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WALKING - Promoting moving in the city among the elderly

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Abstract

BACKGROUND: Falling in elderly is one of the major increasing health issues for aging population. The possible way of fall prevention in elderly is a walking exercise that could be performed in the city. GOAL: Discovering useful aspects in designing software systems for elders, used to encourage daily walking as a fall prevention, by producing a software prototype as an artifact. The idea was to try to utilize social and reflection aspects into the software system design process, while also incorporating playfulness and some other guidelines for intuitive design, in order to produce both appealing and motivating software for the elders. APPROACH: Some seemingly important problems are defined and elaborated. Based on literature review, the solutions are proposed. Software design concepts are developed based on proposed solutions and knowledge gained from related work literature review. Concepts are evaluated and improved. Using software engineering process, the Android application software "Walking" is developed as a prototype based on design concept. "Walking" application is evaluated with users using surveys, and the results are collected anonymously. RESULTS: In making a software more appealing to elders, featuring social support and informational support types of social aspect seem beneficial. Reflection-in-action and reflection-on-action types of reflection aspect seem beneficial for increasing motivation in elders when featured in software. Featuring social traces suggested further increase in motivation in some of the users. Specific playfulness concept, using city maps, implemented in "Walking" was evaluated as useless by elders. Features like daily goal and emotional reinforcement messages were evaluated as motivating by elders. Offering a software in both paid and free version with ads, and featuring a user manual is evaluated as desirable by elders.

Preface

This document represents Nikola Radenkovic’s master thesis. It has been written during the spring of 2016 for TDT4900 Computer Science, Master's Thesis course.

I would like to thank my supervisor Monika Divitini for guidance throughout this research, for pointing out what can be done better, with the directions of how to do it and for helping me understand the research process better. Additionally, I am very grateful for the help I received from Simone Mora, regarding the discussion on the technology I was interested in and to Francesco Gianni who contributed in discussion toward better understanding of the problem.

I especially appreciate help of Babak A. Farshchian who helped me in evaluation of design concepts, and am very thankful to all of the participants of the prototype evaluation survey.

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1 INTRODUCTION

Introduction chapter described the context and background of this thesis, stated research questions which represent the main direction and goal of the research and described the approach used to achieve this goal.

1.1 Context and background

This research has been built upon knowledge base provided by master thesis written by (Hamborg, Rogstad & Thevarajah, 2015) and specialization project done by me (Radenkovic, 2015). The main context of those two papers and also this master thesis is contributing in fall prevention in elders by using ICT (Information and Communications Technology).

In recent years, the number of elders falling, as a result of poor physical condition and little or no physical exercise, is drastically increasing. This is a concern both for elders and their families, and also for governments and health insurance funds. As (Kannus, Parkkari, Niemi & Palvanen, 2005) stated, falling among older people is major increasing issue for health of aging populations. The fifth leading cause of death in elders is caused by injuries. The falls are very common among elders, as mentioned by (Rubenstein, 2006), and they can lead to serious or lethal injuries. This causes earlier need for placement in nursing homes or disability and death in some cases.

This topic has become popular for researchers all around the world. (Rubenstein, 2006) also uncovers that falls are usually result of physical weakness, poor balance, strong medications or confusion. Having regular exercising habit is one of least expensive and decently effective way of preventing falls in elderly. (Gillespie et al., 2009) concluded there are many beneficial interventions using muscle strengthening or Tai Chi practicing in order to prevent falls among elderly. (AGS, 2001) presented some guidelines on fall prevention through offering balance training and long term exercise. Great benefits have been confirmed in case of exercising combined with walking (Sherrington et al., 2008).

The use of ICT is still on relatively low level in this field, as presented by (Smith, 2014), maybe because of fast pace development of modern technology and elders' resistance toward learning to use unfamiliar complex systems, their refusal to accept the need for using assistive devices or systems (Hamborg, Rogstad & Thevarajah, 2015), lack of skill for performing exercise or issues with motivation (Brawley et al., 2003). Another cause might be low level of engagement in developing system attractive for elders and helpful in fall prevention at the same time.

I intend to propose certain solutions for making ICT system that would be relatively easily accepted by elders by using social interaction aspects in design and at the same time good in increasing motivation levels in elders by using social and reflection aspects altogether to offer easier initiation of walking exercise and continuous commitment to it which should further lead to increase in health state and wellbeing of elders through fall prevention.

1.2 Research questions

The main research question (MQ) is a summarization of problem to be dealt with in this thesis, it is answered through following sub-questions (SQ) in order to systematically build up the answer to main question.

MQ: How to design and produce ubiquitous ICT system both appealing and motivating for elders in fall prevention through city walking?

1. SQ1: Can elder's resistance toward using assisting devices and innovative technology be decreased by using social interaction aspect in playful way?
2. SQ2: Can motivation for city walking be increased using reflection and social interaction aspect in playful way?

1.3 Research approach

The research is done side by side with prototype and software development used to evaluate and discuss answers to the problem and research questions defined. The main phases in the research are: Concept design and evaluation, Prototype development, Evaluation and discussion.

1.3.1 Concept design and evaluation

The conceptual design of a mobile device software is made using design guidelines and incorporating social and reflection aspect in an attempt to solve defined problems.

Evaluation with an expert was performed on the concept in order to clarify if ideas from concept indeed help toward solution of the problem, and to gain any valuable feedback for concept improvement.

Concept redesign is done after gaining feedback from evaluation, to improve the concept with gathered knowledge, and prepare for prototype development process.

1.3.2 Prototype development

Prototype is developed based on established concept using software engineering process. The process is done along with software engineering principles in three phases: Requirements specification, Architectural description and Implementation.

The resulting software represents mobile application that incorporates certain aspects in order to solve the problem, and is not thoroughly tested since it is a prototype, but it supports user testing for gaining feedback.

1.3.3 Evaluation and discussion.

The prototype is evaluated with users by using survey and the developed prototype as artifact. Collected data is used in discussion to identify the quality of the product and how much it was able to bring us closer toward the solution of the problem by incorporating certain aspects.

2 PROBLEM ELABORATION

Goal of this chapter is to describe the problem, discuss it and try to divide it on smaller problems and extract useful information. The problem description contains elaborating on the identified problems and offering a set of issues addressable with planned research approach. Proposed solution are the ideas for solving mentioned set of identified issues.

2.1 Problem description

As described by (Radenkovic, 2015) the use of ICT in fall prevention through walking exercise among elderly is low and there is need for suitable ICT system that would both deal with problems with elders using ICT and problems with providing suitable aid.

Problem with use of ICT reflects in older adults refusing to use the assisting device or system, since it makes them feel bad about themselves, and feel weak as (Hamborg, Rogstad & Thevarajah, 2015) explained. Also there is a problem in acceptance of innovative technology by the elders as measured by (Smith, 2014), possibly because of too much effort needed to learn to use something innovative and complex.

Problem with need of providing suitable aid may have roots in elders' lack of motivation to start and continue exercising regularly and also deal with fear of exercise because of lack of skill (Brawley et al., 2003). Another problem with motivation is that as people get older, at some point they can't make a positive exercise progress anymore and may be demoralized by unsuitable reflection concept that is not specifically designed for elders.

2.1.1 Use of assistive devices and systems barriers

In order to identify barriers with assistive devices and systems use in elders, I have used a study by (Aminzadeh & Edwards, 1998) that included interviewing 30 community living elders, from Italian and British ethnical backgrounds, about their views on use of assistive device, such is a cane, in fall prevention. The assistive device used in this study is cane, but I find some amount of similarity in users' perception of using cane and other types of assisting devices in fall prevention and use of ICT systems as assisting object, so I find it relevant and useful for defining this problem.

Both British and Italian participants in this study showed similar perceptions on barriers and benefits toward cane use. They have declared many safety and functionality benefits of using such assistive device that are summarized in Table 2-1, along with chosen citations to better describe how they feel about certain benefit.

Benefits of Cane Use	*Selected Examples of Participant's Comments*
Improved function	*I am losing my strength. I have difficulty with my balance. This cane has given me the best support I've ever had.*
Pain reduction	*You are using a cane to carry your weight. It takes weight off your legs, reduces pain.*
Fall prevention	*You are using a cane to carry your weight. It takes weight off your legs, reduces pain.*
Enhanced feelings of safety	*You are much more steady on your feet. It balances you. If I go without it, then I am staggering. I feel much safer*
A means to proclaim frailty	*When you use a cane, you get spoiled. I am telling you; they are opening the doors for me. It is terrific. They help you. They respect you.*
A means of self-defense	*It's a defense. When someone wants to steal your purse, you can use your cane to defend yourself!*

Table 2-1 Elders view on benefits of cane use (Aminzadeh & Edwards, 1998)

Despite their general agreement on advantages and gains from using a cane, participants greatly varied in their view of their own need for use of such devices. Only the minority felt like they may have benefits of using it, while the majority felt like they are still "strong" and "capable", and that they did not need an assistive device. Even those participants who have reported falling history or problems with knee joints, hip and back were unwilling to express their need. Elder's comments and answers revealed many perceptual, normative, attitudinal and access barriers toward use of assistive devices among older adults. The resulting barriers are summarized in Table 2-2. Some participants also suggested that if they would decide to use a cane, that event would force that person to accept their defenselessness and susceptibility to falls as some sort of serious illness or defect.

Barriers to Cane Use	*Selected Examples of Participant's Comments*
Perception of no need	*Seniors think they must be really handicapped to use a cane.*
Denial of need	*Seniors don't use a cane because of ignorance. They don't want to admit that canes can help them.*
Fear of dependence	*If you get used to a cane, you can no longer walk without it.*
Feelings of embarrassment	*Many of us are advised by our doctors to use a cane. But we feel embarrassed to use it.*
Fear of stigma	*Seniors don't use a cane, because they are afraid that people may say they are too old and handicapped.*
Pride	*My friend is eighty years old. But she doesn't use a cane because of pride!*
Difficulties in adjusting to a cane	*A friend of mine has a cane but she won't use it. She said, "I can't figure out in my head how to change my pattern."*
Lack of feelings of safety	*I wouldn't feel secure with a cane.*
Lack of knowledge about how to obtain the correct cane	*I fall quite often. So, my son suggested that I use a cane. But it didn't help me. I think I wasn't using it correctly, because I was falling just the same. My son told me I needed to have ice picks to keep me from slipping on ice. But I don't know where to get them.*
Cost	*Sometimes seniors don't buy a cane, because they can't afford it. Not that it is expensive. But being on pension, you have to watch your expenses.*

Table 2-2 Elders view on barriers of cane use (Aminzadeh & Edwards, 1998)

Table 2-2 shows some barriers that are highly relative to elders' resistance toward use of assistive ICT systems. Having those barriers in mind is useful for proposing the right solution for a problem, and those relative to the problem described are: denial of need, pride and feelings of embarrassment - stigma, difficulties in adjusting to and using assisting device or system, and cost.

2.1.2 Exercise motivation barriers

Beside barriers with use of assistive devices among elderly, one of main barriers in persistent exercise in older adults is lack of motivation. According to (Brawley et al., 2003), the lack of motivation is probably the largest single cause of physical exercise discontinuity over longer

periods. Maintaining the motivation level to ensure adherence in physical exercise is a big challenge, as reports show high levels of retreating from continuous exercise practice in older adults from personal home-made regimes.

The motivation as a problem for older adults' exercise practice is in details described by (Karen & Graves, 2004). They have suggested some causes for lack of motivation that include not having enough time, not having enough information on benefits of physical exercise and not living close enough to exercise facility. Also in order to ensure benefit of exercise, one needs to make sure that behavior became a habit. The knowledge of cognitive processes involved in behavioral change and motivation is required in order to understand exercise adherence. The essence of this process is self-efficiency.

Self-efficiency concept is regularly identified as very important aspect of physical exercise behavior in different types of populations and in scientific literature as various types of behavioral learning. It represents an individual's faith in their capability to effectively perform certain behavior. According to social cognition theory, self-efficiency is a result of combined both expectations and outcomes. Expectation represent conceived capability to perform certain behavior and outcome is the expected result that certain behavior will give. There are for major sources that are contributing to personal efficiency and those are: emotional and psychological state, verbal persuasion, perceived experiences of others and personal experience in behavior or mastery. Self-efficiency expectations are regulating behavioral change and are there to determine if a practitioner attempts a given exercise, degree of persistence in case of encountering difficulties and final success or failure. The probability of one's initiation and persistence in given behavior is higher as his self-efficiency expectations and outcomes are stronger. Therefore, self-efficiency is acting an important role in exercise motivation and exercise behavior of elders.

The perception of efficiency is very important predictor in initiating and maintaining a new behavior. Generally, majority of researches claims that self-efficiency beliefs are critical in adoption process to a new exercise routine. The satisfaction and feelings of pleasure with self-regulatory skills are more important in sustaining already established exercise behavior. Self-regulatory skills consist of: setting the goal, progress monitoring and motivation through self-reinforcement.

To summarize, key elements in providing motivation for exercise that could be significant to elders are: personal progress monitoring, observation of other's progress, goal setting and emotional reinforcement. Those will be mentioned again later in solution proposal.

2.2 Proposed solution

Here is the proposed solution for two described problems in this chapter that is presented as a set of implemented features later evaluated and discussed in this thesis. This solution proposal represents a briefly explained hypothesis, while its reasonableness is evaluated later in the research.

The assumed usable solution for problems with elder's aversion toward using assistive device is to use social interaction aspect in ICT assistive system. Social interaction is likely to be beneficial in decreasing resistance toward using certain ICT system in multiple ways. People may be appealed to use a system that is already used by their friends or others in their community or age group. Also, they might be thrilled by possibility to compete with friends and others in their age group and be more appealed to use the ICT system that supports competitive social interaction aspect.

The solution for lack of motivation in older adults may lie in using reflection aspect in ICT system design. Reflection on results, and appropriate representation of progress over time may be the great tool for enhancing motivation. The fun way of representing reflection statistics and results, provided using gamification guidelines in ICT system design, may also be beneficial in motivating the user to involve in exercise more often since they might be more likely to observe both the system and exercise as a game and not as device that push them to work.

2.2.1 Use of assistive systems

As concluded in problem description, main issues to be dealt with are: denial of need, stigma, lack of knowledge for system use and cost. The idea is to try to deal with each one using certain type of social interaction with some additional design guidelines, and this will be better explained in the following text.

Denial of need

It is manifested when older adults who might benefit from use of assistive system are refusing to use it because they feel like they do not need it. As mentioned in problem description, they overestimate their capability because that makes them feel better about themselves, since use of assistive system would represent a sign of weakness in their eyes, and by using it they might be less confident in their abilities and feel less worth. The solution may be in using social support aspect to encourage the individual into considering the benefits of using such system or device. As (Ploderer et al., 2014) described, social support represents many forms of interaction between people in order to improve their wellbeing. It can include intimacy, esteem

support, validation and companionship. Also it is found in form of material aid and tangible support and also informational support through advices, recommendation and help in solving problems. Informational support might be the best solution for denial of need, since the correct advice from competent person, physician in this case, has the best impact when comes to giving advice about exercise to elders, as stated by (Karen & Graves, 2004).

Stigma

This is a barrier similar to denial of need as both are issues with acceptance, but stigma is related to lack of capability in eyes of others, while denial of need is more of personal issue. The idea for solution is that one might feel less embarrassed to perform certain activity if he is aware that many other people of his age or even younger are already doing it. If this assumption is correct, the answer may lie in using social traces aspect in the system design. As described by (Ploderer et al., 2014), social traces are very effective tool in behavior changing process and they represent patterns or performance traces of others. Those can be both anonymous like usage statistics and average scores, or they can belong to celebrities or some well-known users. Simple presence of other people is comforting the user and makes him/her feel supported, without any identity, close interaction or explicit relationship. Because of all those benefits, social traces are widely used in setting the social and cultural norms, in other words to define the accepted behavior, and can be very useful in dealing with stigma problem.

