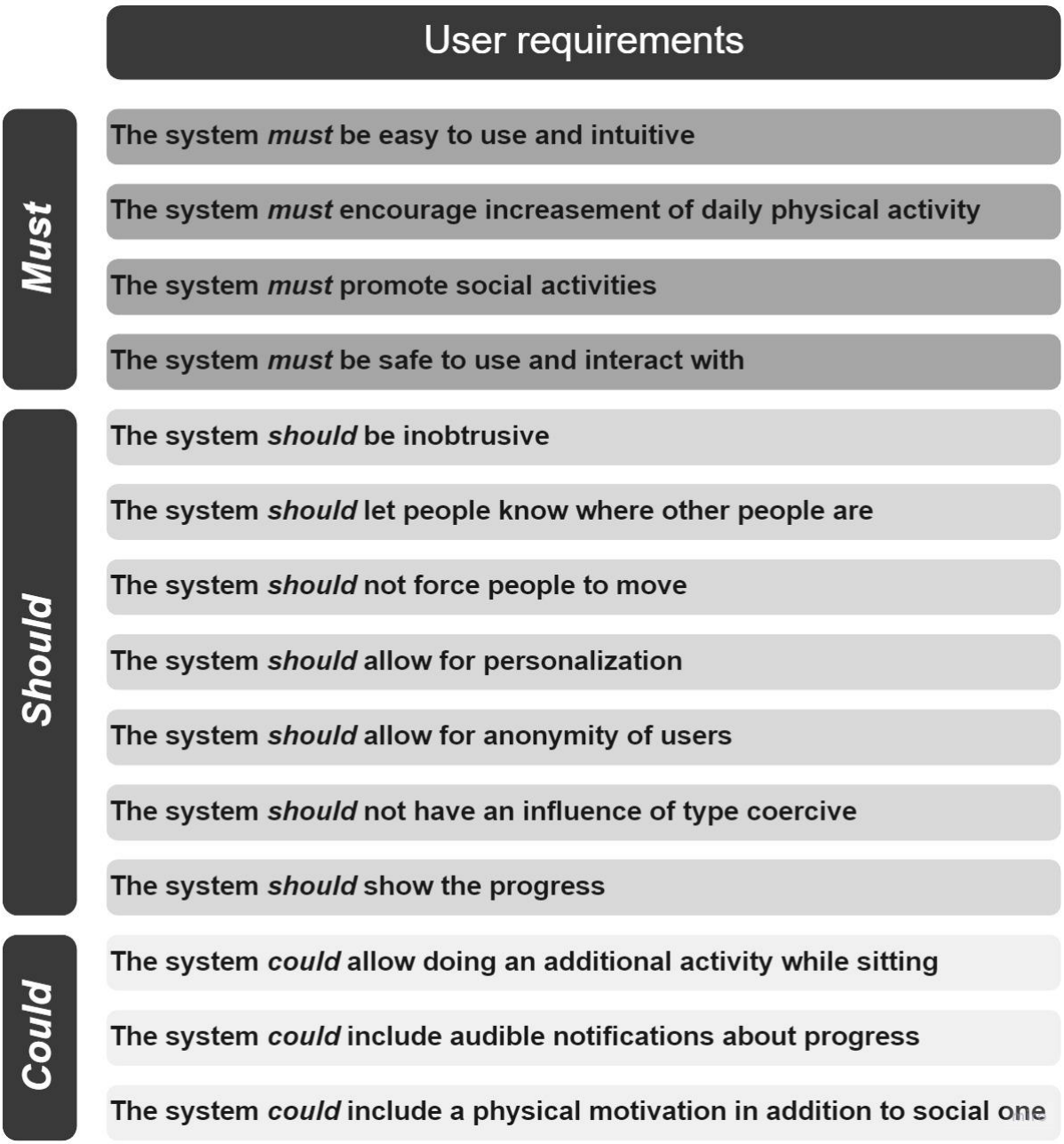

Figure 38. User requirements

6.2 DEVELOPER REQUIREMENTS

Aside from the user requirements list, a list of developer requirements was made to accommodate the project requirements and restrictions. They are presented in the table in Figure 39.

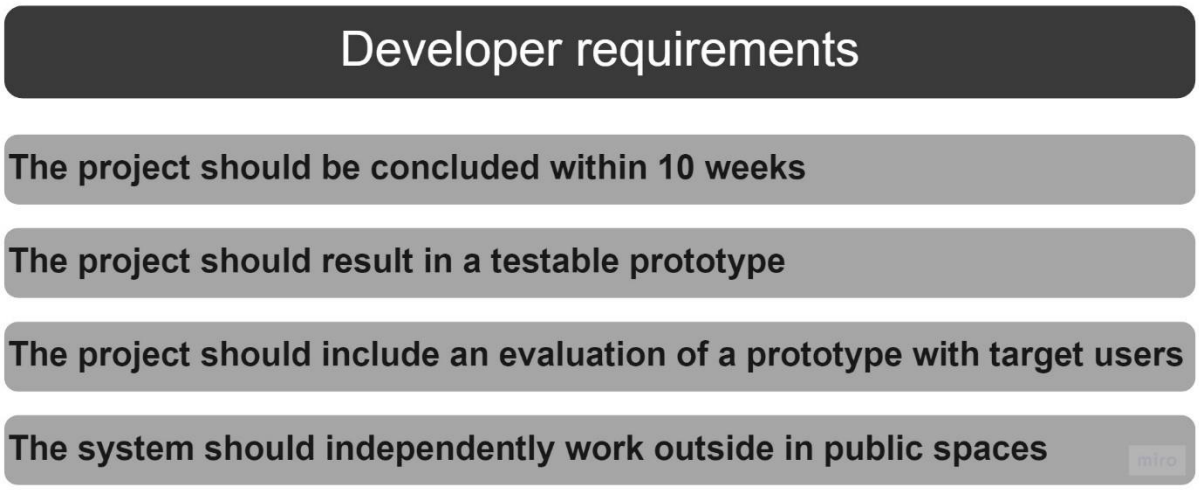

Figure 39. Developer requirements

6.3 CONCEPTS DEVELOPMENT

Based on the requirements identified in the previous two subchapters, three ideas were developed. The difference in the ideas comes from the different technologies used, which leads to the difference in the features they offer. The three concepts are explained in the subchapters below.

6.3.1 Concept 1

The first idea would mostly rely on older adults' private smartphones. This idea would entail creating software that could be utilized by all older adults who own smartphones since it was stated to be widely used among this age group. The location of the phone will be the primary tool used by this program. Users will be able to see where they are in the area and where their friends are based on their location. The most important goal of this concept is to provide older adults with a game-like experience where they will be given tasks that they should fulfil. These could include tasks such as how many benches they should pass that day, or similar. Based on how many tasks they have fulfilled, they can compete with other people using the application. This concept would, however, prevent people who do not own a smartphone from using it, which is still a large share of this age group.

6.3.2 Concept 2

The second idea would be based only on the bench integrated system with the interface also being bench implemented. The bench itself would be the one that the participants are

interacting with. When the bench detects sitting it would allow the user the exact time they wish to stay sitting, 5, 10, or 15 minutes. This could be selected through the buttons on one side of the bench. When the user-selected amount of time has elapsed, the bench will vibrate in the seating area to let the user know that the time has passed. Once someone stood up, the vibration would stop. By just making it uncomfortable to continue sitting, this concept would guarantee that the user will not continue to do so. The technology does not, however, allow for identification and personalization, which older persons in the brainstorming session regarded as being crucial.

6.3.3 Concept 3

The third concept combines the functionality provided by the application and the bench integrated system. Users would be identified on the benches by the sensors implemented inside the benches. Additionally, a screen on the floor in front of each bench would alert users sitting there where other people are detected on the benches in the area. In this way, after some time has passed, the older adult sitting on the bench would go to the other bench where other people are seated. The supplementary application would also provide extra features like data storage, progress monitoring, and general experience personalization. This combination of features that these two technologies offer, makes this concept the most promising one. This idea was selected as the base for the final design.

7. REALIZATION

This chapter will include the elaboration of the final idea chosen and the realization of the testable prototype of that idea. The final idea will be described in detail. This will be followed by an explanation of how the prototype was built and what it consists of.

7.1 FINAL CONCEPT

The final concept is divided into two parts: a physical implementation on a public bench and an additional smartphone application. This strategy was determined to be the best for meeting the majority of user requirements. The goal of this concept is to create a network of benches along a walking path in one area. The neighbourhood depicted in Figure 24 is selected as a starting point in this case. In this scenario, all 24 seats would have sensors that would detect when someone sat on them, as well as a screen on the floor in front of them When someone sits on a bench, the timer starts and counts down 10 minutes from the start of the sitting behaviour. After 10 minutes, the screen on the floor will show an arrow to a person sitting. This arrow would depend on the other benches and where other people are located. The system will detect the nearest bench with people and will lead the individual there. This concept is presented in the storyboard in Figure 40. In this way, the need for social connection will encourage older individuals to move from the bench they are sitting on a walk to a location where other people were detected.

Apart from this physical concept, it was determined in the ideation chapter that older individuals appreciate personalization and data storage. The supplementary smartphone application will be built in order to incorporate this feature as well, while still allowing users to remain anonymous. The individuals who do not wish to download and use an application will be able to use the basic feature explained in the previous paragraph. Those who want to take their experience to the next level, however, may make use of the application's additional features. Users will be able to create their profiles and connect with other individuals they know are using the application. Furthermore, because of this addition, every bench will have a Bluetooth sensor, besides the one that is detecting people. The application will, after first authorization, automatically connect to the benches older adults are sitting on and will store their information. Firstly, the users will be able to track how many benches they have passed in the previous several days, as well as how much time they have spent sitting. Secondly, the application will contain a neighbourhood map so that the users know where they are at the

moment. Finally, users will be able to see where their application friends are currently, as well as their progress over the course of the week.

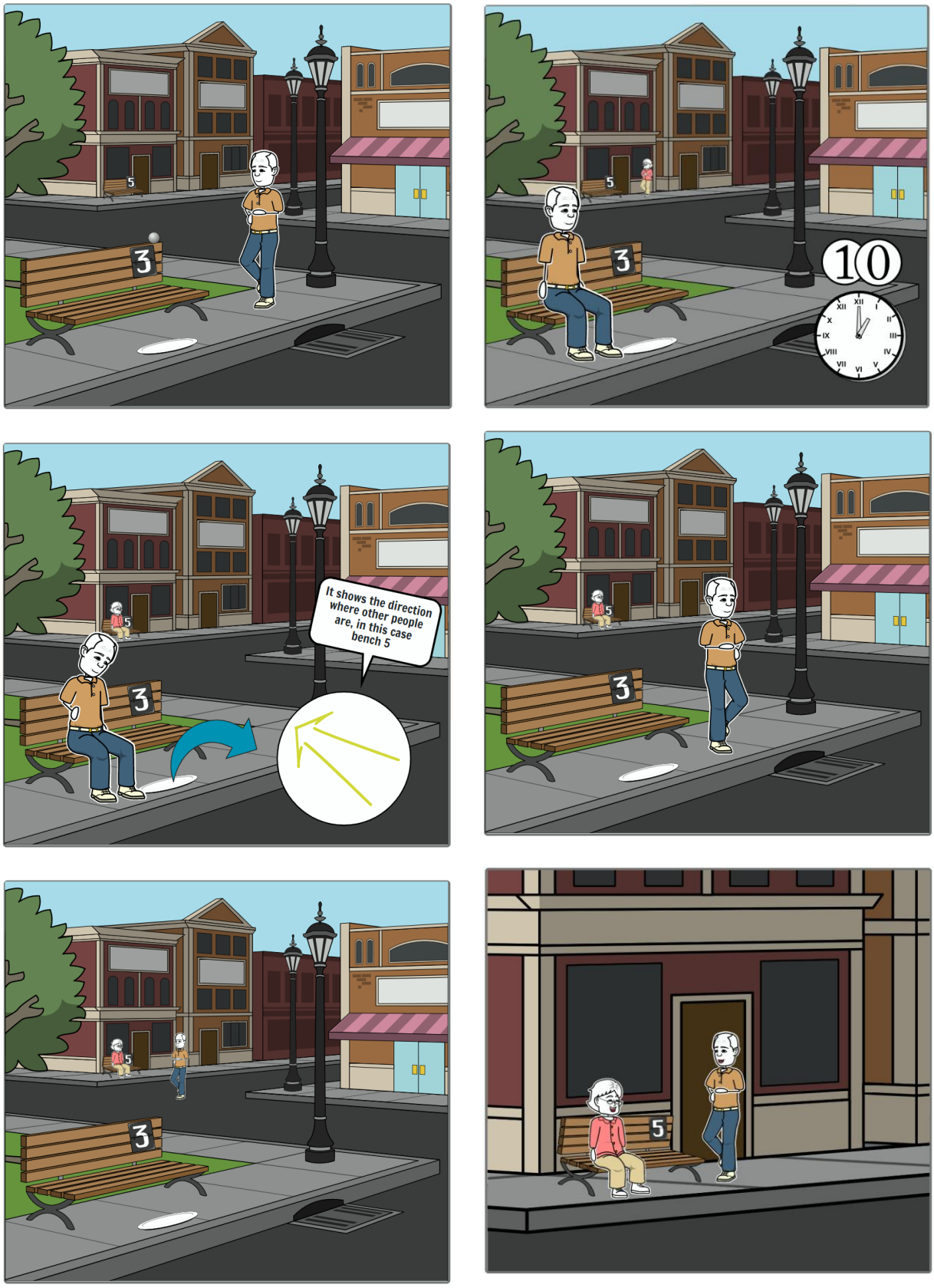

Figure 40. Storyboard

7.2 HARDWARE AND SOFTWARE COMPONENTS

The physical part of the prototype does not have all the features explained in the previous subchapter; however, it is made to be the best representation of the finished product that can be tested with older adults. For this purpose, a system using Arduino was made with the intention to be placed at the already existing public benches in the neighbourhood Serdara Janka Vukotića. This part of the prototype consists of the following components:

- Arduino Nano
- Infrared (IR) Sensor Module
- 8×8 Dot Matrix MAX7219
- Wires and cable

An infrared sensor was used to detect sitting and whether it is continuous or not, then this information was sent to the dot matrix which then prints an arrow on the screen. The picture of the physical part of the prototype all connected can be seen in Figure 41. Furthermore, Figure 42 includes a picture with the prototype showing an arrow. Besides these pictures, there is a fritzing scheme showing how all the components are connected. It can be seen in Figure 43.