Lack of knowledge for system use

It is also important barrier in beginning of system use and it is encountered when the user overcomes first two barriers. The solution for providing the user with suitable knowledge in order to use the system may be in both using the social support and relevant design guidelines. The information support subtype of social support that is mentioned earlier in text can also be useful here, but in this case the information may be given by friends, family members, system support team, etc. since the authority is probably not so important for this issue. Also, following certain design guidelines for making the system more intuitive and easier to learn might be critical in solving this problem.

Cost

This is the last barrier to be dealt with, and although there might be useful for developer to utilize social interaction aspect here in order to persuade the user to buy the system, I think that better solution is to simply make the system very affordable or ideally free. The prototype of the system that I was developing for this research is mobile phone software, and in recent years

I have seen vast increase in free mobile phones software that is still highly profitable for the developer. The solution might be to fund the developing and maintenance of the system by using the advertisement on free software version so user can try it out for free and maybe have an option to buy premium version without advertisements in order to enhance the experience.

2.2.2 Exercise motivation

In problem description sub-chapter, I have identified some of the elements that greatly impact motivation for exercising. Those are personal progress monitoring, others' progress observing, goal setting and emotional reinforcement. Those are the elements I will try to provide with the suitable solution utilizing reflection and social aspect in design with some of the design guidelines to better address the age of users of the system.

Personal progress monitoring

In this case it would be both real-time monitoring and presenting the info to the user while the walking exercise is still in progress and also post-exercise monitoring in form of some statistical data to enable long term progress monitoring. (Plunderer et al., 2014) have stated that some reflection aspects can have a great impact on changing one's behavior or attitude. They have described two types of reflection: reflection-in-action that represents real-time tracking of activity performance during the practice and reflection-on-action which is done after the activity is finished and can offer info to encourage thinking about past action performance and long term progress. Reflection-in-action could be great tool to use for real-time monitoring of single walking workout to show current progress of the workout and reflection-on-action should be suitable for monitoring on higher level considering longer term data.

Observation of others' progress

This is another tool for motivation that is supposed to encourage the user to engage in exercise by showing him/her the progress of others. This is most likely achieved using social traces aspect described by (Plunderer et al., 2014), or more precisely using social competition aspect to positively affect motivation. The solution for providing this can be in using combination of reflection-on-action and social competition aspects to compare performance of current user with performance of his friends or other people from community with similar exercise level and goals. It can be done on weekly or daily timelines to show for example who of the friends have performed how well in walking today or this week.

Goal setting and completion

This is important thing for ensuring good motivation level. The correct goal setting is an important and complex feature that could benefit from intelligent adaption to the user and utilization of social intelligence but this is out of scope of this research and I will focus the solution proposal only on benefits from reflection and social aspects. This means that goal setting, like distance to walk daily, will be left for the user to decide on while the goal completion progress tracking can be covered by earlier described reflection-on-action process.

Emotional reinforcement

This can also be strong motivation lifter. To ensure proper emotional reinforcement of the user various reinforcement messages can be showed to the user in various situations that should make him/her feel better about themselves and their progress. Both reflection-in-action and reflection-on-action can be included to show messages, composed using game design guidelines, during the course of action (walking), and also, when the walking training is completed or the goal has been achieved, etc.

3 RELATED WORK

In this chapter, literature relevant for designing a concept for addressing proposed solution is reviewed. Large part of knowledge base used is gained from literature review performed in specialization project on this topic done by me before starting this thesis, therefore not many sources are used in this chapter. First part is concerned with extracting a design guideline, that could be useful, from theoretical sources. Second part is concerned with studying a related commercial software system in order to learn from it.

3.1 Related design guidelines

Study conducted by (Consolvo et al., 2006) has summarized some of the design requirements and guidelines for physical activity encouraging systems. Some of them are highly relevant to this work so I decided to describe their findings in short lines.

3.1.1 Research overview

The researchers have developed a mobile software based fitness journal, called "Houston", that was supposed to track daily number of steps within small group of friends. They have built 3 versions of the software for the study: baseline, personal and sharing. For the first week all three groups of participants used the baseline version to familiarize themselves with the user interaction model, while researchers got the data needed to establish daily goals for them. Then, to see how much of impact the technology based social related activities have on physical exercise compared to traditional means of communication, two of the groups got to use sharing version of software while one group got personal version for the next two weeks.

Here is description of what each version of the software featured. Baseline version supported daily step count that could be viewed and had to be sent to the server at the end of the day and ability to see their final daily step count for last 7 days. Personal version had all the features of baseline with the addition of daily goal set, progress toward the goal and recognition when the goal is met. Also it featured daily step count average and support for adding comments. Sharing version had all the features of baseline and personal version with additional features that supported social interaction in a way of sharing some results info with members of their group. They could share their progress, see their teammates' progress, and see all the additional info and averages for all teammates,

The results of participants after the end of trial were represented as percentages of days when goal were completed and compared between sharing (groups 1 and 2) and personal (group 3)

groups, which is represented on Figure 3-1. This leads to conclusion that sharing groups were more likely to complete their assigned goal than personal groups.

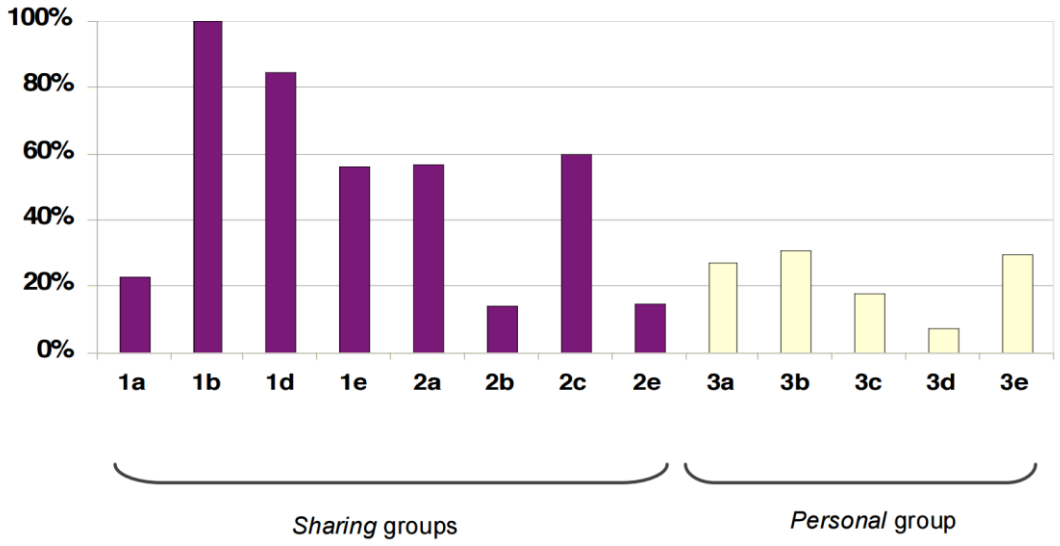

Figure 3-1 Percentage of days groups completed their goals (Consolvo et al., 2006)

Using the qualitative data, (Consolvo et al., 2006) extracted and presented some of the design requirements for physical activity encouraging systems. Key design requirements mentioned are: provide personal awareness of activity level, support social influence, give users proper credit for activities and consider the practical constraints of users' lifestyles. In following text there are descriptions of requirements and guidelines for supporting each one of them.

3.1.2 Personal awareness

The participants want to know their real step counts and see how much they had really worked out in given day. They feel that sometimes they move around and are busy and it look like they have been doing a lot of exercise but actually they are not getting that many steps. So they may want to take an extra walk or run to fulfil their daily goal. The researchers found three types of personal awareness very important to provide: history of past behavior, current status and activity level performance.

History of past behavior

Majority of participants found value in this information. Some explained how it is one thing less to think about and it is very helpful to know what you have really done in a last few days than just guessing. Another thing is that they got motivated when they could see how well they have performed at some of past days, so they want to maintain that level of performance. Other thing worth mentioning is that in addition to 7 days of past history provided by Houston,

participants wanted longer time frames like moths to a year because they were hoping to find patterns of failure and success that could help in future planning. Reflection-on-action is the aspect that they have utilized here.

Current status

Many users used to check their tracking device often through the day. By knowing their current step count and also how many steps they need to make in order to complete daily goal, they could plan the physical activity for the rest of the day. Also, they often found additional time for unplanned exercise at the end of the day so they could meet their goal. Seems like reflection-in-action was a helpful aspect to use here.

Activity level performance

The participants were greatly motivated by possibility to reflect on their performance respectful to their goal. They wanted to know the number of steps they need to make in order to complete their goal, and then enjoyed recognition for completing it. Their motivation level increased greatly with Houston's recognition for meeting the goal, in a form of congratulations dialog and star reward for given step count.

3.1.3 Social influence

Participants were influenced by different types of social influence, and all but one said they were or can imagine being motivated by it. Three types of social influence that had most of impact on participants are: social pressure social support and communication.

Social pressure

Since participants shared their activity level and their goal's current progress with teammates, they felt more pressure to complete the goal or beat their teammate. They surely did not want to have the lowest step count of all, as some of them mentioned, so the competitive aspect vas very motivating for them.

Social support

People enjoyed getting encouragement and recognition from the teammates similar to one provided by Houston. Some of them described how good they felt when they received positive messages. Also, one participant described how she got motivated by her teammate's good performance day.

Communication

The problem in giving the proper credit to the user emerged when results were shared with teammates. The participants wanted to be able to share more information than just step count, as one of them said “The numbers don’t communicate everything”. They wanted to be able to share a little bit more of info, like adding a comment on some low count days to explain why it was a bad day, or some other exercise details.

3.1.4 Giving proper credit

The devices used for physical activity monitoring may not truly represent the activity level of many users, so the systems for encouraging physical exercise have to balance out those inadequacies. For example, in this research, pedometer often gave deceptive measurements so that measurement alone could not provide sufficient information on physical activity level.

Deceptive measurements

Some participants mentioned that measurements they got from pedometer often over-represented or even under-represented their realistic level of physical exercise. The under-represented activities (in some cases completely ignored) were cycling, swimming climbing, bodybuilding, etc.

Sufficient information

Users wanted to supply their measurements with additional information to better describe why it is or is not representative for that day, like adding +10 mile od cycling to 3000 steps, for example. Also, when the measurements were correct, they wanted to add the cause of under-performing, like illness, injury or deadline at work or cause of over-performing as well.

3.1.5 Practical constraints

There are some practical constraints that should be considered when designing physical exercise encouraging systems. The Houston showed well in integrating communication so users have not had to switch to another ways of communication to share with their teammates and also it provided quick access to past and current level of activity for participant and teammates.

Most common complaints, on the other hand, besides improper activity level crediting, was the size of pedometer and phone. They said the devices were large and unattractive to wear with many outfits. The conclusion was that the systems that encourage physical activity should not require to wear any additional devices or if it has to be the case, the proper form and size of devices is critical design requirement

3.2 Related commercial systems

In this part I wanted to review the similar system to one I developed for this research in how to find some useful guidelines and tactics used to encourage use of device and encourage daily training. Currently, I could not find any good quality walking encouragement mobile phone software that is design specifically for elders, but I found an app named "Noom Walk Pedometer" that seems to be suitable for elders, and also uses the social interaction and reflection aspects in design, both integrated in very simple and elegant way. The source of information and screenshots in this review is my own experience with this app in addition to review by (Billawal, 2015).

Noom Walk Pedometer is walking mobile application that is very easy to use and there are almost no additional advanced features. When installed, it automatically starts calculating user's movements. It has highly accurate step counter and uses low amount of device's resources while quietly runs in the background. Although, this application does not include any advanced features, it can be augmented by also installing Noom Coach Application, but this is not done for this review.

3.2.1 Interface

The interface of the app is very simple and straight forward as Figure 3-2 shows. There are two tabs on the top, one is showing all about the user and the other is used to show results of friends and family.

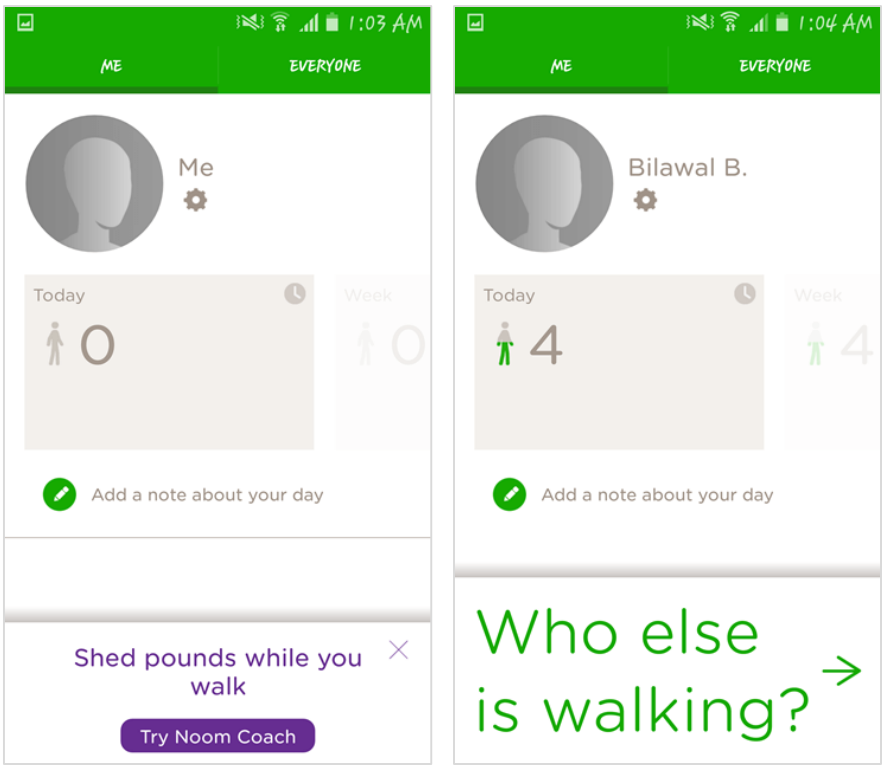

Figure 3-2 Interface (Billawal, 2015)

The picture of a user is automatically presented when user decides to connect the application to his social network or he can make an account specifically for this app. Right under the picture, there is users step counter for the current day that is automatically updated with each step taken.

There is an option to add a note about the day, a useful option if we consider research mentioned in this chapter earlier, which allows user to remember something specific for that day or particular exercise session.

At the bottom of the screen is present an ad for another application from the same developer. The one on the Figure 3-2 is Noorm Coach, application used to augment the features of this application as mentioned earlier.

3.2.2 Reflection features

As for personal reflection of the user, this app offers very simple reflection that consists only of tracking user's steps for the day and past history of it, as presented on Figure 3-3. As already mentioned, there is a way to augment the features with another app, if desired.