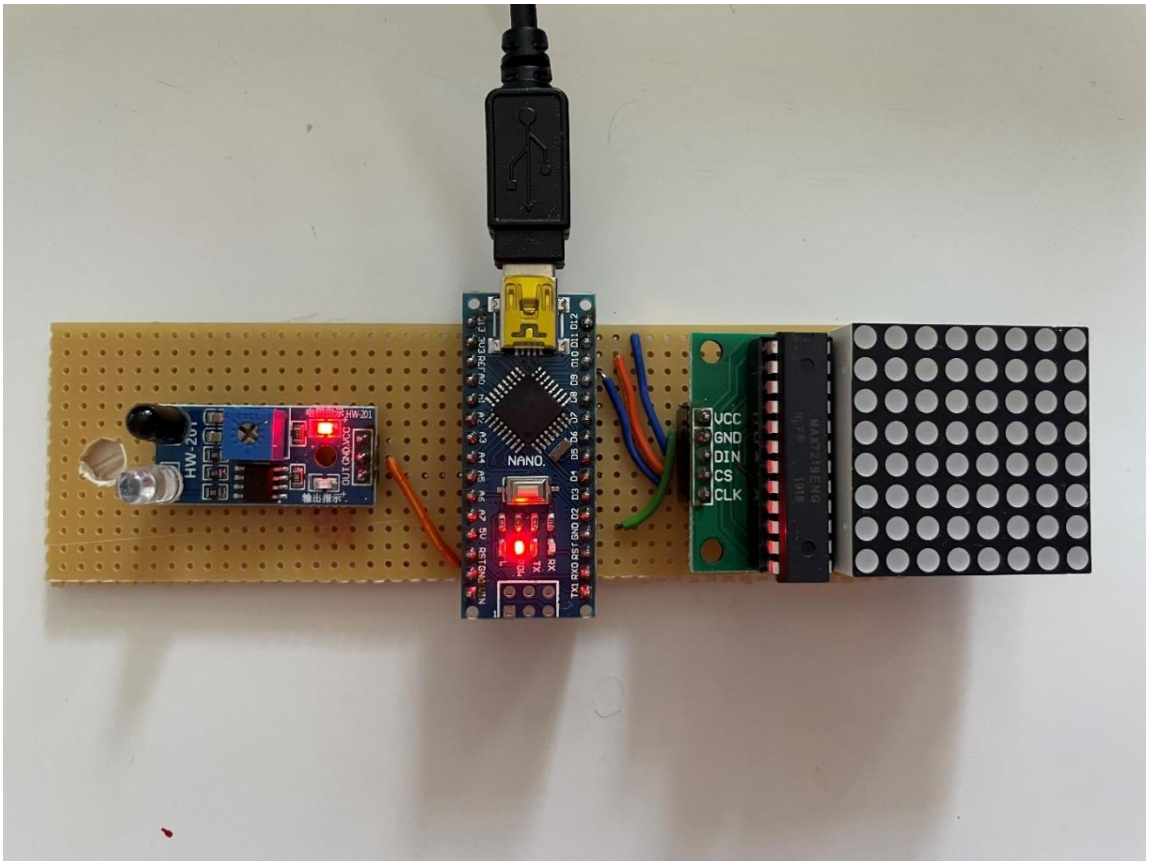

Figure 41. The physical part of the prototype

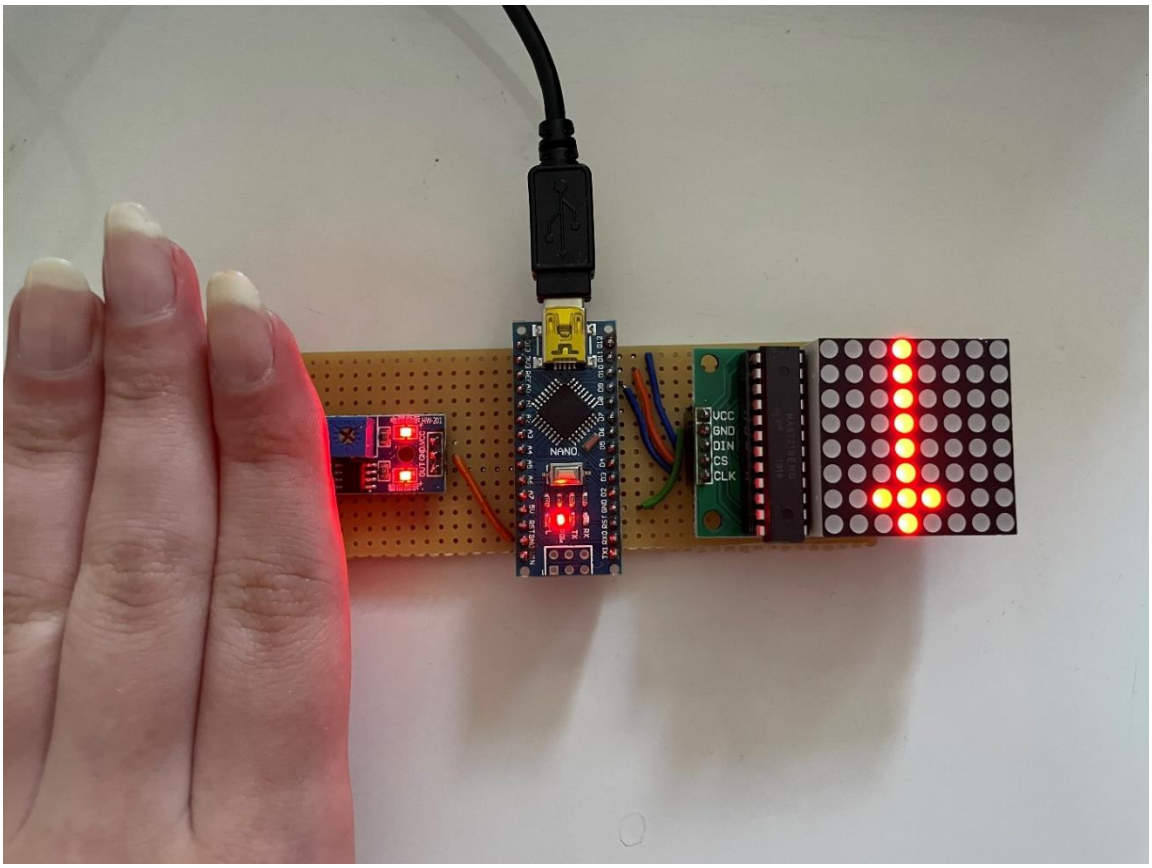

Figure 42. The physical part of the prototype shows an arrow

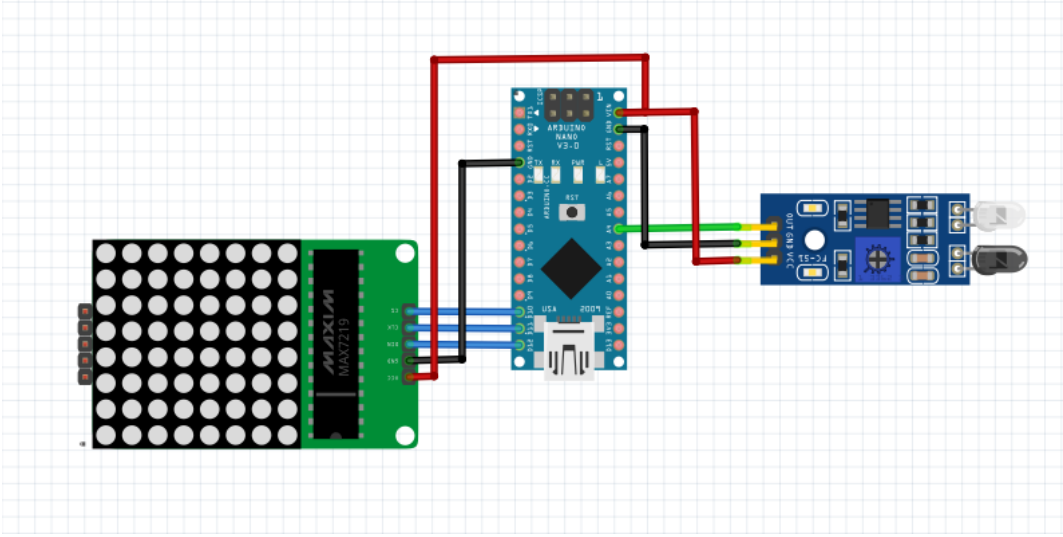

Figure 43. Fritzing scheme of the prototype

The dot matrix can be programmed in several ways to print any 2D shape within an 8x8 frame. For this prototype, the left and right arrows were programmed as presented in the first two parts of the code in Figure 44. The third one presents a circle that the matrix prints from when the sitting is detected until the arrow appears. The printed circle is presented in Figure 46, while the example of an arrow is presented in Figure 45.

```
char right_arrow[8]={

  0b00010000,
  0b00111000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,

};


char left_arrow[8]={

  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00111000,
  0b00010000,

};

char sitting[8]={

  0b00000000,
  0b00011000,
  0b00111100,
  0b01111110,
  0b01111110,
  0b00111100,
  0b00011000,
  0b00000000,

};
```

Figure 44. Code, left, right arrow and a circle

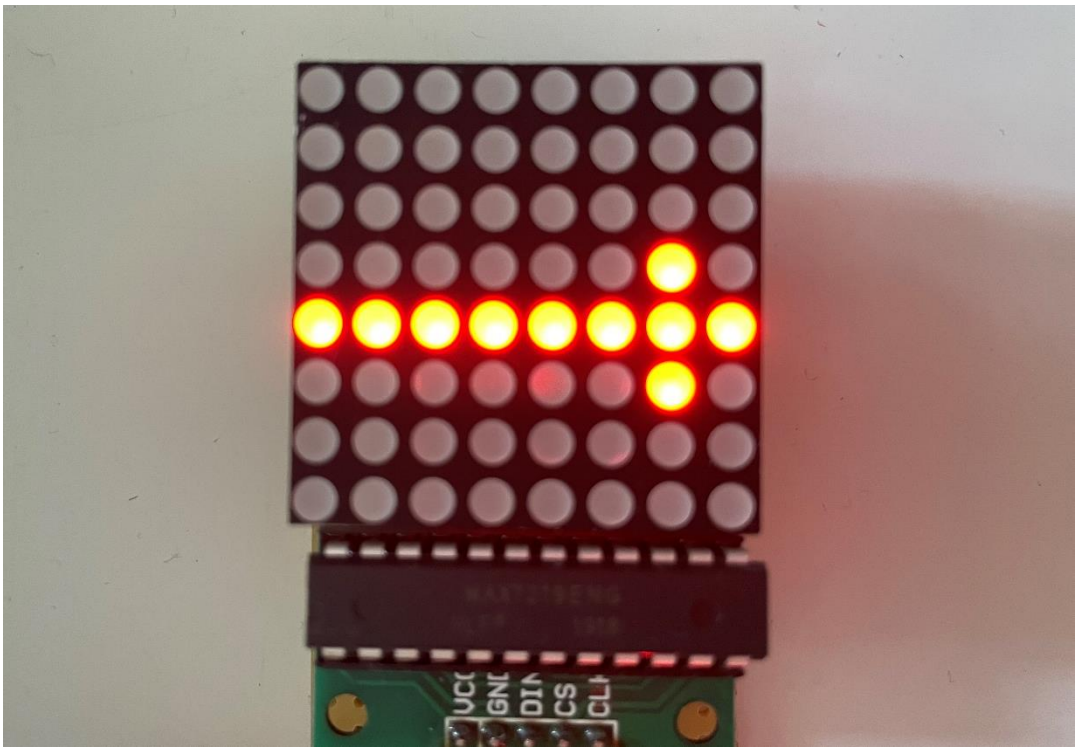

Figure 45. Arrow on matrix

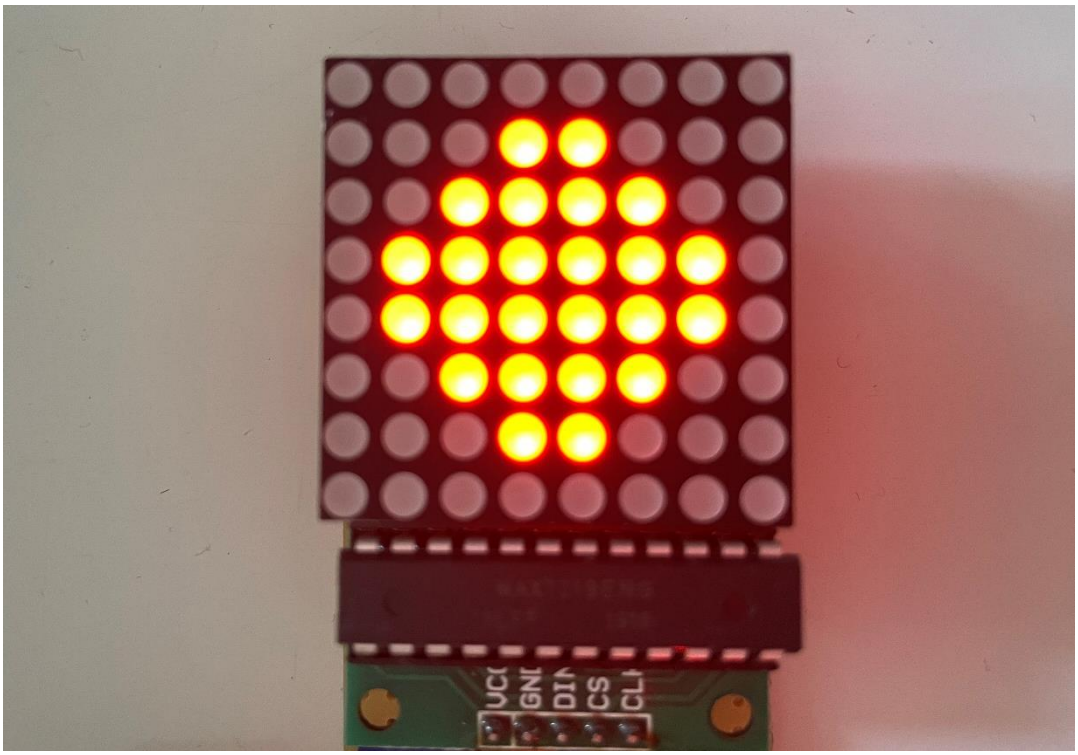

Figure 46. Circle on matrix

The essential part of the code that controls the time in which the arrow will show and the direction of the arrow is presented in Figure 47. The part of the code where the time is controlled is marked with a comment “Sitting timeout” while the part which controls what is

printing out on the matrix is marked with a comment “Code for direction”. The rest of the code can be found in Appendix B.

```
if (SittingState == LOW && lastSittingState == LOW)
{
     sittingTime = millis() - sittingStarted;

     if (sittingTime > 10000)   // Sitting timeout
     {
       // Code for direction
       Display_Left();
     }
}
```

Figure 47. Time and arrow code

7.3 ASSEMBLED PHYSICAL PROTOTYPE

Figure 48. Assembled physical prototype

Figure 49. Closeup of the bench

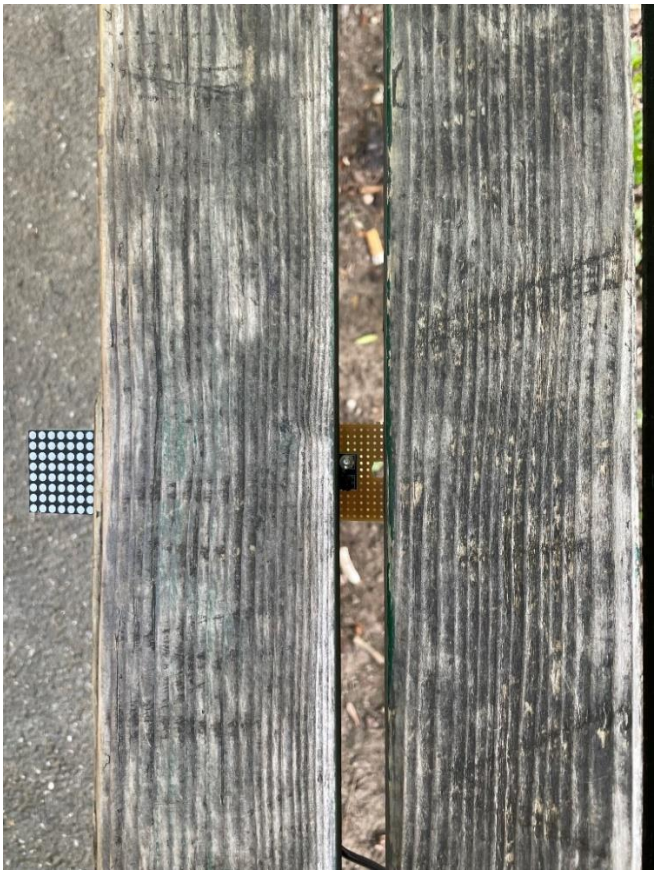

Figure 50. Bench integrated matrix and IR sensor

7.4 APPLICATION

An application, as mentioned in section 7.1, will be supplemental to an existing system. A prototype was created utilizing the online tool Proto.io in order to create a testable version of the application. The prototype is completely interactive and may be used to build a viable user interface. All the screens of the prototype are in Appendix C. The application's colours were chosen based on the readability ideation. Walkee was chosen as the application's name since it is simple and has a straightforward logo featuring a bench. The logo is presented in Figure 51. There is also a representation of how the icon of the application would look on the smartphone. This can be seen in Figure 52.