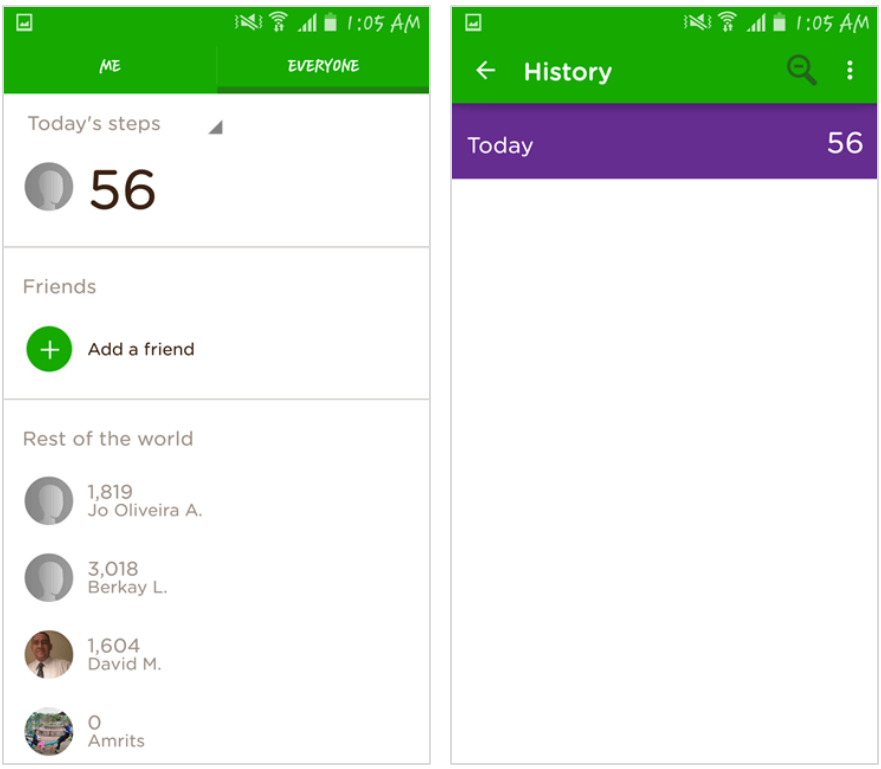

Figure 3-3 Reflection (Billawal, 2015)

The additional reflection feature is the option to add little notes to every day in order to better describe the workout.

Accuracy wise, this app excelled in performing, as for the whole trial of walking with steps counted manually, the application was wrong only for few steps. Also, there is an option to manually adjust the steps count if user thinks that application is wrong with calculations. Therefore, it can be said that this application gives simple but highly reliable measurements.

3.2.3 Social interaction usage

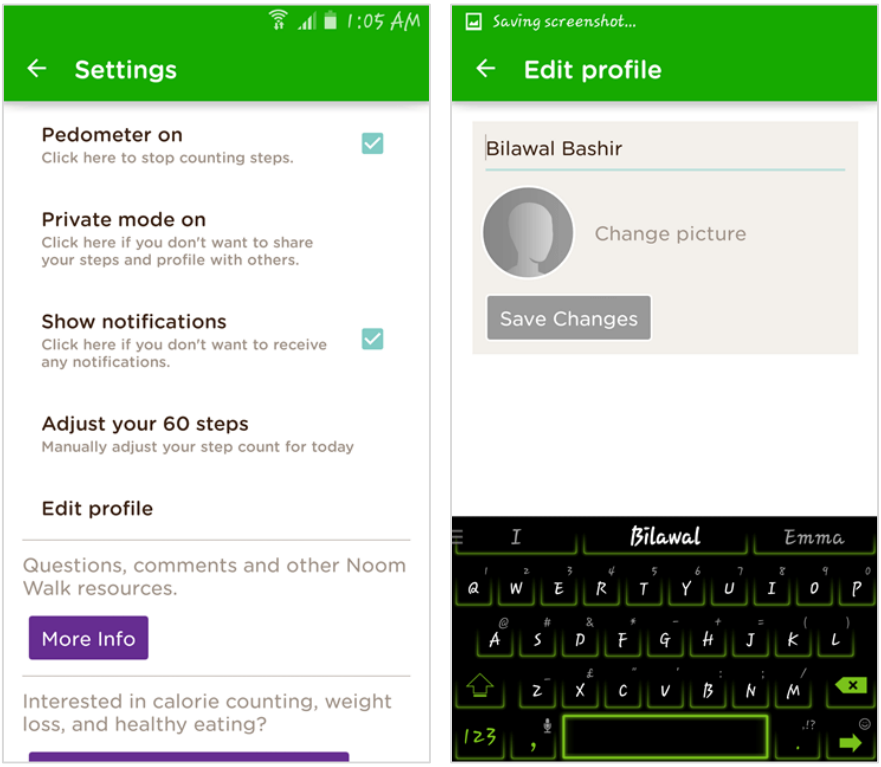

Figure 3-4 Additional social features (Billawal, 2015)

The application also features adding friends and competing with them daily, which is shown on Figure 3-3. This is a nice example of using competitive aspect to motivate users to exercise more.

Other than that, profile personalization is available where user can choose the picture to use as avatar and for display on his friends' devices, as shown on Figure 3-4. In addition, user can choose to activate "Private mode" in order to disable sharing of his profile and results with others, in case he/she does not like social interaction features.

4 CONCEPT DEVELOPMENT

This chapter described concept design for fall prevention mobile application used to provide practical way of implementing research questions ideas as described in proposed solution sub--chapter. All concepts are based on proposed solutions, and they represent concrete practical ideas to support those solutions within a context of mobile software. Also, the information gathered in related work chapter is used as knowledge base in order to make better suited design. The concepts are on rather abstract level with some simple sketches to describe the overall ideas for the application. This chapter is organized in problem oriented hierarchy, in the same way as problem description and problem solution sub-chapters for easier reflection and correlation between those.

Initial idea for incorporating playfulness in the application is to use GPS tracking and maps of the city of the user in order to make a walking exercise more interesting through city walking, and also ensure including of both social and reflection aspects in design.

4.1 Concept design

Here are the initial developed concepts for both of the problems that are later evaluated with expert as described in following sub-chapter and then redesigned based on reflecting info gathered from evaluation. I started with exercise motivation problem first, because some concepts within this problem had to be developed before some other concepts in use of assistive systems problem.

4.1.1 Exercise motivation

For consistency of work and easier evaluation the concept design will be done in four parts that reflect four issues extracted and elaborated in solution proposal. Those are: personal progress monitoring, others' progress observing, goal setting and emotional reinforcement.

Personal progress monitoring

In solution proposal, it has been determined that reflection-in-action and reflection-on-action are good methods to address personal progress monitoring in order to impact user's motivation. Both of those will have a separate design concept describing the idea of how they should work,

To represent the reflection-in-action I have idea of showing four parameters to a user during the course of walking exercise: Distance walked in session, number of falls in session, indication of path walked and current location on map, and progress toward completing daily

goal. First two are discussed here, while goal related parameter is discussed within goal setting related concepts later in text.

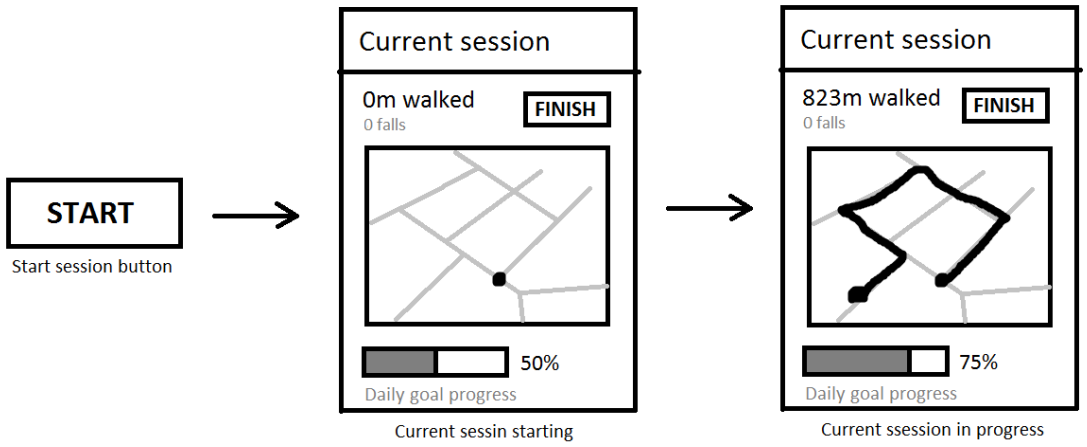

Figure 4-1 Reflection-in-action concept

Figure 4-1 shows simple sketch of reflection-in-action concept design. The current walking session is started by pressing "START" button. Reflection-in-action interface is opened and GPS connection is established. Current location of the user is shown on the map and when he/she moves, their walked path is marked. Also, the distance walked in meters is recorded and added to their daily goal progress. "FINISH" button is used when user wants to finish his current walking session. User can have infinite number of walking sessions in a day. The number of falls during the session are recorded and user is asked to write the cause of fall at the end of session.

Regarding reflection-on-action there are many different ways of representing past performance data. The data can be represented like history that consists of collection of past exercises or past days' performance and it can be represented on a graph in order to show long term progress. Problem with later method is that users over certain age might not have an increase in performance over longer periods of time, but rather just focus on maintaining of current performance or in some cases slow decrease of performance is expected over long period of time because of aging, and reflecting this as a negative performance might result in demotivation instead of positive encouragement. Since the application is mainly targeting older adults, I believe that best solution is not to use long term data for measuring performance, but rather only shorter-term history of past few days, week or month for measuring walking distance. On other hand, for long term data, some normalized parameter can be used for performance representation that is taking in consideration distance walked relative to expected distance to walk. This might be achieved using goals and goal setting, so the long term data can

be populated using goal completion performance instead of simple distance, or number of falls comparison. This way, proper goal setting can handle different expectations and needs of a user, while still presenting proper relative performance progression.

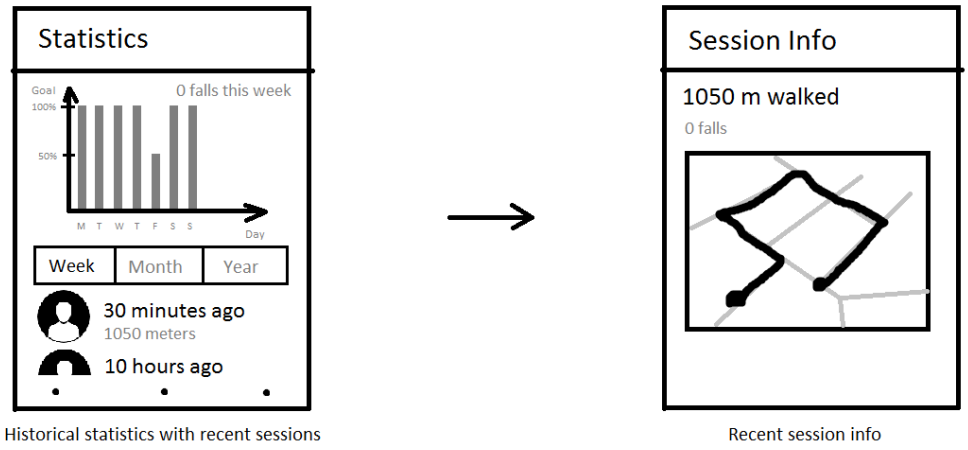

Figure 4-2 Reflection on past performance

My idea is to show two different things for use of reflection on past activity. Firs is chart-like representation of long term daily goal completion statistics that shows past days' goal completeness in percents, as shown on Figure 4-2. User can adjust it to show data for week, moth or year. All time data is also possibility. Days with the fall can be represented in different color or marked with some kind of indicator.

This screen also contains list of recent sessions that is placed under the chart. It should present only most recent sessions (past week) to allow user to reflect on them. Each one is clickable and should lead to session details screen presented on the right. This should represent reelection on history of past behavior that was selected as very motivational for the users in related work chapter.

Also, number of falls, for the chosen timeline is showed and is clickable in case user wants to check additional info on falls. Click on it opens falls reflection screen that is presented on Figure 4-3. This screen should present reflection on precious falls with ability to see exact date, cause of fall and position on map.

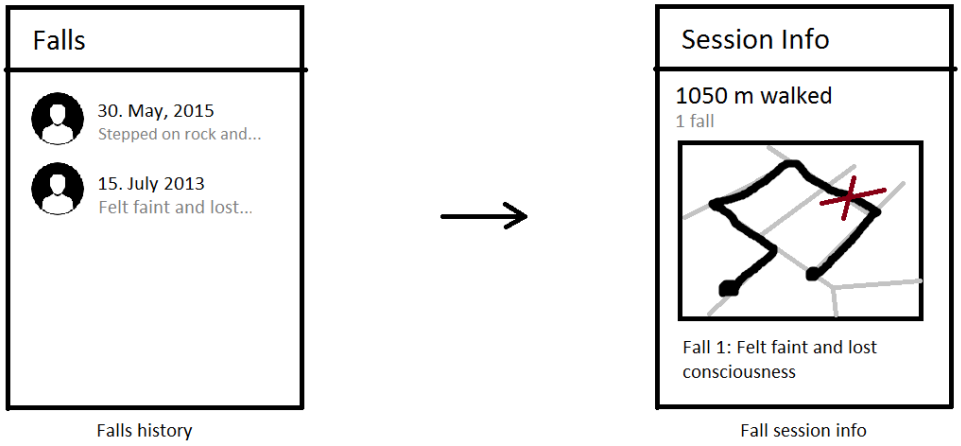

Figure 4-3 Reflection on falls concept

Others' progress observing

This problem could be solved using social traces aspect as mentioned in solution proposal, which is combined with reflection-on-action in order to enable user to monitor the progress of others and also compare it to his own progress. The idea is to connect with friends and other users through the application using social network application interface and then use their data to populate the list. This connectivity concept is better explained in next sub-chapter. The user should be able to see the distance their friends passed in their last session, also with additional details of the session like path on the map. This way user can get motivated both by competitive social aspect, but also by collaboration with his/her friends in case user discovers that some of them are walking similar path and they might want to walk together.

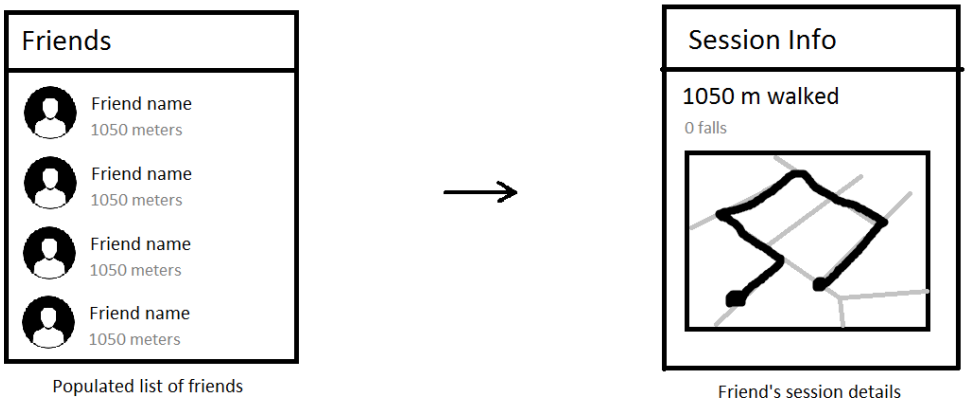

Figure 4-4 Others' progress observing concept

Figure 4-4 shows the screen populated with friends that are fetched using connected social network. The picture, name and distance walked in last session is showed for all friends in the

list. When user interacts with one of the friends listed, the screen on the right, presenting details of chosen session, is presented with the additional details like path walked on the map.

Goal setting and completion

Goal setting can be based on walking distance for this case. As written in solution proposal, the goal setting decision itself is left for the user. So the user can set their daily goal and amend it once they feel it should be changed according to their needs or after consulting with their physician. Goal completion progress is tracked through both reflection-in-action and reflection-on-action aspects in the way that is described earlier in text. The only thing that I intent to offer in order to help a user set the goal for the first time could be some default values for different age groups.

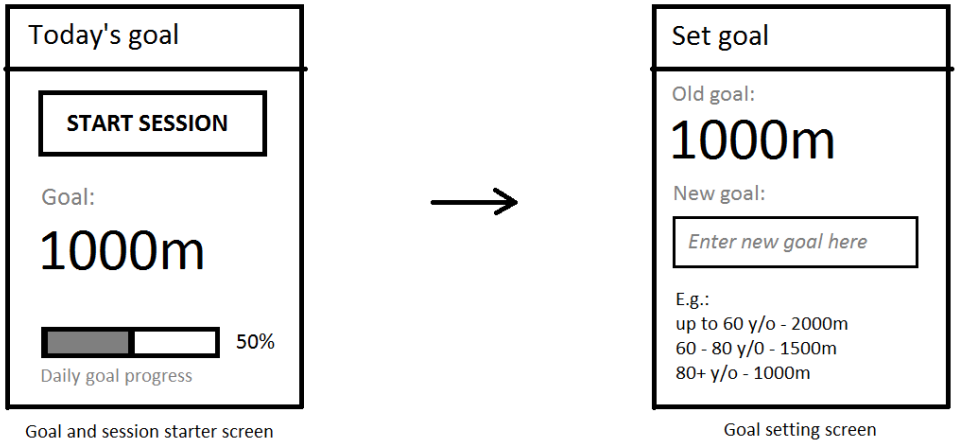

Figure 4-5 Goal setting and completion concept

Figure 4-5 shows the idea for setting and completing the walking distance daily goal. User can track his current daily goal progress on left screen and can contribute toward its completion by having a walking session. Also, user can interact with the goal value to open the screen on the right that represent setting a new goal. User is expected to write the value of new goal in meters inside the text box as hint suggests. Also some example values are presented below to make it easier for first time goal setting in case of unexperienced user.

Emotional reinforcement

This can be achieved by showing emotional reinforcement messages to the user in various situations. I believe that having in mind concepts developed so far, it would be a good option to offer some king of encouragement message when daily goal is completed. It would be as a reward for going through all the walking sessions through the day, and user will be positively reinforced to regularly complete goal every day. To make it even more interesting, the

application can contain a base of quotes from wise famous people, relative to physical exercise progress, so users will want to complete the daily goal in order to read new quote. In addition, it can be enabled for users to share their achievement with friends via social network or other sharing methods. Sharing concept is better described in next sub-chapter.

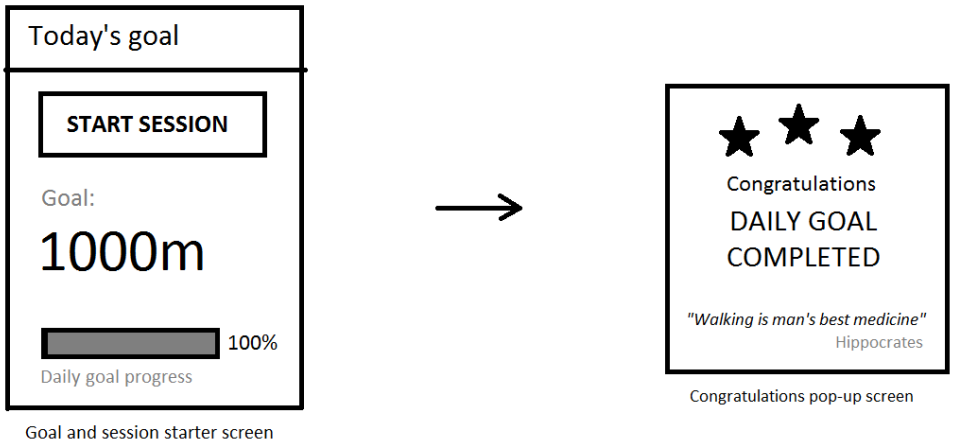

Figure 4-6 Goal completed congratulations concept

Figure 4-6 represents a concept where on 100% goal completion, user gets a pup-up dialog in a form of congratulations message. The random motivational quote is presented on the bottom of dialog. It can be ensured that randomizing do not give the same quote twice unless all the quotes have been listed.

4.1.2 Use of assistive devices

The solution proposal for this problem targeted four different identified issues. At least one concept is developed for every targeted issue. I believe this approach made the evaluation easier in a way that each concept can be evaluated in relation to its targeted problem. Here are, once again, targeted problems: denial of need, stigma, lack of knowledge for system use and cost.

Denial of need

As stated in proposed solution, informational support version of social support could be a good way to target this issues. So the most logical approach seems to make use of person of competence (physician) and persons of trust (friends and family) to encourage the user to start using the application. The actual appliance of this concept is rather on physical social interaction level, but can be supported in application by providing a way to share the application to a user so he/she can try it and see how useful it can be.

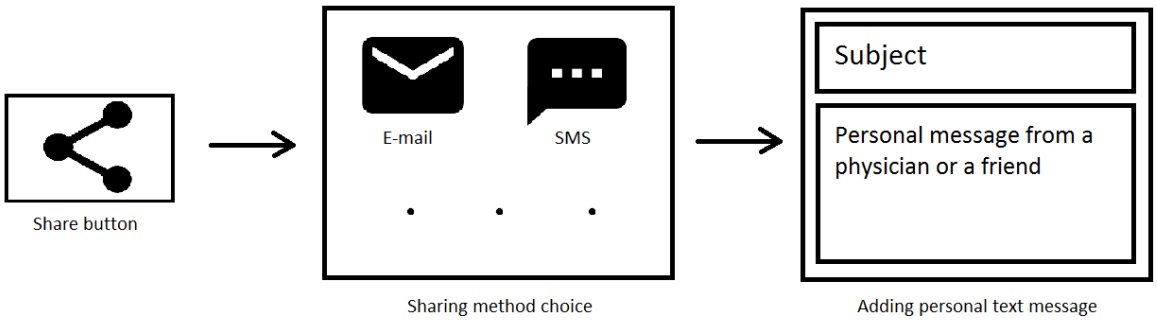

Figure 4-7 Sharing concept

Figure 4-7 shows the sketch of sharing concept that should support recommending an application from a friend or a physician. It consists of a share button or option that is implemented in the application. When activated it opens the dialog for choosing a sharing method among available methods found on device and after selecting desired method the text message is showed to be personalized if user wishes or he/she can just send the chosen default template text for sharing (e.g. "I have found a great value in this application, I recommend you also try it").

Stigma

Social traces aspect, or simple presence of others, especially friends, should be helpful in solving stigma problem, as stated in solution proposal. To make the users friends appear in the application, they must be either manually added or fetched via some social network already used by user. I believe that using a major social network to fetch friends is better than manual approach because it requires less annoying work and also provides with a lot more friends straight after application is installed and therefore a stronger social traces from the first use.

According to article ("Top 15 Most Popular", 2016), Facebook is most popular social network and, in my opinion, is the best single choice for fetching friends for social traces use.

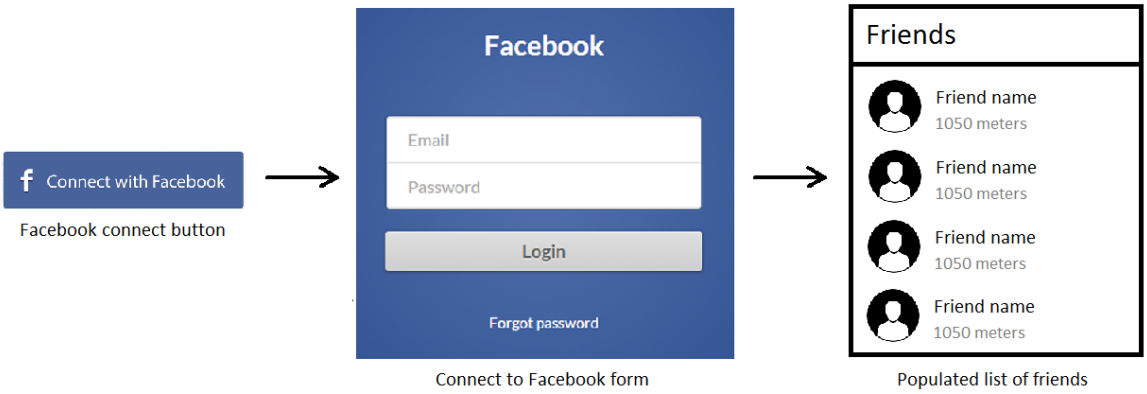

Figure 4-8 Connection with social network concept (Facebook, 2016)

The application would contain "Connect with Facebook" type button that will connect the application with this social network automatically or ask for credentials if user does not have Facebook application installed on the device, as illustrated on Figure 4-8. After connecting to social network, the application will fetch all user's friends that are already connected with the application and add them to a list with some details, like name and today's score.

Also, as mentioned in earlier reviewed study by (Consolvo et al., 2006), some users would prefer not to be seen by others or to remain anonymous in order to feel more comfortable. This can be achieved by adding anonymous mode option. By activating this mode, user is automatically excluded from showing in any of his friends' lists.

Lack of knowledge for system use

The proposed solution mentioned using social support and appropriate design guidelines can be used to help the user get familiar with the device and software itself. Social support can be done in personal or over any social network so it might be pointless to implement in-app messenger client just for that purpose. Recent devices, unlike mobile phones used 5 or more years ago in mentioned study from related work, have great support for instant messaging over 3rd party software, so it might be redundant feature if implemented. I would rather recommend building the application user interface in the way that it offers increased simplicity, intuitiveness and enables faster learning.

As already mentioned in related work chapter, within practical constraints sub-chapter, the researchers found out that users preferred simpler and smaller devices. And also, using more than one device for the system would mean increased complexity. Having less devices would decrease complexity. Therefore, my design concept will focus on using only one smartphone

device for this system. Recent mobile devices offer capabilities of both devices mentioned in study and much more, so they should be able to offer the same or greater support for measurement of physical activity with less separate physical devices.

The commercial software "Noom Walk Pedometer" described in related work chapter is using a user interface design that look simple, and from my experience with it, I can say that it is very easy to learn and use. So, I would like to use some principles used in this application in order to design similarly simple and intuitive user interface.

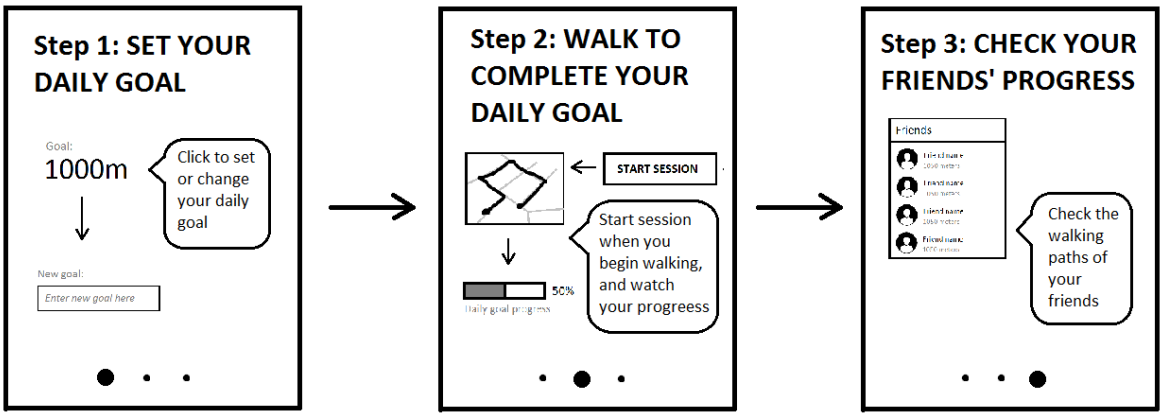

Figure 4-9 Fist time user guide concept

In order to make sure user understands how the basic features of the application work, I wanted to show the user guide screen when the application is started for the very first time. Figure 4-9 represent the guide of three steps with use tips, that I believe is not too long and still menages to give the user a decent introduction. First screen shows how to set the daily walking goal, second screen shows how to start walking sessions and track goal completion progress and third screen shows use tips for one of the social aspect concepts of the application – friends' progress screen.

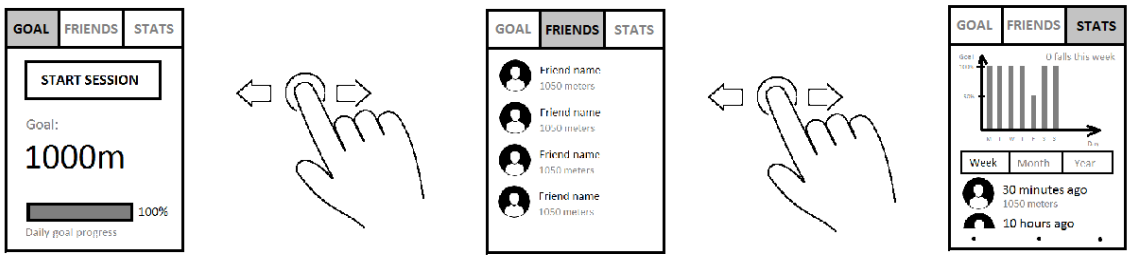

Figure 4-10 Easy navigation concept

Figure 4-10 shows idea of how to implement easy navigation between different parts of application. This concept uses “Tabs” view to represent selected screen but also make it possible to navigate to any other major screen using only one tap. It also enables using swipe gestures to navigate between two successive screens which is in my opinion very elegant and amusing way of navigating through the application.

Cost

The solution proposal for this issue was to make the application free for the user by using in-application advertising to fund the application development and maintenance. In order to keep the same level of usability and user’s satisfaction, ads have to be as less intrusive and annoying as possible. The solution might be to use “Native ads”, the latest way of advertising in smartphone applications that is, as described by (Reynolds, 2014), designed in such format to blend into the native application content, and mimic it’s look and feel in order to provide better visual experience for the user. This minimizes the intrusiveness of the ads.

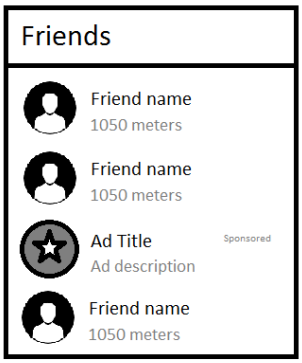

Figure 4-11 Native ads concept

The drawing of how native advertisement would look like in this application is presented on Figure 4-11. Advertisement mimic the content in form, but at the same time it is clearly marked as sponsored so user does not mistake it for an actual content.

4.2 Concept evaluation

This subchapter describes the concept evaluation process. The plan was to interview the expert in elderly fall prevention area and ask for guidelines on how to improve each of the initial concept. The concept evaluation guide was constructed before the evaluation in a way that it gives a brief introduction to the research direction of this thesis and then introduces each individual concept with drawing and quick explanation of how it should work and why it was

developed. After each concept, there is a list of questions that were supposed to give some directions and ensure proper structured interview. This guide is presented in Appendix A: Concept evaluation guide.

The interviewed expert was Babak A. Farshchian, Adjunct Associate Professor at Department of Computer and Information Science, NTNU. His expertise comes from involvement in many researches related to fall prevention in elders. He was also the supervisor of the group of students who worked on master thesis that was part of knowledge base I have used for this research (Hamborg, Rogstad & Thevarajah, 2015).

The interview results in a form of answers to the questions from guide and some additional suggestions that came from the expert are described in following text. Since I was the only interviewer, I have taken only the quick notes after the interview was done so here is the evaluation feedback as I remember it.

4.2.1 Exercise motivation

Personal progress monitoring

1. Is this way of reflecting on falls a bit too much (scary) for the user. What would be a better way to use reflection on falls in fall prevention?