Figure 51. Logo for the application

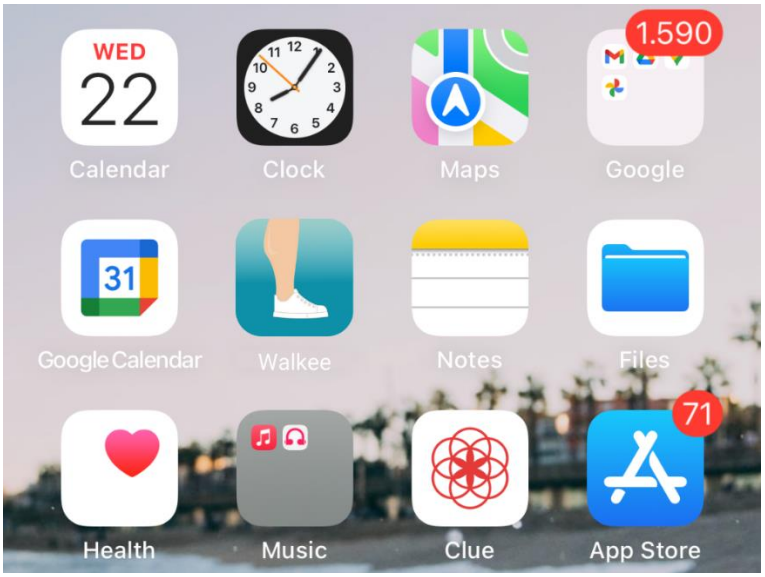

Figure 52. Application icon with other icons

The application has two versions, English and Serbian since the participants of the brainstorming session complained about know knowing the English language. Because of that, when the application is opened by the user, the first thing they will be able to select is the language. This screen can be seen in Figure 53.

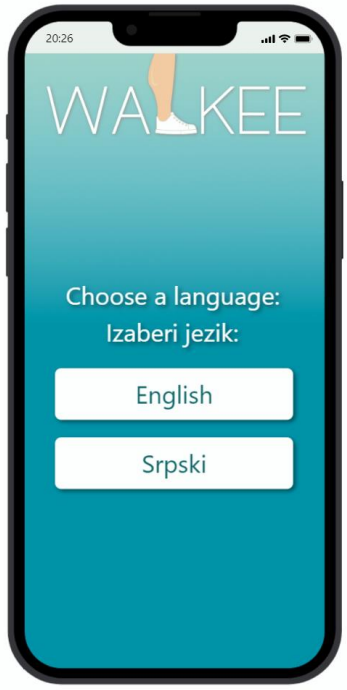

Figure 53. Language selection screen

When language is selected, the user will be asked to fill in personal details and to connect to the nearest bench via Bluetooth. Once that is done, the application is supposed to automatically connect to every other bench in the network. Based on those connections the application would be able to store data about where the user is currently, as well as how many benches have they passed or how much time they spent sitting. These screens can be found in Figure 54.

Figure 54. Map and progress screens

Furthermore, the users can connect to other people using this application if they want to. If they decide to make friends with people through the application, they will be able to see them on the map if they are sitting at any bench in the network at the moment. This can be seen on the first screen in Figure 54. Also, they will be able to compete with their friends because they will be able to see their progress as well, which could serve as an additional motivation. This screen can be seen in Figure 55.

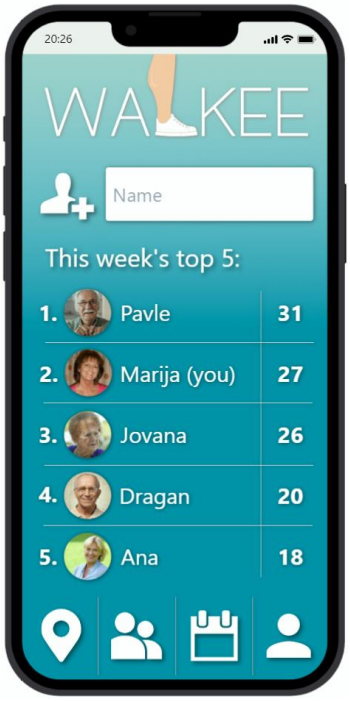

Figure 55. Friends' progress board

8. EVALUATION

An evaluation session was organized once the prototype was developed. This was done to see how far the prototype had succeeded in achieving its purpose and meeting the specification criteria. The method for this phase is explained in the methodology section 4.3. This chapter will present the detailed process and the results of the evaluation session. To begin, user experience testing was carried out, in which five participants that already participated in the ideation session were requested to use the prototype and were monitored during the session, after which they were given a few questions about their experience. Lastly, the participants were invited to complete a survey evaluating the prototype's usability and readability. The evaluation session took place on the 22nd of June 2022 in the neighbourhood Serdara Janka Vukotića.

8.1 USER EXPERIENCE TESTING

8.1.1 Observations

As explained in the methodology, in this stage of the user experience evaluation the participants were asked to engage with all the parts of the prototype and show how they would use this product in their everyday life. All five participants did this task independently and were observed independently of each other. Firstly, I, the researcher, explained what the prototype is, what is its goal and what are its parts of it, but I did not explain how to use it step by step since in this stage the intuitiveness of the prototype was also tested. Although, the participants were informed about the parts of the prototype that weren't completely functional, such as the direction of an arrow or the application not connecting to the bench. The participants were then interacting with the physical part of the bench and after that was done they tried out the prototype of the application. If they had a smartphone of their own, the link to the application prototype was delivered right to it; if not, they received a smartphone that already had the application on it. The observations noted are divided into three main criteria: face expressions and body language, smoothness of the interaction, and intuitiveness. An example of one of the participants trying out the application can be seen in Figure 56.

Figure 56. The older individual using the application prototype

Face expressions and body language

While interacting with the prototype, participants' behaviour was observed and noted, and more specifically their face and body movements. The goal of this observation was to understand participants' emotions and feelings towards the prototype and different parts of it. In general, the participants positively reacted to the prototype. They were smiling and interacting with the prototype without hesitation. Participants' expressions frequently showed signs of joy, typically when they found a new feature or completed a task successfully. In some instances, they even spoke out loudly to express their joy, making statements like:

Participant 2: "Oh, it lights up. Nice!", when the arrow appeared on the matrix.

All participants looked comfortable sitting on the bench and did not show any signs of anxiety or disturbance in response to the device linked to the bench. A slight confusion was observed in some cases which were connected to the matrix that is supposed to show an arrow because it was smaller than expected, so some participants were not able to spot it easily.

With regard to the application, participants were positively surprised by it. They all seemed comfortable with using it especially since it had a version in Serbian. They looked like they understood all the tasks given on the screen and followed them without any signs of confusion. They looked comfortable using a smartphone, especially the two participants who used their own smartphones. Participants' faces showed no evidence of struggle when pushing buttons or reading the application's text, indicating that the readability was satisfactory.

Functionality

Assessing if the product will serve its purpose was one of the key objectives of this evaluation session. Unfortunately, because the evaluation session was so brief (approximately 30 minutes), it was impossible to determine if the system will unquestionably alter the daily behaviour of older individuals. The individuals did, however, express verbal and nonverbal expressions of enthusiasm and reinforcement that may be viewed as a promising indicator of progress. Several participants showed interest in discovering who are the people sitting on the bench an arrow is pointing at. One participant even said:

Participant 1: "Even if I would not join the other person sitting on the next bench, I would be interested to go and see who it is."

Participants also looked intrigued using the application and expressed excitement with comments such as:

Participant 3: "Can it really track all of this?"

Or:

Participant 4: "It would be so cool if I could compete with my friends like this!"

These remarks show that the system has the capacity to perform as intended and that potential users would be interested in using it for its functionality.

Intuitiveness

Since in the ideation phase the participants indicated that they are not proficient in using various types of technologies, the intuitiveness of the system is extremely important for this age group. This was also one of the top priorities in the user requirement list in section 6.1. Whether or not the system is intuitive was judged based on their behaviour towards it and the smoothness of the interactions, As was previously mentioned in this chapter, the participants were not informed about all the details and how exactly to use this prototype in order to properly judge whether it is easy to use on its own.

In general, it was not observed that the participants were struggling with anything in particular. Using of the application prototype was smooth for all the participants, they were able to understand the tasks and follow them accordingly. With regard to the bench itself, as already mentioned, some participants struggled to spot the screen, but other than that all the other interactions looked simple and easy to conduct.

8.1.2 Interviews

Even though the observations revealed many useful insights into the user experience, a semi-structured interview with each participant was conducted in order to obtain additional information and potentially validate remarks made during the observations, as explained in the methodology. This interview lasted around 10 minutes per participant and all of them were asked the questions listed in section 4.3.1. The answers and their analysis will be divided into two categories based on the topic. Those will be the titles of the subsections below.

Motivational capabilities of the prototype

After using the prototype during a session, all of the participants were aware of the desired purposes for both the potential product and this prototype. Even though it is impossible to predict the prototype's level of motivational power, early judgments might be made based on participant interviews and observational findings. The prototype's level of intrusiveness was well-received by all five participants, with several saying they appreciated its subtlety and freedom of choice.

Participant 1: "It is not coercive, I like the fact that I can stay sitting on the bench."

And:

Participant 3: "It's good that everyone participating in this system can choose their level of involvement and decide not to use the application if they don't like it."

Thoughts on whether the system is more beneficial with or without the application, however, were divided. Some people claimed that the system is very helpful even without the application, pointing out that the inability to see who is seated on the other benches would be an extra motivating factor to get people to relocate.

Participant 4: "My age group, including myself, is quite curious about other people's whereabouts and activities. I believe that this product would make good use of older people's curiosity and turn it into motivation."

Other participants, on the other hand, expressed amazement with the application and mentioned that its added features are what appeal to them. Two participants indicated that they believe measuring their development and evaluating it against that of others their age will significantly boost their motivation. They also mentioned how the application's map, which depicts the area visually, greatly aids in better coordination.

Participant 2: "Without a doubt, I would also use the app. It dramatically improves the system and the overall experience."

And

Participant 5: "It is excellent that you can track how other individuals your age are progressing. Not only does it increase my desire for competing, but I can also see how active others in my age group are and whether I am falling behind."

The participants also mentioned that it would be beneficial if the application allowed users to set goals for themselves or their friend group and get alerts when required.

Participant 1: "Sometimes I forget to check my phone, so being able to turn on notifications would be great."

And:

Participant 5: "I should be able to set my objectives and monitor them in the application so that I may increase them as I improve."

Other than this, the participants made no significant suggestions for improving the prototype's ability to motivate them. They all were overall satisfied with the prototype's motivational capabilities by emphasizing how it would benefit them if they had it. When asked whether they would recommend it to other older adults, they universally answered affirmatively, particularly given that using the application allows them to connect with them in a way that is advantageous to both parties.

Participant 1: "I would recommend it to anyone interested. I love the idea and I think it would be very beneficial for our neighbourhood."

Functional capabilities of the prototype

Besides the motivational capacity of the prototype, its functional capabilities were equally important. Through the interviews, it was determined if the prototype physically works and if its features contributed to the prototype as a whole. As reported by the participants, they observed no particular errors when using the prototype. They said the features were well-integrated and easy to find and use. Regarding the prototype's physical design, they simply made note of the matrix's problematic size, which was already noted above and is directly connected to usability. Other than that, they made no specific mention of anything that was defective or non-operational.

Participant 3: "Everything worked well and I felt comfortable using the prototype."

The participants brought up the possibility of a bench interface in addition to the bench integrated system, giving the example of setting up sitting time. One participant said it could be a good idea to determine the ideal time for a particular person to sit before the arrow suggests they move.

Participant 4: "There could be buttons available directly on the bench that people can press to select how long they can sit before the arrow displays, like 5, 10, or 15 minutes."

The participants also suggested that the sensor used to detect sitting may be enhanced to sense not just if somebody is sitting but also how many people are sitting on a given bench. Due to the existence of Bluetooth sensors, they were aware that exact functionality was available when the application was being used, but that was not the case when it was not used. For this reason, they advised either adding multiple sensors to a single bench or upgrading the sensor to one that can detect this.

Participant 5: "I would like to know how many people are where I am headed, this could greatly add to the whole experience."

With regard to the application, the participants did not notice any inconsistencies like with the physical part of the prototype. The functions worked well and the interactions were smooth. All the participants reported that it was easy for them to understand what they are supposed to do and the buttons and other text were straightforward and functional. They understood exactly what would result from the application's operations.

Participant 2: "The application was excellent, the language was clear and informative, and it was simple enough for anyone to comprehend."

The participants also described the map as static and a little uninteresting when asked what they would add or alter in the application. They proposed that allowing users to zoom in on the map would be extremely beneficial for individuals who have poor vision. One participant also proposed including a map with the location of the benches and their numbers.

Participant 5: "It would be easier for me to recognize where exactly I am in relation to other people if I could zoom in and see the map in more detail."

Aside from this, the participants were quite enthusiastic about the application, particularly those who tested the prototype on their own devices. One of them even stated that if it were offered, he would pay for an application similar to this one.

Participant 4: "I haven't seen anything like this yet. It is really interesting, I would consider using it even if it wasn't free."

8.2 USABILITY TESTING

Even though some of the usability questions were addressed during the observations and subsequent interviews, usability testing was nonetheless carried out as a distinct component of the user assessment to properly estimate the system's overall usability. The participants were asked to fill in a survey presented in Figure 15 in chapter 4.3.2. The results can be seen in Figure 57. All five filled-in surveys can be found in Appendix D.

Participant	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total score
Participant 1	5	1	4	1	5	2	4	2	4	1	87,5
Participant 2	5	1	5	1	5	1	3	2	4	1	90
Participant 3	4	2	3	1	5	1	3	1	4	3	77,5
Participant 4	5	3	4	3	4	2	3	2	4	3	67,5
Particiapant 5	5	1	5	1	5	1	4	1	5	2	95
											Average: 84,4

Figure 57. Usability scores

According to industry standards (*How To Use The System Usability Scale (SUS) To Evaluate The Usability Of Your Website*, 2015), a usability score higher than 80,3 is exceptional and granted a grade A, which is true in this situation as the average is at 84,4.

9. CONCLUSION

In this final chapter, the research will be summarized and it will be followed by a reflection on the research question and the discussion. Finally, the limitations and recommendations for future work will be presented.

9.1 SUMMARY OF THE RESEARCH

The main goal of this project was to design a product or a service targeting older adults as the user group and help them improve their overall health and well-being by encouraging them to increase their level of physical activity. Through the literature review, it was discovered that the social life and relationships that older adults form are crucial for their physical and psychological health. Furthermore, it was shown that changes in behaviour, such as modifying habits and lifestyle, may be highly impacted by one's social environment. For that reason, this project was focused on the social factors as the main driver for change.

Regarding related work and already existing similar solutions, there were a few examples that tackle one part of the problem, but none that social impact with physical activity of older adults. Projects like The Smart Carpet had the potential to do both; however, even in their case, older adults are not a target user group. That group of consumers is important to consider since older adults account for a larger percentage of the population every year, and the projections show that the number of older adults will only increase in the future. As a result, it was attempted to address this issue with this project.

The main method used was working closely with older adults themselves. The whole process was based on the Double Diamond design model combined with the Creative Technology process with included ideation, realization and finally evaluation. Older adults were included as much as possible in the whole process, through observations, interviews and creative brainstorming sessions. The research was conducted on the territory of Belgrade, the capital of Serbia. Even though the initial observations of older adults in two neighbourhoods, it was concluded that the communities of older adults in this region are quite strong and that they spend a lot of time outside and together. However, it was noticed that their behaviour is mostly of sedentary nature. After directly talking to them it was concluded that they are interested in increasing their physical activity, however, they emphasized that they would what that to be in a non-coercive way and with the freedom of choice. They mostly emphasized smartphones

and the technology they are most familiar with, but they were not against other types of technologies as long as they are easy to use and intuitive.

After the development of the specification list, a prototype was built to accommodate the majority of older adults' top requirements. During the ideation phase, the people were seen meeting each other on the benches around the neighbourhoods observed. Based on that, it was decided to build a system of smart benches that will encourage older adults to walk more, at least to another bench. The prototype of this concept includes 24 benches in one of the neighbourhoods along a walking path. Each bench has its own number and a sensor which detects whether someone is sitting on it. There is also a screen in front of each bench which shows an arrow in which the person can walk after some time sitting has passed. The direction of the arrow depends on where other people are detected on other benches. In this way, older adults can meet each other and walk more around the neighbourhood. Besides this physical component of the prototype, it was decided that it would be beneficial to build a supplemental smartphone application that older adults can use if they are interested in the application's additional features. People using the application would automatically connect to each bench they are sitting at and in this way, they can track their progress and even make friends through the application. Another benefit is the ability to compete with other older adults in physical activity and track their progress. This also implements social encouragement in this project.

The prototype was evaluated with the help of the same older adults who participated in the ideation phase. The goal of the evaluation was to check the motivational and functional capacities of the prototype. The participants were asked to use the prototype and were observed while doing that. This was followed by a short interview and finally filling out the usability survey. During the evaluation phase, no functional mistakes were noticed. The participants were able to use the prototype on their own and clearly understood its purpose. They were all positive about the product and stated that they would use it if it were available on the market. Some minor recommendations for improvement were made by the participants, but the prototype was generally successful in its purpose. In terms of usability, the prototype received a score of 84,4 from the participants, confirming the prior favourable results.

9.2 REFLECTION

As a reminder, the research question was the following:

How can a technology-assisted service be designed to benefit the strength of relationships in older adults' communities to encourage them to be more physically active throughout the day?

Through this research, I attempted to answer it in several ways. Firstly, I researched how to understand older people's relationships and their lifestyles. Secondly, I looked for opportunities in which spheres of life older adults could be more active. And lastly, I studied which technologies are most suitable for this age group and their needs. All of these resulted in a complex combination of solutions to cover all three aspects mentioned in a research question. The system is meant to utilize their smartphones, which they are already familiar with, as their primary method of system contact. It also makes use of benches, which they are already familiar with physically, and modifies them to provide an extra advantage to the user. The arrow on the bench integrated screen and the application itself are two ways in which the relationships that already exist between the older adults are made into extra motivation for them. By making use of the system, older adults can enhance their physical and mental health with little to no impact on their daily life activities.

9.3 DISCUSSION

The topic of social influence in the life of older adults addressed in this study is often overlooked in the scientific literature. Not many scholars consider that factor when talking about the health of older adults, even with the proofs that state how influential the social environment can be for an individual. As humans are social beings it is important to see and study them in relation to each other and not just as individuals. Michie et al. (2011) find social factors to be the most important ones in the process of behaviour change. There are several reasons for this. Firstly, the sense of commitment can be very strong and human beings feel responsibility when certain behaviour is promised to or is monitored by other people. Secondly, the nature of one's connection with another person can have a significant impact on how a message from one person is received by another. The emotions that one invests in a relationship with another person can have a massive effect on one's actions. Thirdly, humans are interested in others' options and their reputation in society. This desire to be liked may have a significant impact on one's actions. Older adults as an age group are even more vulnerable than younger people they are typically isolated and deprived of the majority of social connections. Because this can also be the cause of poor physical and psychological health, it is critical to treat both their mental and physical condition at the same time.

Despite knowing all this, scholars tend to avoid the subject and treat older adults as isolated individuals. Various reasons could be linked to this gap in the scientific literature and product development industry. On one hand, researching and designing for a group of linked individuals can be more challenging than when looking at only a single person and their

behaviour and lifestyle. Because the nature of human relationships is so diverse and may be extremely valuable, as mentioned in the preceding paragraph, it can also be risky. Relationships with other people cannot be foreseen, and products that rely on them face a high failure risk. On the other hand, the benefits of social interactions are not instant and can only benefit the users in the longer run. That is why it is difficult to evaluate a product that includes a social element, and it may prevent many scientists and developers from integrating it.

9.4 LIMITATIONS AND RECOMMENDATIONS

Despite this project's strength which is integrating two topics that are seldom combined, it also has certain limitations, some of which are closely related to its strength. Because the benefits of the design system may only be observed in the long term, as explained in the previous chapter, it is impossible to draw definitive conclusions after only one session of evaluation. Even though there are clear indicators that this system has potential, it requires more extensive and longer evaluation sessions, as well as several iterative development sessions. Furthermore, since the ideation session included a brainstorming session with several older adults together, it is possible that their responses were impacted by one another. It would be beneficial in the future to conduct more detailed sessions with users alone and in groups. It could also help to include more than five people in the research to ensure statistical significance with regard to the results.

The prototype itself was not fully functional and the outcome and the conclusions from the evaluation session could also be skewed because of that. Two parts of the prototype were not connected and people were not able to see where other people actually are and act on it. It would be necessary in the future to improve the prototype and conduct longer evaluation sessions in order to see participants' long-term responses to the system.

Another thing that needs to be taken into account is the location in which the research was conducted. The participants in the study are all of the Serbian descent and reside in the same area, making the study extremely homogeneous. This can have a huge impact on their answers and the feedback that they gave. Moreover, the observations were also conducted in the same area so the solution designed with this base could be difficult to implement in another environment. People from different cities, let alone other nations, have vastly diverse perspectives and everyday lifestyles. Nevertheless, the infrastructure in other countries could influence the way in which this product can be implemented. The context of Serbia is very specific and cannot be compared to the other developed European countries. If this product

were to be expanded to the Netherlands, the study would have to be broadened to include more diverse individuals and regions in order to design a product for that unique setting.

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APPENDIX A (CONSENT FORM)

Consent Form for the Project designing a community-based technological solution helping older people start and maintain healthy habits

*****a version in Serbian language will be provided alongside with English one*****

Study information

This research serves as the graduation project of the University of Twente student Nađa Marčetić for the study program Creative Technology. It aims to gain insight into the use of digital technology and physical activity of the older people. Based on data you provide with your participation in this research, a prototype will be developed that aims to stimulate the older adults to engage in a more active lifestyle.