The interviewee agreed that users probably do not want to reflect on falls in explicit way as sketched in Figure 4-3. He suggested that I emphasize prevention part and focus more on users that are not succeptible to falls, as those who tend to fall during the walking exercise would probably not benefit from walking at all and therefore are not the targetted user group. He said that those who happen to fall during the walking session are also not likely to reflect on that fall and then be happy to describe how it happened, but rather try to get medical help if they get injured and reconsider whole walking exercise thing.

2. When having long term progress, very old people may benefit of just maintaining daily walking distance or even slowly decreasing the distance. For those, regular daily distance increase over time chart might show depressing results, so I am using goal completion over time chart to compensate. Is this idea good, or maybe there is a better way?

Graph for long term progress representation presented on Figure 4-12 was very interesting for the interviewee. He said that he does not know what solution is the best for this problem, but that my idea has some potential. Also, he mentioned that this might be the thing that I want to

put some extra attention to, since it can be a novelty comparing to existing walking promotion applications, and therefore a quality contribution.

3. General thoughts on how to improve this concept?

The real-time progress tracking by starting and finishing sessions manually when user wants to go for walking might be too much work for elder users. User might be happier with the reflection if the application can do all the work by itself and does not require too much of a manual input from the user.

Others' progress observing

1. What data from friends might the user be interested in seeing?

The targeted users usually want to see distance that their friends have walked for certain period (today, this week, this month) since they enjoy comparing their own results with those. Therefore, having the list of friends' progress as presented on Figure 4-13 should be a good way to integrate social traces when designing for elderly.

2. General thoughts on how to improve this concept?

Some older adults expressed that they like to have a way to challenge some of their friends in some way, according to interviewee. If there is a suitable way to integrate this, it might further motivate some users who like competition.

Goal setting and completion

1. What would be the best simple way to assist the user with goal setting without involving complex schemes like intelligent adaptation to user?

The interviewee suggested that the simple solution for assisting the user with initial goal setting is to utilize their friends' goals. By showing the current daily goals of their friends, users might be able to get idea of what their own goal should look like, without disrespecting any age group. Also, this method implies further use of social interaction aspect for encouraging motivation.

2. General thoughts on how to improve this concept?

No additional ideas discussed regarding this concept.

Emotional reinforcement

1. When it comes to emotional reinforcement messages, is there anything that I should consider having in mind that I am designing for elders?

The interviewee said that elders do not care much about opinion of others, so I should put less emphasis on letting them earn social badges in a form of achievements like one represented on Figure 4-14. What they preffer more, is receiving the information on how something is benefitial for their health or physique. Therefore it might be more motivational for them to show messages like “You improve your health 20% by walking 1 hour a day” than “You are fabulous, the best walker on Earth!” .

2. General thoughts on how to improve this concept?

No additional ideas discussed regarding this concept.

4.2.2 Use of assistive systems

Denial of need

1. Is there any other way to help with denial of need for use of this system/application by elders?

The idea that interviewee gave me regarding dealing with denial of need for this system is to simply make it more appealing. By making the application interesting and playful the users are going to be more likely to try it out. Also, the good way to attract users to try out the application would be to make an appealing website or promotional page on social network or application store.

2. General thoughts on how to improve this concept?

Sharing looks like helpful feature for distributing the application and should be the part of it.

Stigma

1. Is using Facebook to connect user with friends a good option for elders, or they might benefit more if the application itself would provide adding friends?

The interviewee pointed out to a use-case scenario where the user wants to add his friend in application but cannot do so, since his friend does not have a Facebook profile. This is clearly a big flaw and it is for sure a better solution to implement social network like feature in the application (ability to add and track friends), and use connectivity with Facebook just as an additional way to find and add friends.

2. General thoughts on how to improve this concept?

Allowing users to remain anonymous is a good way to handle those who do not like to share their results for various causes.

Lack of knowledge for system use

1. Any idea of how to utilize social interaction to deal with this problem?

No ideas discussed regarding this question.

2. General thoughts on how to improve this concept?

User guide is very usefull for this while easy navigation concept is more of a usability feature. The additional things that could be done is to make an PDF manual or post a manual on a web page for some users who wants to get familiar with all the features in the application in detail.

Cost

1. Could showing the advertisements confuse elders, is it worth it in order to make the application free of cost?

The interviewer is not sure about elders' opinion on ads and if integrating them it would make an application more confusing.

2. General thoughts on how to improve this concept?

We discussed about some different ways of marketing this system, including user funded, government funded and hybrid. User funded would consist of developer charging every user for the application or using the advertisement technique that I have mentioned. Government funded way would imply that government want to fund the development of this application with goal of decreasing fall rates in elders and cut social security budget expenses. Hybrid of the two would be a developer selling the finished application to the government.

4.3 Concept improvement

After the evaluation was finished and the feedback on concepts is received, this sub-chapter is to incorporate the improvements of the initial concepts based on the evaluation feedback. The changes to initial concept are emphasized and some additional sketches are added where I thought they were needed.

4.3.1 Exercise motivation

Personal progress monitoring

Regarding this concept, there was only one change to be applied. This is removal of falls detection and tracking for the reason mentioned in evaluation of this concept. Second idea was adding automated detection of walking session when user starts walking and also automated finish when he/she returns home, but the problem with adding this is that it is too complex for

an initial prototype, and it would probably require GPS to be active all the time on the device and that would drastically increase battery consumption. According to my experience, it is very important for the application to be conservative on battery use. Anyway, for the initial prototype build, I would suggest staying with simple but efficient start/finish button approach.

Others' progress observing

The idea to allow users to challenge each other is a nice way to add a competition as an additional social aspect to encourage motivation. The users can challenge others and compete in walked distance during the next day. Users could be allowed to challenge only those friends who have a similar goal.

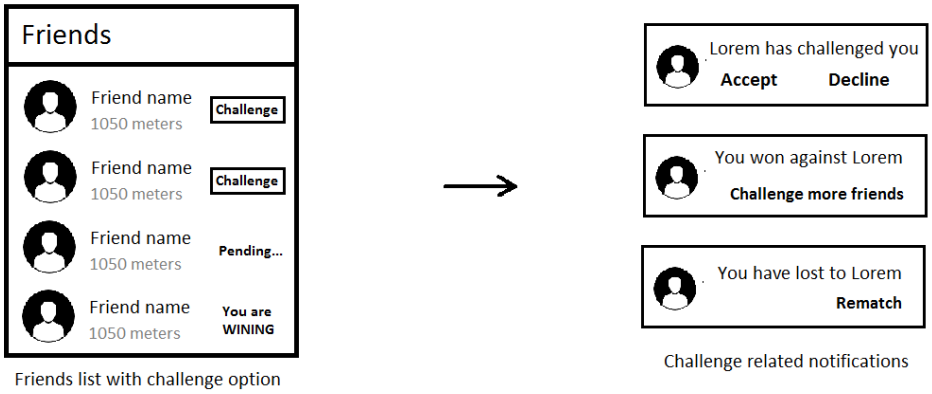

Figure 4-12 Challenging friends concept

Figure 4-12 shows the improvement of the initial concept. On the left, there is a friends list with additional action for challenging a friend and the info on who has accepted the challenge and who is winning or losing to your current walked distance. On the right, there are some of the notifications that could be presented to users in order to provide them with the current info regarding the challenge.

Goal setting and completion

The use of friends' goals in order to help the user decide on his first goal could be a great idea since it applies the social aspect in one more way with a goal to increase the level of motivation in user.

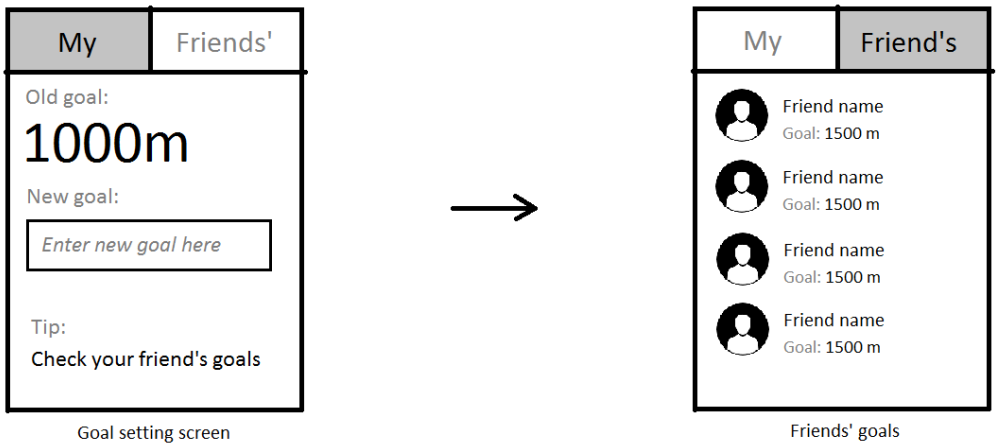

Figure 4-13 Goal setting with friends concept

The Figure 4-13 shows improved concept for goal setting where the user can access the screen that shows his friends' goals. That way user can get the hint to set his goal both for the first time and later when he/she wants to adjust it.

Emotional reinforcement

Improvement for this concept is related only to deciding on emotional reinforcement message content. Therefore, the concept stays in place while the message changes every day, in a form of useful quotes in the initial concept, should be adjusted to show useful info for the users in a way that shows them how much their walking exercise is beneficial for their health.

4.3.2 Use of assistive systems

Denial of need

Regarding this problem, the improvement idea is to make the application more appealing and playful. That is where my idea for using maps and path tracking can fit very well. Using maps to track one's path, as shown in Figure 4-1, and ability to share them with others, or fetch some path ideas from others might be a good way to add playfulness to the application and make potential users more likely to want to try out the application.

Stigma

The initial concept developed to deal with stigma issue in users used Facebook as the main method for connection with friends. This is not the best option, since not all the users have a Facebook account, so the improvement on this concept would be adding a possibility to add friends using only the main application. Facebook could be used as an additional source for fetching friends.

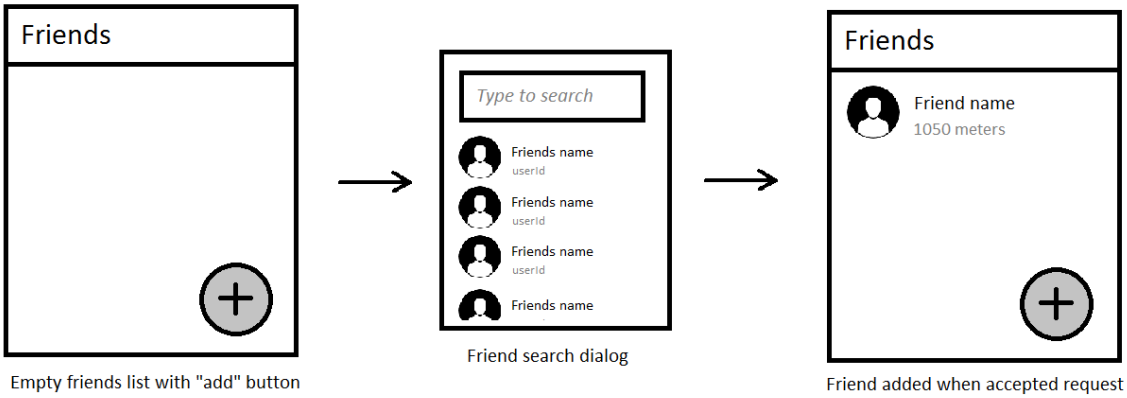

Figure 4-15 In-app adding friends concept

The friend list on left in Figure 4-14 contains additional button used to open dialog for searching for friends and sending them friend requests, shown in the middle, and then the friends list gets updated when the selected friend accepts the friend request.

To respect the privacy of those who do not want to be found, additional option to hide from search can also be added as an improvement to option to remain anonymous.

Lack of knowledge for system use

The improvement on concept connected to this might be making a nice manual for the app that could be used on a web page, application store or shipped in PDF to the user, depending on how the application is to be marketed. This is, however, not so relevant to the application design and development process so it is something only to be mentioned in this thesis for the sake of future work.

Cost

No changes are to be made for this concept as well. It would be useful to evaluate users' opinion on the way they would prefer to get the application, but this does not affect the prototype development process greatly.

5 PROTOTYPE DEVELOPMENT

The software engineering process of software development is used to develop the prototype. The prototype is developed in three phases described in this chapter. First, requirements specifications are defined based on developed concepts, then software architecture engineering process is used to define architectural description and how to fit all of the features together, and finally, the application prototype is implemented and presented.

5.1 Requirements specification

The requirement specifications for this prototype are done according to ("IEEE Guide to Software Requirements Specifications", 1984). Software requirement specification document represents a description of the software that is to be made in a form of functional and non-functional requirements, along with a set of constraints which apply to this prototype.

The final concept design, developed in previous chapter, is here translated to system requirements specification and organized in the more formal way mentioned in previous paragraph. Therefore, the overall system description will be omitted here, since it is already covered in previous chapters and I intended only to present functional and non-functional requirements derived from developed concepts and constrains that apply to this software development.

5.1.1 Functional requirements

The functional requirements are grouped by feature and represented in following tables (Table 5-1 – Table 5-24). Each functional requirement (FR) is represented by name, priority, purpose in the application, input action that should trigger it, operations that are performed when the input is finished and output that is given to the user when operations are done.

FR1.1	**Start session**
Priority	High
Purpose	Start tracking of walking for the user
Input	Pressing the button
Operations	Tracking components are activated
Output	Current session tracking page shown

Table 5-1 Start session FR

FR1.2	**Finish session**
Priority	High
Purpose	Stop tracking of walking for the user
Input	Pressing the button
Operations	Tracking components are deactivated, session data is recorded
Output	Return to main page

Table 5-2 Finish session FR

FR2.1	**Real-time distance tracking**
Priority	High
Purpose	Tracking the distance walked during the session in real-time
Input	Movement of user (device)
Operations	Distance moved from previous point is calculated using GPS and accumulated, with update interval of 5 seconds.
Output	Real-time walked distance in meters

Table 5-3 Real-time distance tracking FR

FR2.2	**Real-time map path tracking**
Priority	Medium
Purpose	Tracking the walking path on map during the session in real-time
Input	Movement of user (device)
Operations	Location on map is fetched from GPS every 5 seconds and the path is formed by connecting the fetched points
Output	Walked path drawn on the map

Table 5-4 Real-time map path tracking FR

FR2.3	**Goal progress tracking**
Priority	Medium
Purpose	Tracking the daily goal progress during the session in real-time
Input	Real-time distance tracking
Operations	The percentage of completion for daily goal is calculated each time walked distance is increased
Output	Real-time daily goal progress

Table 5-5 Goal progress tracking FR

FR3.1	**Long term progress chart**
Priority	High
Purpose	Reflecting on past performance
Input	Navigating to “Stats” page
Operations	Presenting the daily goal completeness data in a form of a chart.
Output	Goal completeness in % as a function of time in discrete manner.