This research consists of two parts: ideation phase and evaluation phase. In the ideation phase, a brainstorming session with other 2-4 participants will be conducted where you will be asked to discuss your current physical state, everyday activities and what could be improved in your life regarding this topic. This session will last approximately 30 minutes. For this purpose you will be given different tools, such as markers, sticky notes and mapping templates that will help sort out and organize all the ideas that emerged during the session. The goal of the brainstorming session is to obtain first-hand information form potential users in order to design the best possible prototype. The second stage will be evaluative where you will get a chance to use and interact with a pre-made prototype and give your opinion on it. You will receive your timeslot during which you will be alone with the researcher. This will take no more than 30 minutes. First, you will have 5-10 minutes to use a prototype where the researcher will observe and take notes about you behavior. Secondly, you will be given a questionnaire about the usability of the prototype, which will be followed by a short debriefing where you will have a chance to give final remarks and options and talk to the researcher. The purpose of this evaluation is to gain insight into the effectiveness of the prototype and to collect feedback for further development.

Participation in this study consists of two 30-minute time slots that will be held at a location that you will be informed about in advance. If you have any difficulties getting to the location, please notify the researcher as soon as possible. The research will comply with all the current COVID-19 rules. The researcher will do a self-test prior to the sessions, keep a 1.5m distance and wear a facemask. You are not required to wear a facemask yourself, however several will be provided at the location if you opt for using it. If you at any point feel unsafe participating in this research, inform the researcher and the necessary adjustments will be made. Furthermore, if you for any other reason feel uncomfortable continuing with the research, you can opt out at any moment without a particular explanation. I, the researcher, will be present at all times and you can ask any additional questions before, during or after the research sessions.

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Please tick the appropriate boxes

	Yes	No
Taking part in the study		
I have read and understood the study information dated [11/05/2022], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	○	○
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	○	○
I understand that taking part in the study involves an audio-recorded brainstorm session with other participants. (The audio recordings will be destroyed after 08/07/2022)	○	○
Use of the information in the study		
I understand that information I provide will be used for the graduation project of a student at the University of Twente and will not be used for any other purpose.	○	○
I understand that personal information collected about me that can identify me [e.g. my name or where I live], will not be shared beyond the study team.	○	○
I agree that my information can be quoted in research outputs.	○	○
Consent to be Audio Recorded		
I agree to be audio recorded.	○	○

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Signatures

_____	_____	_____
Name of participant [printed]	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name [printed]	Signature	Date

Study contact details for further information

If you wish to contact the researcher Nađa Marčetić regarding any questions, you can do that via a following e-mail: n.marcetic@student.utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher, please contact the Secretary of the Ethics Committee Information & Computer Science: ethicscommittee-CIS@utwente.nl

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Образац сагласности за пројекат дизајнирања технолошког решења у заједници које помаже старијим људима да започну и одрже здраве навике

Информације о студији

Ово истраживање служи као дипломски пројекат студенткиње Универзитета Твенте Нађе Марчетић за студијски програм Креативна технологија. Има за циљ да стекне увид у употребу дигиталне технологије и физичку активност старијих особа. На основу података које дате својим учешћем у овом истраживању, биће развијен прототип који има за циљ да стимулише старије особе да се укључе у активнији начин живота.

Ово истраживање се састоји из два дела: фазе развоја идеја и фазе евалуације. У фази развоја идеја, биће спроведена браинсторминг сесија са још 2-4 учесника где ће од вас бити затражено да разговарате о свом тренутном физичком стању, свакодневним активностима и шта би се могло побољшати у Вашем животу у вези са овом темом. Ова сесија ће трајати око 30 минута. У те сврхе ће вам бити дати различити алати, као што су маркери, лепљиве белешке и шаблони за мапирање који ће вам помоћи да средите и организујете све идеје које су се појавиле током сесије. Циљ сесије браинсторминга је добијање информација из прве руке од потенцијалних корисника како би се дизајнирао најбољи могући прототип. Друга фаза ће бити евалуативна где ћете добити прилику да користите и комуницирате са унапред направљеним прототипом и дате своје мишљење о њему. Добићете свој временски оквир током којег ћете бити сами са истраживачем. Ово ће трајати не више од 30 минута. Прво, имаћете 5-10 минута да користите прототип где ће истраживач посматрати и бележити ваше понашање. Друго, добићете упитник о употребљивости прототипа, након чега ће уследити кратак разговор где ћете имати прилику да дате завршне примедбе и опције и разговарате са истраживачем. Сврха ове евалуације је да се стекне увид у ефикасност прототипа и да се прикупи повратна информација за даљи развој.

Учешће у овој студији се састоји од два термина од 30 минута који ће се одржати на локацији о којој ћете бити унапред обавештени. Ако имате било каквих потешкоћа да дођете до локације, обавестите истраживача што је пре могуће. Истраживање ће бити у складу са свим актуелним правилима о КОВИД-19. Истраживач ће урадити самотестирање пре сесије, држати размак од 1,5 м и носити маску за лице. Не морате сами да носите маску за лице, али неколико ће бити обезбеђено на локацији ако се одлучите да је користите. Ако се у било ком тренутку осећате несигурно да учествујете у овом истраживању, обавестите истраживача и биће извршена неопходна прилагођавања. Штавише, ако се из било ког другог разлога осећате непријатно да наставите са истраживањем, можете да одустанете у било ком тренутку без посебног објашњења. Ја, истраживач, ћу бити присутна у сваком тренутку и можете поставити било каква додатна питања пре, током или после истраживачких сесија.

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Молимо означите одговарајућа поља

	Да	Не
Учествовање у студији		
Прочитао сам и разумео информације о студији од [11/05/2022], или су ми прочитане. Могао сам да постављам питања о студији и на моја питања је задовољавајуће одговорено.	○	○
Добровољно пристајем да будем учесник у овој студији и разумем да могу да одбијем да одговарам на питања и да се могу повући из студије у било ком тренутку, без потребе да наведем разлог.	○	○
Разумем да учешће у студији укључује аудио снимљену браинсторминг сесију са другим учесницима. (Аудио снимци ће бити уништени након 07.08.2022.)	○	○
Коришћење информација у студији		
Разумем да ће се информације које пружим користити за дипломски пројекат студента на Универзитету Твенте и да се неће користити у друге сврхе.	○	○
Разумем да прикупљени лични подаци о мени могу да ме идентификују [нпр. моје име или место где живим], неће се делити изван студијског тима.	○	○
Слажем се да се моје информације могу цитирати у резултатима истраживања.	○	○
Сагласност за аудио снимање		
Слажем се да будем аудио снимљен.	○	○

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Потписи

_____	_____	_____
Име учесника [штампано]	Потпис	Датум

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Име истраживача [штампано]	Потпис	Датум

Контакт детаљи за додатне информације

Уколико желите да контактирате истраживача Нађу Марчетић у вези са било каквим питањима, то можете учинити путем следеће е-поште: n.marcetic@student.utwente.nl

Контакт информације за питања о вашим правима као учесника у истраживању

Ако имате питања о својим правима као учесника у истраживању, или желите да добијете информације, поставите питања или разговарате о било којој забринутости у вези са овом студијом са неким другим, а не са истраживачем, контактирајте секретара Етичког комитета за информације и рачунарске науке: ethicscommittee-CIS@utwente.nl

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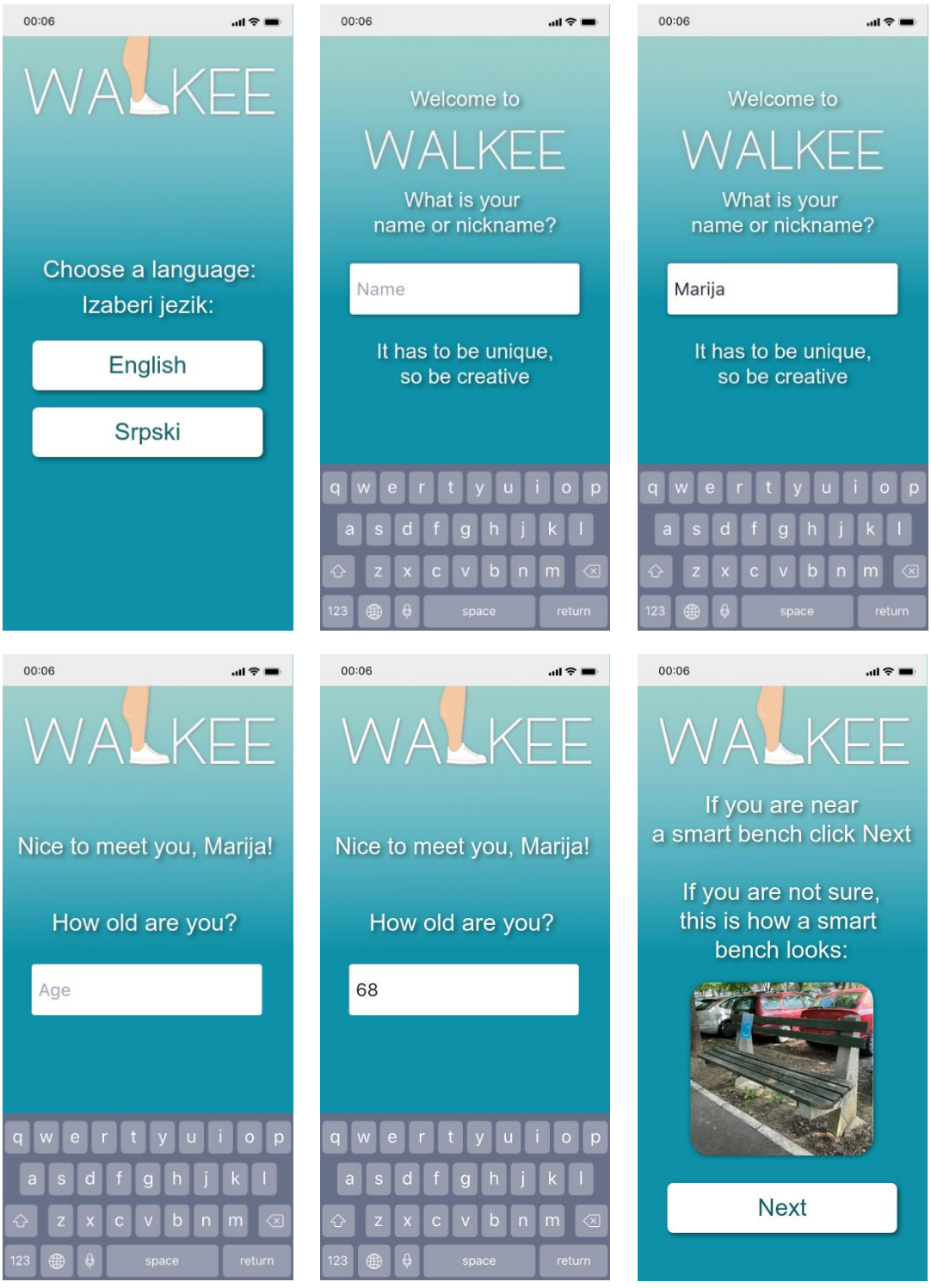
APPENDIX B (CODE)

```
#include <LedControl.h>

// Matrix LCD used pins
int matrixLCDPin = 12;
int clockPin = 10;
int CSPin = 11;
int inUse=1;

LedControl matrixLCD = LedControl(matrixLCDPin, clockPin, CSPin, inUse); // add pin to Matrix


const int sensorPin = A5;
int SittingState = 1;
int lastSittingState = HIGH; // previous state of the button

unsigned long int sittingStarted = 0;    // the moment the button was pressed
unsigned long int sittingTime = 0;        // how long the button was hold

int entry = 0;


// Arrow matrices

char up_arrow[8]={

  0b00000000,
  0b00000000,
  0b00000000,
  0b01000000,
  0b11111111,
  0b01000000,
  0b00000000,
  0b00000000,

};

char down_arrow[8]={

  0b00000000,
  0b00000000,
  0b00000000,
  0b00000010,
  0b11111111,
  0b00000010,
  0b00000000,
  0b00000000,

};

char right_arrow[8]={

  0b00010000,
  0b00111000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,

};
```

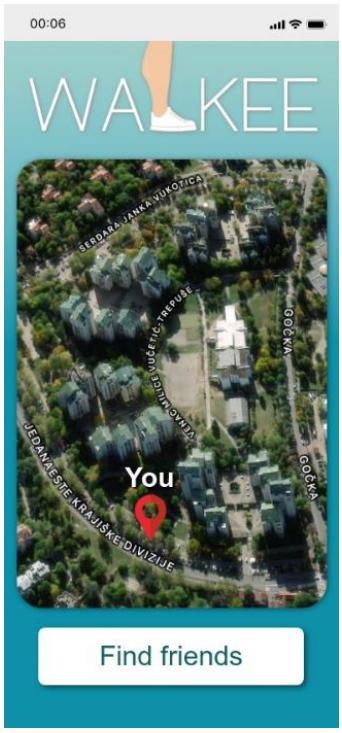
```
char left_arrow[8]={

  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00010000,
  0b00111000,
  0b00010000,

};

char sitting[8]={

  0b00000000,
  0b00011000,
  0b00111100,
  0b01111110,
  0b01111110,
  0b00111100,
  0b00011000,
  0b00000000,

};

char NM[8]={

  0b00011111,
  0b00001000,
  0b00000100,
  0b00001000,
  0b11111111,
  0b00100000,
  0b01000000,
  0b11110000,

};

void setup() {

pinMode(sensorPin, INPUT);

matrixLCD.shutdown(0,false);
matrixLCD.setIntensity(0,4); // intensity is 0 - 15
matrixLCD.clearDisplay(0);

Display_NM();
delay(2000);

matrixLCD.clearDisplay(0);

Serial.begin(9600);

}
```

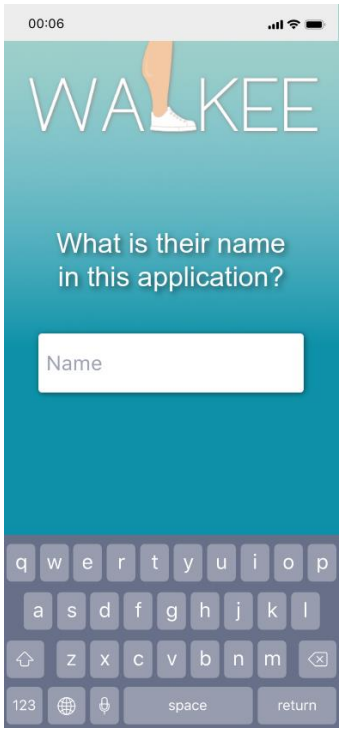
```
void loop() {


  SittingState = digitalRead(sensorPin); // read the sitting input

  if (SittingState == LOW && lastSittingState == HIGH)
  {
      sittingStarted = millis();
      lastSittingState = LOW;
      Display_Sitting();
    }

  if (SittingState == LOW && lastSittingState == LOW)
  {
      sittingTime = millis() - sittingStarted;

      if (sittingTime > 3000)  // Sitting timeout
      {
        // Code for direction
        Display_Left();
      }
  }

  if (SittingState == HIGH && lastSittingState == LOW)
  {
    matrixLCD.clearDisplay(0);
    lastSittingState = HIGH;
  }


  }



void Display_Up(){

  for(int i=0; i<8; i++){
    matrixLCD.setRow(0,i,up_arrow[i]);
  }

}


void Display_Down(){

  for(int i=0; i<8; i++){
    matrixLCD.setRow(0,i,down_arrow[i]);Z
  }
}

void Display_Sitting(){

  for(int i=0; i<8; i++){
    matrixLCD.setRow(0,i,sitting[i]);
  }
}

void Display_NM(){

  for(int i=0; i<8; i++){
    matrixLCD.setRow(0,i,NM[i]);
  }
}
```

APPENDIX C (APPLICATION)

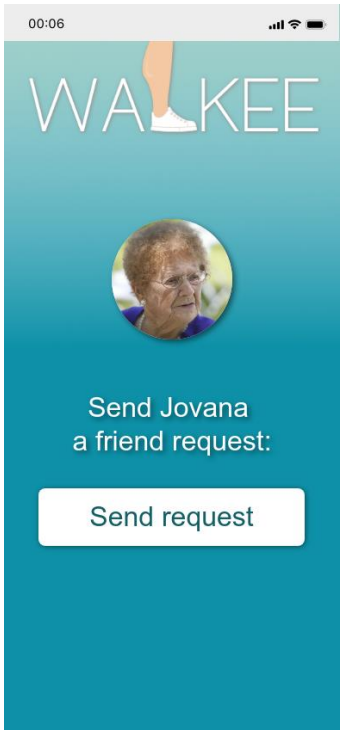


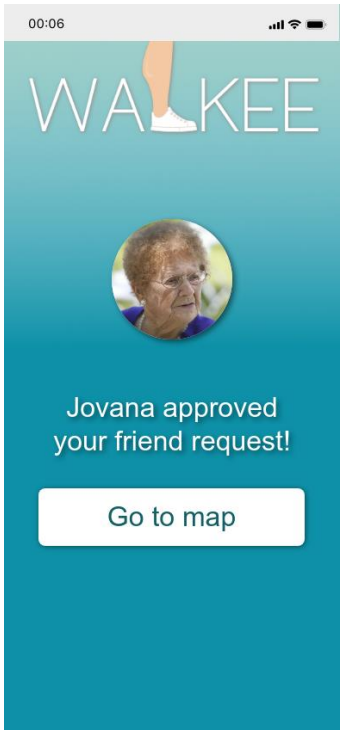

00:06
WALKEE
Select an option that is called Bench followed by a number
Examples:
Bench 1
Bench 3
Found devices
Bench 3
Ana's Iphone
CarBT