Table 5-6 Long term progress chart FR

FR3.2	**Chart time span setting**
Priority	Medium
Purpose	Customizing the chart using different time spans
Input	Pressing the button
Operations	Changing the set of data used for chart
Output	Chart within requested time span

Table 5-7 Chart time span setting FR

FR4.1	**Listing recent sessions**
Priority	Medium
Purpose	Short term past performance reflection
Input	Navigating to “Stats” page
Operations	Populating the list with recent sessions of last 7 days
Output	List of entries containing user photo, time when session was finished and distance

Table 5-8 Listing recent sessions FR

FR4.2	**Session details page**
Priority	Medium
Purpose	Details of finished sessions
Input	Pressing the listed session entry in recent sessions or friend’s session
Operations	Data for requested session is fetched
Output	Session info page with distance walked and path walked on map

Table 5-9 Session details page FR

FR5.1	**List friends**
Priority	High
Purpose	To encourage social aspect by offering social traces
Input	Navigating to “Friends” page
Operations	Added friend list is fetched
Output	Page with list of friends photo, name and last session distance walked entries which can lead to session details page when pressed

Table 5-10 List friends FR

FR5.2	Adding friends
Priority	Medium
Purpose	To populate the list of friends used by various social features
Input	Clicking the “+” button on “Friends page”
Operations	Request friend search dialog
Output	Friend search dialog is shown

Table 5-11 Adding friends FR

FR5.3	Friends search
Priority	Medium
Purpose	To find a friend that is using the application
Input	Typing the user name in the search field
Operations	After 3 characters are typed, start showing best matched results that improve with each additional letter typed
Output	Users with matching username are shown.

Table 5-12 Friends search FR

FR5.4	Friend request
Priority	Medium
Purpose	To request a friend to be added
Input	Clicking “Add” button in friend search result entry
Operations	The pending request is registered for selected user
Output	Selected user receives the notification about request with option to accept or refuse

Table 5-13 Friend request FR

FR5.5 Add friends from Facebook

Priority	Low
Purpose	To make it easier to find friends who are using the application
Input	Clicking “Add from Facebook”
Operations	Connect with Facebook, fetch all friends who are using the app
Output	Show resulting users in search result list

Table 5-14 Add friends from Facebook FR

FR5.6 Challenge friends

Priority	Low
Purpose	To utilize competitive aspect for motivation
Input	Clicking “Challenge” button next to friend who is challengeable
Operations	Send challenge request to a friend with 12 hours response period
Output	Friend receives notification and is able to reject or accept challenge.

Table 5-15 Challenge friends FR

FR5.7 Challenge tracking

Priority	Low
Purpose	To track status of the challenge
Input	Navigating to “Friends” page
Operations	Fetching the challenge status data for all the friends in the list
Output	Showing challenge status next to (pending / wining / loosing)

Table 5-16 Challenge tracking FR

FR5.8	Showing notifications
Priority	Medium
Purpose	To inform the user about friend or challenge request
Input	Time scheduled notification check
Operations	Fetch data that should be parsed to a notification
Output	Showing notification

Table 5-17 Showing notifications FR

FR6.1	Setting daily goal
Priority	High
Purpose	To set the goal in a form of distance to be walked daily
Input	Distance in meters typed
Operations	Change the daily goal data
Output	New daily goal is used in tracking

Table 5-18 Setting daily goal FR

FR6.2	Friends' daily goals
Priority	Medium
Purpose	To offer a hint when setting a goal in a form of social traces
Input	Navigating to "Friends' goals" page
Operations	Fetch data of all friends' goals
Output	Show list of entries containing picture, name, and goal of a friend

Table 5-19 Friends' daily goals FR

FR6.3	Goal completed message
Priority	Medium
Purpose	To utilize emotional reinforcement and informational support to motivate user
Input	Finishing a session that adds up to 100% or more distance of a daily goal value
Operations	Fetch the message and prepare the dialog
Output	Show the “Congratulations” dialog with random informational quote related to walking / exercising

Table 5-20 Goal completed message FR

FR7.1	Application sharing
Priority	High
Purpose	To enable users to share the application to their friends
Input	Pressing “Share” button
Operations	Activating sharing mechanism
Output	Show default sharing dialog / wizard

Table 5-21 Application sharing FR

FR8.1	First use guide
Priority	High
Purpose	To present a short guide to app on the first start
Input	Starting the application for the first time
Operations	Fetching the guide assets
Output	Show application use guide

Table 5-22 First use guide

FR9.1	Anonymous mode
Priority	High
Purpose	To prevent showing user's data to others
Input	Activating "Anonymous mode" checkbox
Operations	Set anonymous flag
Output	User data is no longer shown to others

Table 5-23 Anonymous mode FR

FR10.1	Native ads
Priority	Low
Purpose	Show native ads to get financial support for application development
Input	Navigating to "Friends" page
Operations	Get ads from ad provider and insert them in the list of entries
Output	Show ads in the list of entries

Table 5-24 Native ads FR

5.1.2 Non-functional requirements

The quality attributes that I have declared as relative are usability and reliability. Non-functional requirements connected with those quality attributes are defined in following tables (Table 5-25 – Table 5-29) and presented along with use-case scenarios to better describe them. Each requirement is defined by its name and use case scenario components: source of action, stimulus for given action, artifact that enables performing given action, environment in which the given action occurs, response that given action should return and expected response measure that satisfies design.

U1	**Easy to learn**
Source	User
Stimulus	Looking for certain feature in the application
Artifact	Navigation mechanism
Environment	Run-time
Response	The feature is found
Response measure	90% of available features should be findable in less than 20 seconds

Table 5-25 Usability – Easy to learn scenario

U2	**Confirmation for important actions**
Source	User
Stimulus	Adding a friend or sending a challenge request
Artifact	“Friends” od “Friend search” page
Environment	Run-time
Response	A confirmation dialog
Response measure	Prevent 99% of all accidental triggering of important actions

Table 5-26 Usability – Confirmation for important actions scenario

U3	**Attractiveness**
Source	User
Stimulus	Browsing the application
Artifact	Whole application
Environment	Run-time
Response	User is appealed by page layout and colors
Response measure	80% of users like the application page layout and colors

Table 5-27 Usability – Attractiveness scenario

R1	**Distance accuracy**
Source	User
Stimulus	Checking distance walked after the session
Artifact	GPS data parser
Environment	Run-time
Response	Distance walked data is shown
Response measure	Distance shown should not differ for more than 100 meters compared to real distance walked

Table 5-28 Reliability – Distance accuracy scenario

R2	**Path accuracy**
Source	User
Stimulus	Checking walked path on map after the session
Artifact	GPS data parser
Environment	Run-time
Response	Walked path is drawn on map
Response measure	95% of the users should be satisfied with the accuracy of the drawn path

Table 5-29 Reliability – Path accuracy scenario

5.1.3 Constraints

In order to further describe what exactly the software I am developing will represent, I have declared a constraint that represent a restriction on the scope of this software system.

C1: The software is designed to support working under Android OS operating system only

C2: The software should not support various screen sizes and device types, but only has to work on the device used for presentation of features used for evaluation not prevent proper presentation of features used for evaluation

C4: Any complex features and resource demanding implementation can be simplified or pruned as long as long as it does not prevent proper presentation of features used for evaluation

C5: Performance efficiency optimization is omitted in prototype

C6: Clean code practices like unit tests and code refactoring are omitted in prototype

5.2 Architectural description

The architectural description of this software is made according to guidelines given in ("IEEE Recommended Practice for Architectural Description", 2000) standard. This standard is intended for systems where software part is essential in both design and deployment. The architectural description is supposed to show the way the system expresses and evolves, what is the relationship between stakeholders, evaluation of architectures, planning, executing and managing the development activities and verification of implementation's compatibility with architectural description.

5.2.1 Architectural Drivers

Architectural drivers or architecturally significant requirements are high level requirements that have important business and mission value and are expected to have an impact on the architecture. I have derived the following drivers from the idea and concept of this software, defined system requirements and constraints.

Technical constraints

D1: Software should be able to work on single device with Android OS

Business constraints

D2: Software prototype has to be developed within less than 4 weeks

D3: Low level of expertise in user interface design

Quality requirements

D4: Constant real-time updating of data is required

Functional requirements

D5: Non-persistent communication between users is required

D6: Use of Android sharing API is required

D7: Software requires use of third party APIs (Google maps, Facebook and ads)

5.2.2 Stakeholders and concerns

Stakeholders in this software and assumed concerns of each one are presented in Table 5-30.

Stakeholder	*Concerns*
User	Is the application easy to learn and use? Is the application free? Is the application useful and reliable? Does the application looks and feels nice?
Developer	Can the application prototype be developed in 4 weeks? Will the third party APIs offer required service and functionality? Is it possible to produce a good quality user interface without hiring a user interface expert?

Table 5-30 Stakeholders and concerns

5.2.3 Architectural tactics

The architectural tactics used to support usability and reliability quality attributes with explanations are listed below:

T1: Separation of user interface from the application logic.

This architectural tactic is used to ensure that user interface can be easily and rapidly changed and customized during development time in order to make it more suitable for the users

T2: Providing redundancy.

To ensure that data is correct, more than one way of measurement can be used and then combined to give the most accurate result.

T3: Use view-data binding.

The views and the model are expected to interact often, therefore when one is changed, corresponding counterparts should be updated.

5.2.4 Architectural and design patterns

In order to support the architectural drivers and tactics, following architectural and design patterns are used:

MVVC – Model View ViewModel is quite recent architectural pattern used to separate the two parts of the application found in its name, and at the same time offer easy interaction between

those. It is similar to MVC (Model View Controller) pattern, but differs in a way that it exposes commands to the view and binds view to the model. The separation of a model of a user from the multiple views that represent parts of the model in various ways is desired in this application, so one could be changed without having to modify other. On the other hand, binding between view and model is a great way of satisfying real-time update requirement.

Encapsulation – Design pattern used to support MVVC architecture and also offer good way to structure lower level application logic in classes and methods.

Observer – Design pattern used to support MVVC by providing a way of binding model to views.

Adapter – Design pattern that is very common in android and useful for adapting the various lists data to list view presentation.

Singleton – Design pattern useful for creation of various helpers and utilities which can be globally accessed across the application.

5.2.5 Views

In order to better describe the software to be developed, I have developed two different architectural views: Process view and Development view with the diagrams and explanations. The views presented are based on "4+1" view model of software architecture developed by (Kruchten P, 1995).

Process view

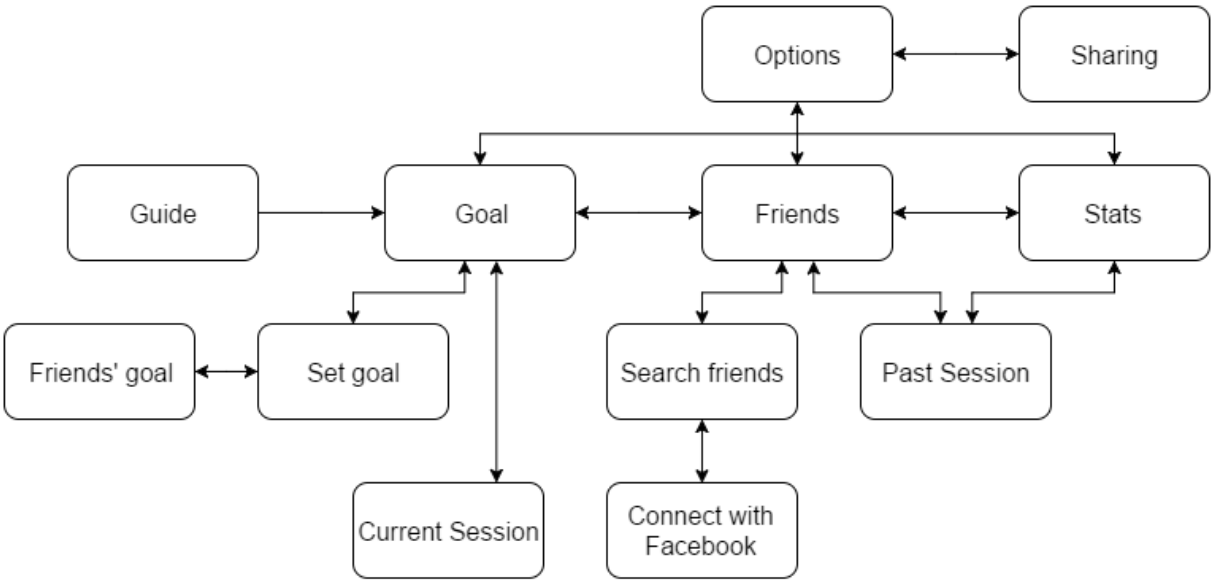

Figure 5-1 Process view

Process view presented on Figure 5-1 represents a set of distinct pages (activities) in the application and workflow between them. The arrows represent in which direction user can go from one step to another. This represents the basic process flow of the application from user's perspective.

Development view

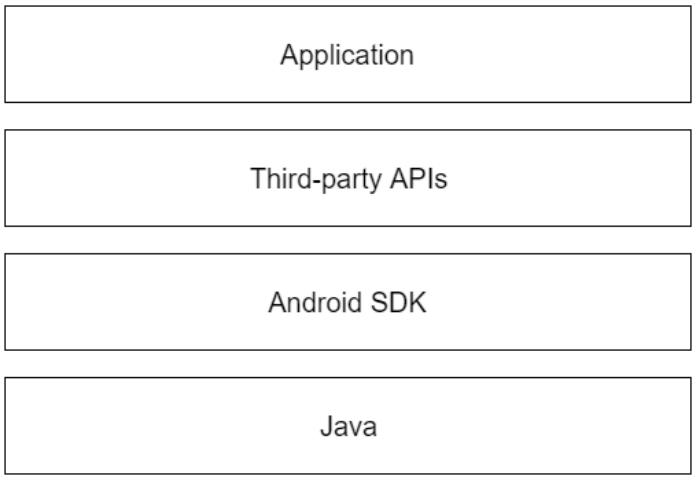

Figure 5-2 Development view

Development view on Figure 5-2 describes how the system is built from developer's side, on high level. Each layer is aware of all layers under it and is able to use their methods and classes, while lower levels are not aware of layers above.

5.3 Implementation and preview

In order to better explain the implementation of certain parts of the prototype, I have decided to show a preview of implemented features, in form of screenshots, along with explanations of implementation details. This way it may be easier for the reader to understand the context of each separate implementation explanation.

This sub-chapter is concerned with description of environment, libraries and code build tools used to develop the prototype, structure of the classes and their correlation among each other and connection with resources. Also, it is described how the features are produced using those classes and resources, how certain design patterns are used to make implementation easier and how the prototype works in Android OS.

5.3.1 Environment and tools

Development environment used for this project was Android Studio 2.0. It is a standard integrated development environment for android projects recommended and provided by

Google, the developer of Android itself. It uses the Gradle dependency resolver and building system, along with Android SDK (Standard Development Kit) to build the project from .java classes, .xml resources, according to specified settings, into .apk file that is runnable on Android device. It also allows various code writing tips, quick documentation, code templates, auto complete features, editor color theme and code style customization, and a lot more customization options. Therefore, it was my first choice as development environment.

The code is built using API 23 as a target Android OS version (Android 6.0), and API 15 as a minimal supported Android OS version (Android 4.0.3) which provides the application that is runnable on 97.4% of all present Android devices at the time of writing, according to approximation given by Android Studio. Application name is decided to be “Walking”, as its main purpose is to promote walking. It uses Android support libraries to ensure that features from targeted android version will also work on older versions.

5.3.2 Project structure

In the following text, project files hierarchy and structure is explained. Figure 5-3 shows the basic project structure, .java classes structure and .xml layouts.