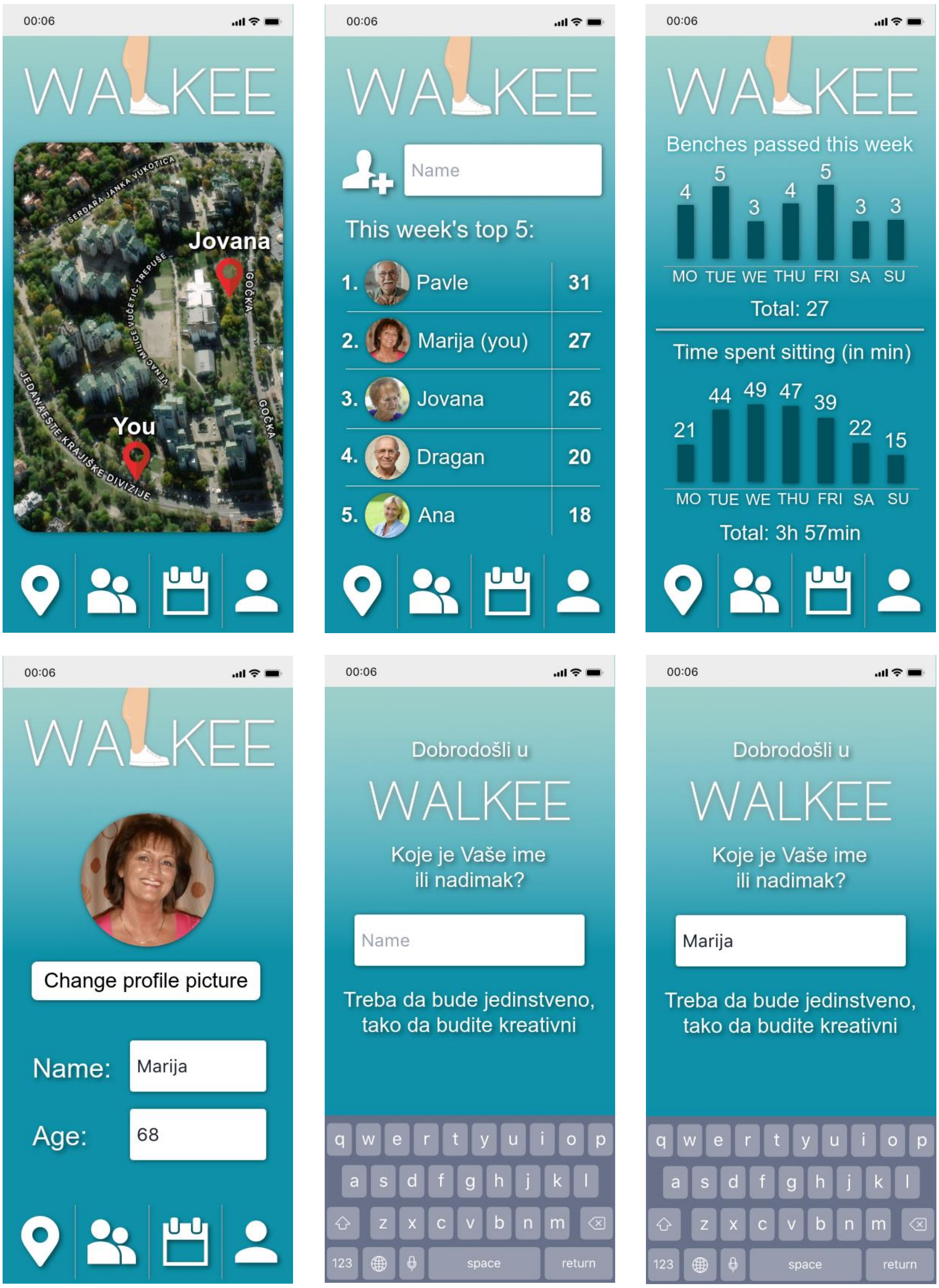

00:06
WALKEE
You
Find friends


00:06
WALKEE
What is their name in this application?
Name

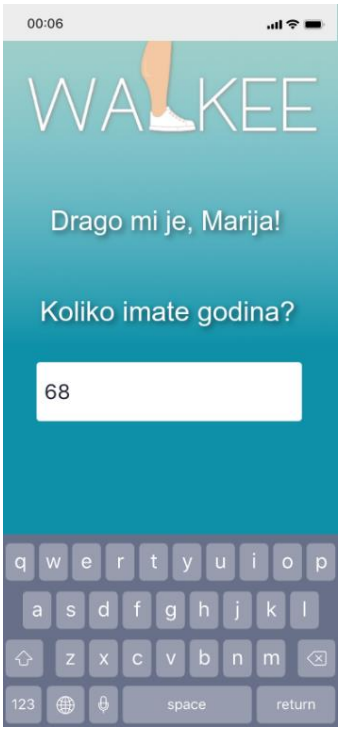

00:06
WALKEE
What is their name in this application?
Jovana


00:06
WALKEE
Send Jovana a friend request:
Send request


00:06
WALKEE
Jovana approved your friend request!
Go to map

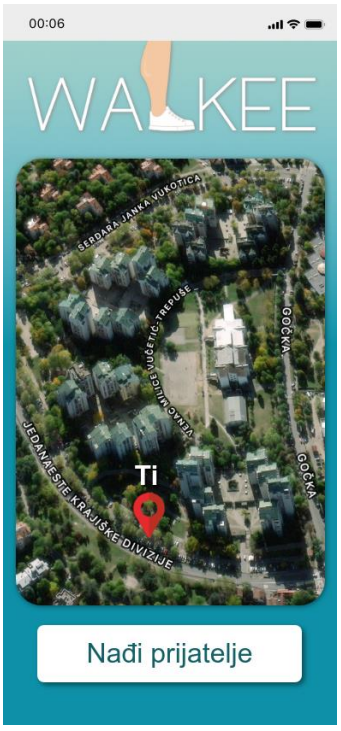

00:06
WALKEE
Jovana
You
SERDARA JANKA VUKOTICA
GOČKA
JEDANAESTE KRAJIŠKE DIVIZIJE
00:06
WALKEE
Name
This week's top 5:
1. Pavle 31
2. Marija (you) 27
3. Jovana 26
4. Dragan 20
5. Ana 18
00:06
WALKEE
Benches passed this week
4 5 3 4 5 3 3
MO TUE WE THU FRI SA SU
Total: 27
Time spent sitting (in min)
21 44 49 47 39 22 15
MO TUE WE THU FRI SA SU
Total: 3h 57min
00:06
WALKEE
Change profile picture
Name: Marija
Age: 68
00:06
Dobrodošli u
WALKEE
Koje je Vaše ime ili nadimak?
Name
Treba da bude jedinstveno, tako da budite kreativni
q w e r t y u i o p
a s d f g h j k l
z x c v b n m
123 space return
00:06
Dobrodošli u
WALKEE
Koje je Vaše ime ili nadimak?
Marija
Treba da bude jedinstveno, tako da budite kreativni
q w e r t y u i o p
a s d f g h j k l
z x c v b n m
123 space return

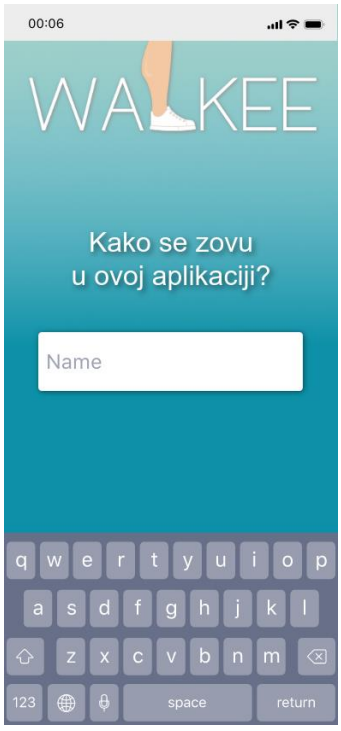

00:06
WALKEE
Drago mi je, Marija!
Koliko imate godina?
Age

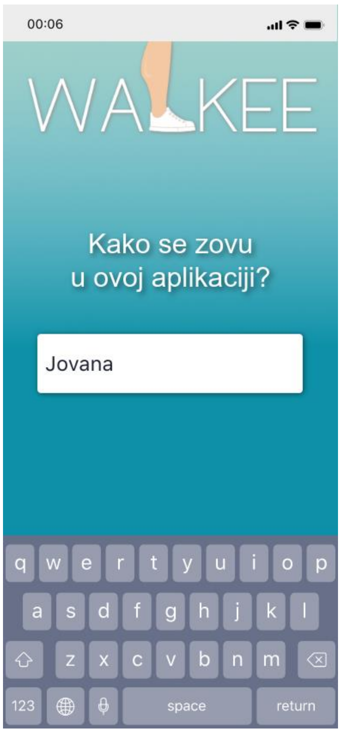

00:06
WALKEE
Drago mi je, Marija!
Koliko imate godina?
68


00:06
WALKEE
Ako se nalazite pored pametne klupe, pritisnite Sledeće
Ako niste sigurni, ovako izgleda:
Sledeće


00:06
WALKEE
Izaberi opciju koja koja se zove Bench sa brojem
Primeri:
Bench 1
Bench 3
Nađeni uređaji
Bench 3
Ana's Iphone
CarBT


00:06
WALKEE
Ti
Nađi prijatelje


00:06
WALKEE
Kako se zovu u ovoj aplikaciji?
Name


00:06
WALKEE
Kako se zovu
u ovoj aplikaciji?
Jovana
q w e r t y u i o p
a s d f g h j k l
z x c v b n m
123
space
return


00:06
WALKEE
Pošalji Jovani
zahtev za prijateljstvo:
Pošalji zahtev


00:06
WALKEE
Jovana je prihvatila Vaš
zahtev za prijateljstvo!
Idi na mapu


00:06
WALKEE
SERDARA JANKA VUKOTIĆA
Jovana
GOČKA
Ti
JEDANAESTE KRAJIŠKE DIVIZIJE


00:06
WALKEE
Name
Ovonedeljni top 5:
1. Pavle 31
2. Marija (ti) 27
3. Jovana 26
4. Dragan 20
5. Ana 18


00:06
WALKEE
Pređene klupe ove nedelje
4 5 3 4 5 3 3
PO UT SRE ČET PET SU NED
Ukupno: 27
Vreme provedeno sedeći
21 44 49 47 39 22 15
PO UT SRE ČET PET SU NED
Ukupno: 3h 57min


00:06
WALKEE
Promeni profilnu sliku
Ime:
Marija
Godine:
68

APPENDIX D (FILLED IN USABILITY SURVEYS)

participant 1

	The System Usability Scale Standard Version		Strongly disagree 1	2	3	4	Strongly agree 5
1	I think that I would like to use this system.		○	○	○	○	⊗
2	I found the system unnecessarily complex.		⊗	○	○	○	○
3	I thought the system was easy to use.		○	○	○	⊗	○
4	I think that I would need the support of a technical person to be able to use this system.		⊗	○	○	○	○
5	I found the various functions in the system were well integrated.		○	○	○	○	⊗
6	I thought there was too much inconsistency in this system.		○	⊗	○	○	○
7	I would imagine that most people would learn to use this system very quickly.		○	○	○	⊗	○
8	I found the system very cumbersome to use.		○	⊗	○	○	○
9	I felt very confident using the system.		○	○	○	⊗	○
10	I needed to learn a lot of things before I could get going with this system.		⊗	○	○	○	○

participant 2

	The System Usability Scale Standard Version		Strongly disagree 1	2	3	4	Strongly agree 5
1	I think that I would like to use this system.		○	○	○	○	⊗
2	I found the system unnecessarily complex.		⊗	○	○	○	○
3	I thought the system was easy to use.		○	○	○	○	⊗
4	I think that I would need the support of a technical person to be able to use this system.		⊗	○	○	○	○
5	I found the various functions in the system were well integrated.		○	○	○	○	⊗
6	I thought there was too much inconsistency in this system.		⊗	○	○	○	○
7	I would imagine that most people would learn to use this system very quickly.		○	○	⊗	○	○
8	I found the system very cumbersome to use.		○	⊗	○	○	○
9	I felt very confident using the system.		○	○	○	⊗	○
10	I needed to learn a lot of things before I could get going with this system.		⊗	○	○	○	○

participant 3

	The System Usability Scale Standard Version		Strongly disagree 1	2	3	4	Strongly agree 5
1	I think that I would like to use this system.		○	○	○	⊗	○
2	I found the system unnecessarily complex.		○	⊗	○	○	○
3	I thought the system was easy to use.		○	○	⊗	○	○
4	I think that I would need the support of a technical person to be able to use this system.		⊗	○	○	○	○
5	I found the various functions in the system were well integrated.		○	○	○	○	⊗
6	I thought there was too much inconsistency in this system.		⊗	○	○	○	○
7	I would imagine that most people would learn to use this system very quickly.		○	○	⊗	○	○
8	I found the system very cumbersome to use.		⊗	○	○	○	○
9	I felt very confident using the system.		○	○	○	⊗	○
10	I needed to learn a lot of things before I could get going with this system.		○	○	⊗	○	○

participant 4

	The System Usability Scale Standard Version		Strongly disagree 1	2	3	4	Strongly agree 5
1	I think that I would like to use this system.		○	○	○	○	⊗
2	I found the system unnecessarily complex.		○	○	⊗	○	○
3	I thought the system was easy to use.		○	○	○	⊗	○
4	I think that I would need the support of a technical person to be able to use this system.		○	○	⊗	○	○
5	I found the various functions in the system were well integrated.		○	○	○	⊗	○
6	I thought there was too much inconsistency in this system.		○	⊗	○	○	○
7	I would imagine that most people would learn to use this system very quickly.		○	○	⊗	○	○
8	I found the system very cumbersome to use.		○	⊗	○	○	○
9	I felt very confident using the system.		○	○	○	⊗	○
10	I needed to learn a lot of things before I could get going with this system.		○	○	⊗	○	○

participant 5

	The System Usability Scale Standard Version		Strongly disagree 1	2	3	4	Strongly agree 5
1	I think that I would like to use this system.		○	○	○	○	⊗
2	I found the system unnecessarily complex.		⊗	○	○	○	○
3	I thought the system was easy to use.		○	○	○	○	⊗
4	I think that I would need the support of a technical person to be able to use this system.		⊗	○	○	○	○
5	I found the various functions in the system were well integrated.		○	○	○	○	⊗
6	I thought there was too much inconsistency in this system.		⊗	○	○	○	○
7	I would imagine that most people would learn to use this system very quickly.		○	○	○	⊗	○
8	I found the system very cumbersome to use.		⊗	○	○	○	○
9	I felt very confident using the system.		○	○	○	○	⊗
10	I needed to learn a lot of things before I could get going with this system.		○	⊗	○	○	○

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