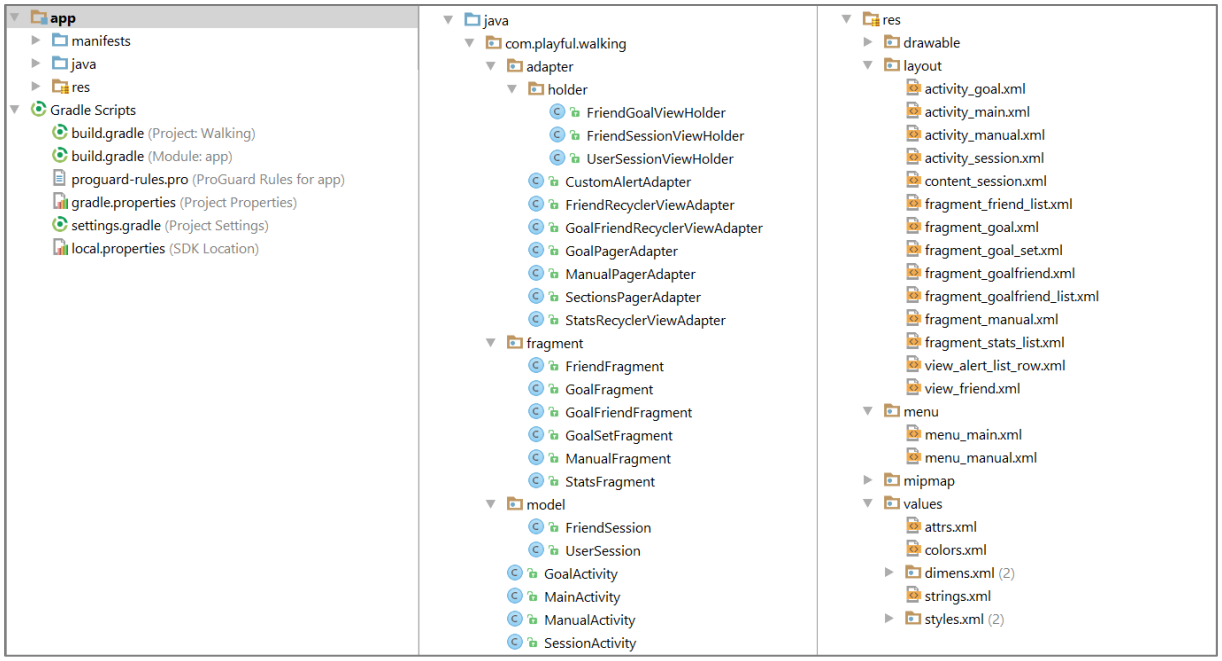

Figure 5-3 Project files hierarchy

The base Android application structure is presented on the left side. It shows that the project consists of manifest file that is used to describe the basic behavior of application and activities, like names, labels, child-parent relationships or defining permissions and launcher activity,

.java classes that represent a codebase of the application and resources that contain .xml files and drawable. Gradle Scripts come along with this basic structure and they are used to describe how the application is built, which libraries to use, and what OS version to support.

The .java classes hierarchy is presented in the middle. Classes are grouped using packages, and Activity classes, that are the base of every android application, are kept in base "com.playfull.walking" package. It contains "model", "fragment" and "adapter" sub-packages, which represents separation of model from view classes according to architectural pattern discussed in previous chapter. "model" classes are used to represent data models, "fragment" classes are used to present views inside the activities and "adapter" classes are used to control how the data model objects are presented in fragments, or how child fragments are presented in its parent view. "holder" classes are used by list adapters to bind data model instances to corresponding views in list fragments.

Resources, which are presented on the right side, consist of drawables, layouts and values. "drawable" directory contains image resources used in application image views and "mipmap" folder contains image resources used for icons. Layouts are used to describe views presented by activities, fragments, and dialogs. Values are resources that store various primitive data type values, strings, dimensions, color codes and styles and themes that can be used by views.

5.3.3 Navigation

The user navigates through the application by swiping through pages or pressing the desired tab above, using back button and options menu. The swiping behavior is achieved using "ViewPager" view that is inflated in the host activity. "ViewPager" class uses my custom made adapter that extends "FragmentPagerAdapter" class, and defines the pages (Fragments) that user can swipe through, how they are created and tab titles.

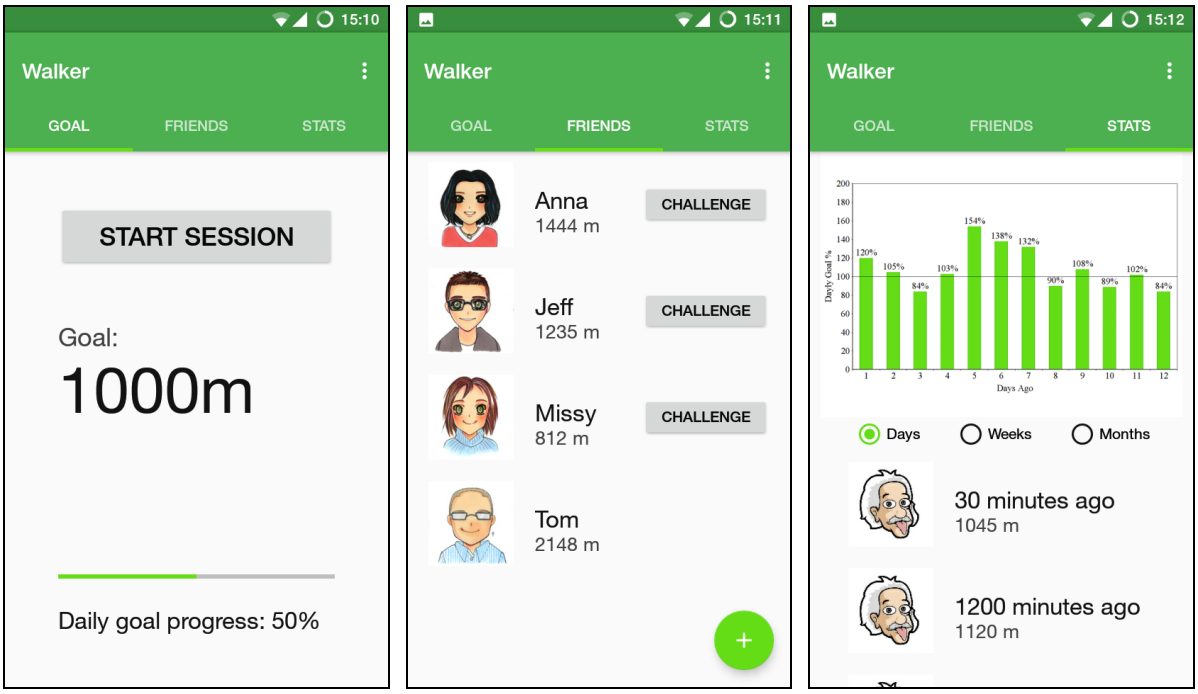

Figure 5-4 Main application navigation

Figure 5-4 shows the main application navigation that is implemented by placing "ViewPager" into "MainActivity":

```
mViewPager = (ViewPager) findViewById(R.id.container);
mViewPager.setAdapter(mSectionsPagerAdapter);
```

and using "SectionsPagerAdapter" to set "GoalFragment", "FriendFragment" and "StatsFragment" as swipeable pages:

```
@Override
public Fragment getItem(int position) {
    switch (position) {
        case 0:
            return new GoalFragment();
        case 1:
            return new FriendFragment();
        default:
            return new StatsFragment();
    }
}
```

"TabLayout" class is used to set up the view pager with tabs:

```
TabLayout tabLayout = (TabLayout) findViewById(R.id.tabs);
```

```
tabLayout.setupWithViewPager(mViewPager);
```

and the tabs count and titles are defined inside “SectionsPagerAdapter”:

```
@Override
public int getCount() {
    return 3;
}

@Override
public CharSequence getPageTitle(int position) {
    switch (position) {
        case 0:
            return "GOAL";
        case 1:
            return "FRIENDS";
        case 2:
            return "STATS";
    }
    return null;
}
```

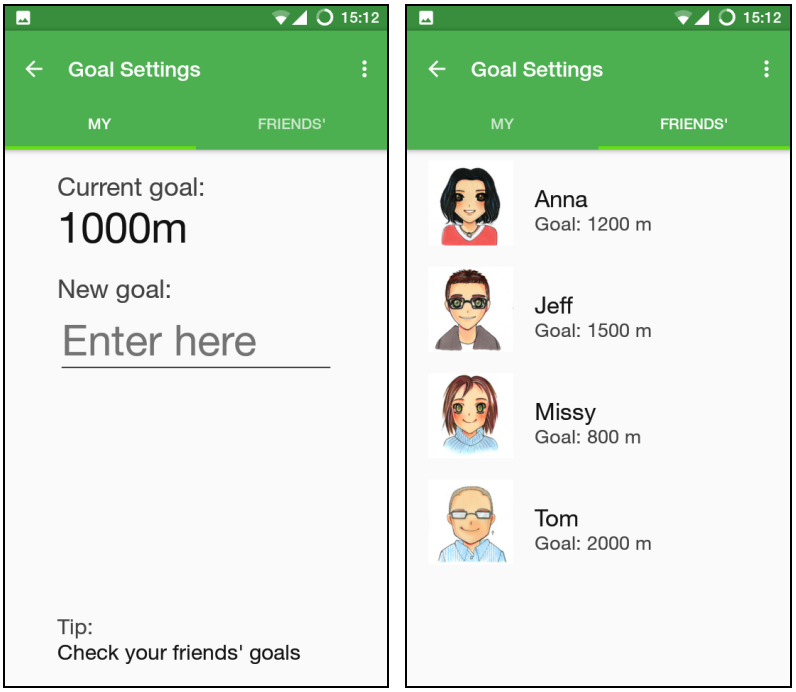

Figure 5-5 Goal settings navigation

Figure 5-5 shows the goal settings navigation, which is presented after user presses the current goal number. This action starts the new activity named “GoalActivity”:

```
public void setGoal(View v) {
    Intent intent = new Intent(this, GoalActivity.class);
    startActivity(intent);
}
```

“GoalActivity” navigation is implemented the same way as main navigation, but this time placing “ViewPager” into “GoalActivity” and using “GoalPagerAdapter” to set “GoalSetFragment” and “GoalFriendFragment” as swipeable pages.

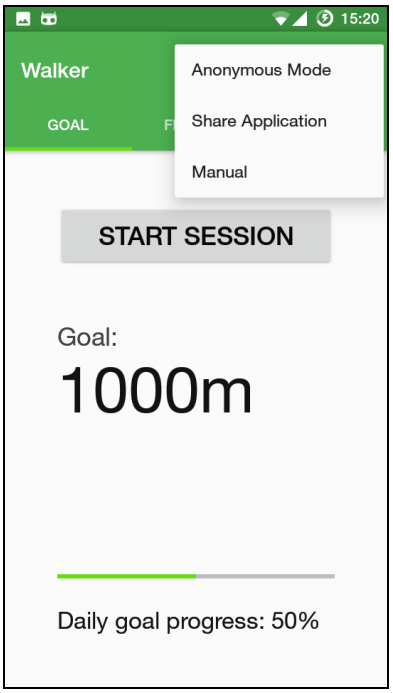

Figure 5-6 Options menu navigation

Options menu on Figure 5-6 is accessed by pressing three dots in the upper-left corner on the screen. It is shown on “Toolbar” and inflated in “MainActivity” and “GoalActivity”:

```
@Override
public boolean onCreateOptionsMenu(Menu menu) {
    getMenuInflater().inflate(R.menu.menu_main, menu);
    return true;
}
```

The option menu items are defined in the “menu_main.xml” layout file.

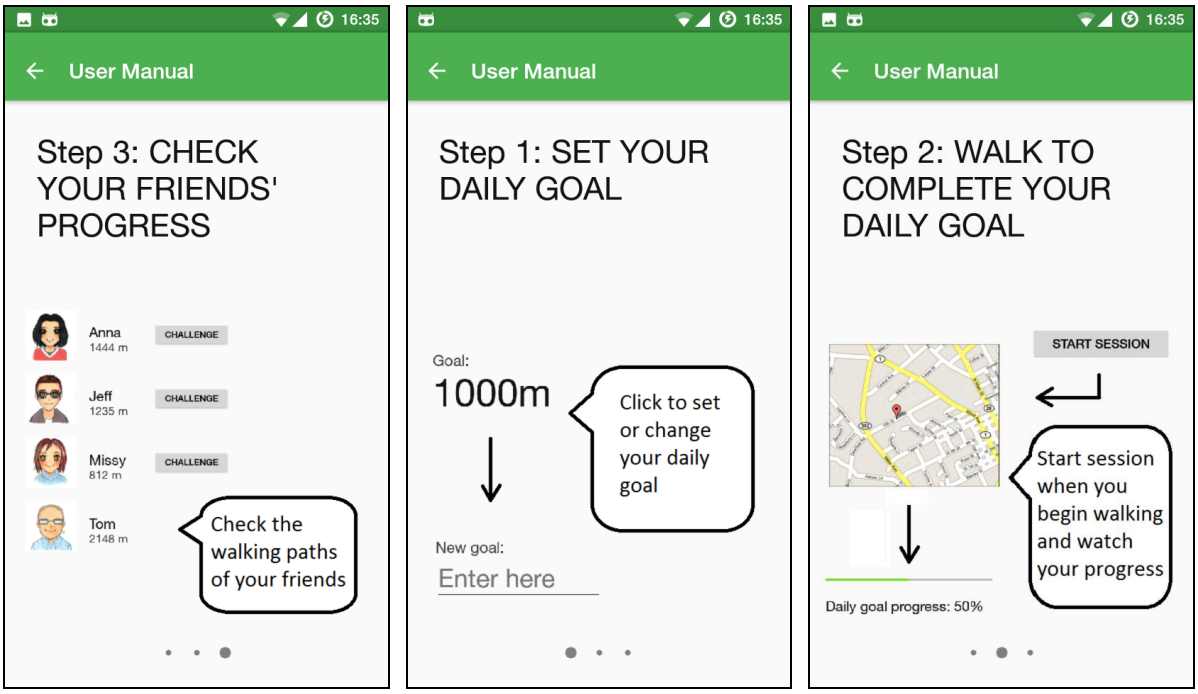

Figure 5-7 User manual

The user manual presented on Figure 5-7 is activated by pressing the "Manual" option on menu shown on Figure 5-6. This action starts the "ManualActivity":

```
@Override
public boolean onOptionsItemSelected(MenuItem item) {
    int id = item.getItemId();
    if (id == R.id.action_manual) {
        Intent intent = new Intent(this, ManualActivity.class);
        startActivity(intent);
    }
    return super.onOptionsItemSelected(item);
}
```

The "ManualActivity" uses the "ViewPager" to show swipeable pages in an earlier explained way using "ManualPagerAdapter" that instantiates "ManualFragment" with a page number as a parameter. "ManualFragment" then inflates one of three drawables and one of three texts depending on page number parameter:

```
switch (mParam1) {
    case 0:
        text.setText("Step 1: SET YOUR DAILY GOAL");
        image.setImageResource(R.drawable.manual_1);
        break;
```

```
            case 1:
            text.setText("Step 2: WALK TO COMPLETE YOUR DAILY
GOAL");
                image.setImageResource(R.drawable.manual_2);
                break;
            case 2:
                text.setText("Step 3: CHECK YOUR FRIENDS'
PROGRESS");
                image.setImageResource(R.drawable.manual_3);
                break;
              }
```

Pressing the back button closes the activity and returns to “MainActivity”.

5.3.4 Tracking

The tracking features implemented in prototype consist of goal setting, session tracking, long term tracking chart and recent user sessions.

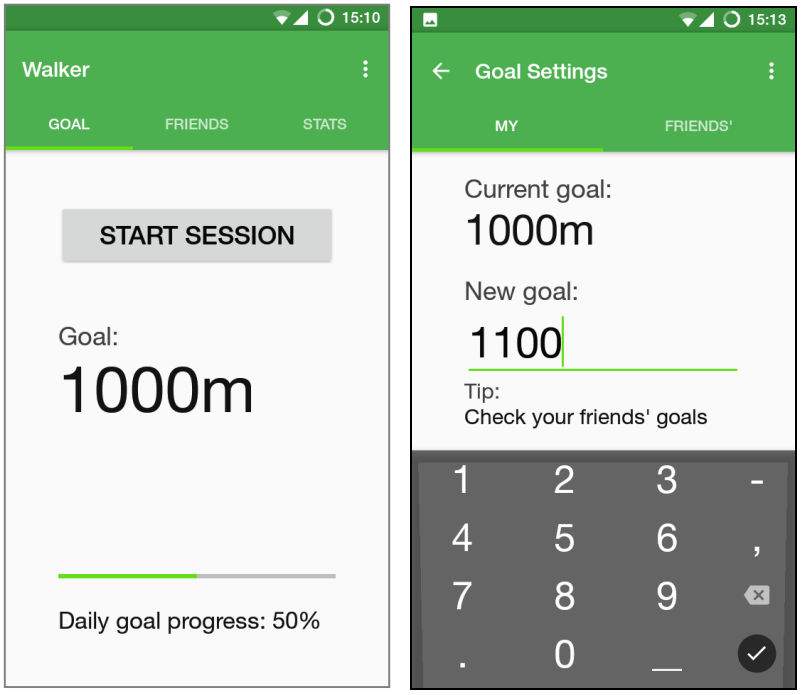

Figure 5-8 Goal setting

Daily goal setting and editing, as shown on Figure 5-8 is performed by entering desired distance in meters into “EditText” field and pressing “Done” action (checkmark). The “Done” action is handled by setting custom “OnEditorActionListener” to “TextView” which updates the global “goal” variable to new value:

```
        EditText goalEditText = (EditText)
view.findViewById(R.id.goal_edit_text);
        goalEditText.setOnEditorActionListener(new
TextView.OnEditorActionListener() {
            @Override
            public boolean onEditorAction(TextView v, int actionId,
KeyEvent event) {
                if(actionId == EditorInfo.IME_ACTION_DONE){
                    if (!v.getText().equals("")) {
                            updateGoal(Integer
.parseInt(v.getText().toString()));
                    }
                }
                return false;
            }
        });
```

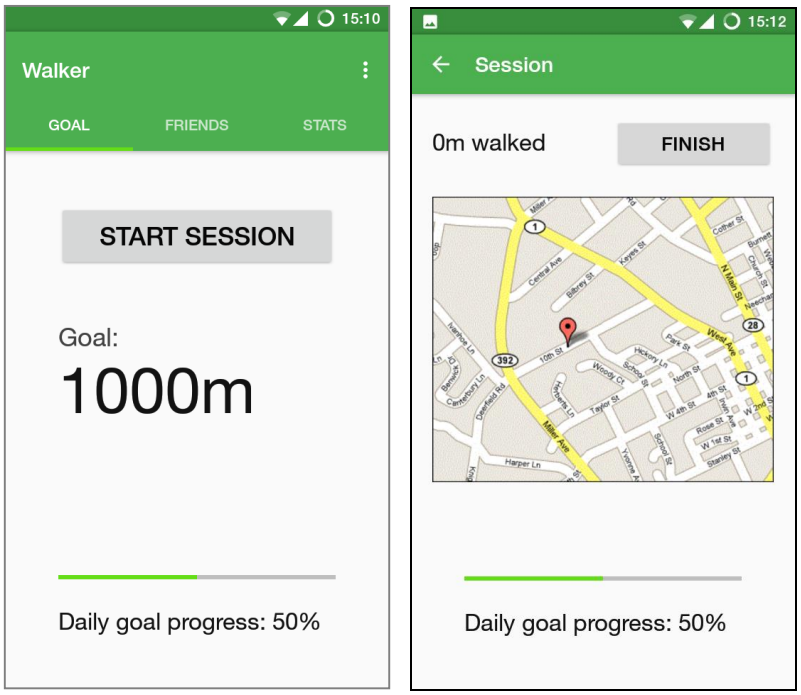

Figure 5-9 Session tracking

Start session button starts “SessionActivity” when pressed which is shown on Figure 5-9. “SessionActivity” is supposed to track distance and draw a path on the fetched area map using GPS location. Both distance tracking and map path drawing is mocked in this prototype instead of using the actual API, to increase prototype development speed since it was not priority to have actual functionality during evaluation with users. Pressing the Finish button stops the “SessionActivity” and returns to “MainActivity”.

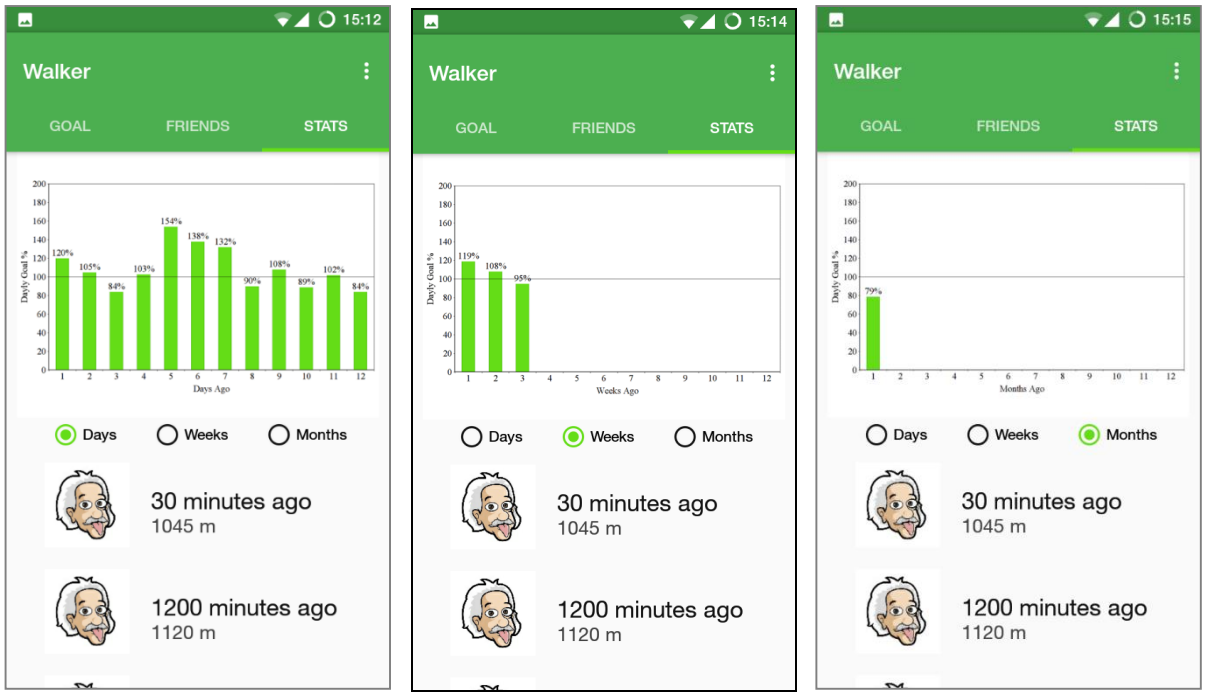

Figure 5-10 Long term tracking chart and recent sessions list

"StatsFragment" on Figure 5-10 shows chart based on chosen timespan using radio buttons under it. This is implemented by setting custom "OnCheckedChangeListener" to "RadioGroup" that contains those radio buttons:

```
        RadioGroup radioGroup = (RadioGroup)
view.findViewById(R.id.radioGroupChart);
        radioGroup.setOnCheckedChangeListener(new
RadioGroup.OnCheckedChangeListener()
        {
            @Override
            public void onCheckedChanged(RadioGroup group, int
checkedId) {
                setChart(checkedId);
            }
        });
```

"setChart" method is supposed to activate the logic that draws the desired chart based on long term data, but that functionality is also omitted in this prototype for its long development time and mocked drawings are presented instead for each chosen timespan:

```
    public void setChart(int id) {
        ImageView chart = (ImageView)
getView().findViewById(R.id.chart);
        switch (id) {
```

```
            case R.id.radioButtonDays:
                chart.setImageResource(R.drawable.chart_days);
                break;
            case R.id.radioButtonWeeks:
                chart.setImageResource(R.drawable.chart_weeks);
                break;
            case R.id.radioButtonMonths:
                chart.
setImageResource(R.drawable.chart_months);
                break;
        }
    }
```

Recent user session list under the chart is presented using "RecyclerView" inside "StatsFragment" that is using "StatsRecyclerViewAdapter":

```
        RecyclerView recyclerView = (RecyclerView)
view.findViewById(R.id.list);
        recyclerView.setLayoutManager(new
LinearLayoutManager(context));
        recyclerView.setAdapter(new
StatsRecyclerViewAdapter(mDataSet, mListener));
```

in order to create "UserSessionViewHolder" instances and bind "UserSession" model class instances to them by calling "bind" method inside this customized "ViewHolder":

```
    public void bind(UserSession userSession) {
        mTime.setText(userSession.time + " minutes ago");
        mDistance.setText(userSession.distance + " m");
        mPhoto.setImageDrawable(itemView.
getResources().getDrawable(R.drawable.einstein));
         }
```

Pressing on any of those entries activates callback through "OnListFragmentInteractionListener" that is implemented in "MainActivity":

```
    @Override
    public void onListFragmentInteraction(UserSession userSession) {
        Intent intent = new Intent(this, SessionActivity.class);
        intent.putExtra("distance", userSession.distance);
        intent.putExtra("progress", 0);
        startActivity(intent);
```

}

and “SessionActivity” is started with additional parameters which also tells it this is not an active, but past session, and it is not supposed to show finish button and track goal progress, buy only show distance walked and path on the map. So instead of getting the active session view presented on Figure 5-9, user gets past session like one presented on Figure 5-11.

5.3.5 Social

Social features of this application are those that provide connectivity with friends and are implementing social aspect in a way described in concept design chapter. The implemented social features consist of friends list and ability to see their last session info, friend searching and adding interface, challenging a friend, checking daily goal of those friends and application sharing over third party communication software.

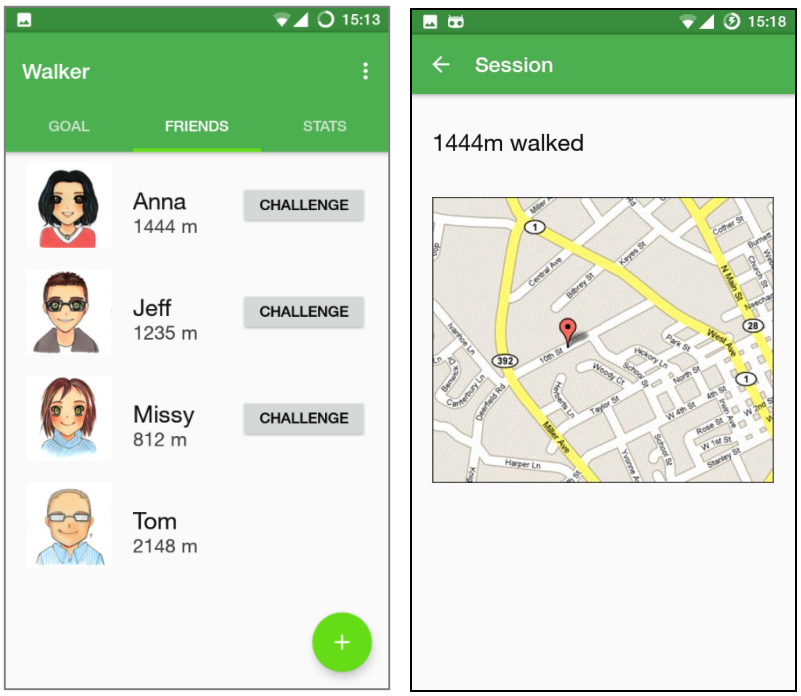

Figure 5-11 Friends’ last session

The list of friends presented on Figure 5-11 is implemented inside “FriendFragment” which is presented using “ViewPager” hosted by “MainActivity”. The list is implemented the same way as recent user sessions list, but this time using “FriendRecyclerViewAdapter” to populate the “RecyclerView” inflated inside the “FriendFragment” with “FriendGoalViewHolder” instances bound to “FriendSession” data model instances.

Pressing any entry in the list starts the “SessionActivity” with parameters to show the view in past session mode, the same way as recent user sessions are handled, except this time “FriendSession” data is presented inside the view. Dummy data is used for this prototype preview.

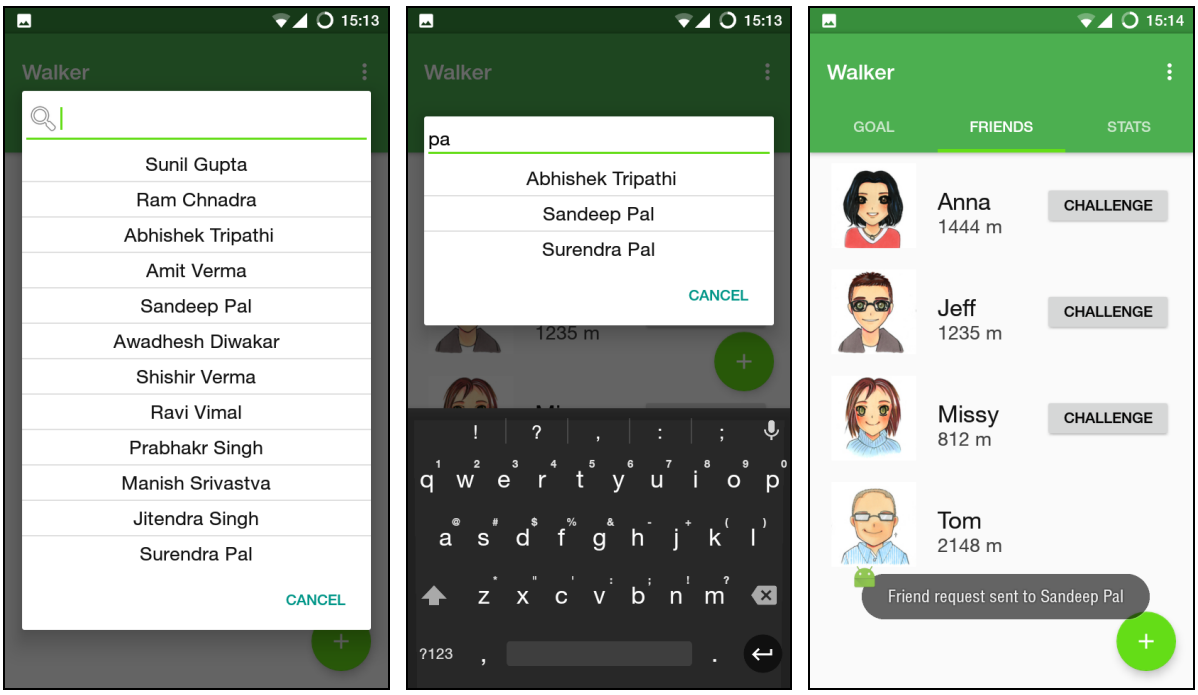

Figure 5-12 Searching for friends and sending friend requests

By pressing the “+” floating button user gets a friend search dialog implemented as the customized “AlertDialog”, shown on the left side of Figure 5-12, which uses “CustomAlertAdapter” to inflate data set into the dynamically created “ListView”:

```
    public void addFriend(View v) {
        AlertDialog.Builder myDialog = new
AlertDialog.Builder(v.getContext());
        final EditText editText = new EditText(MainActivity.this);
        final ListView listview = new ListView(MainActivity.this);
        editText.setCompoundDrawablesWithIntrinsicBounds(android.
R.drawable.ic_menu_search, 0, 0, 0);
        arraySort = new ArrayList<> (Arrays.asList(TitleName));
        LinearLayout layout = new LinearLayout(MainActivity.this);
        layout.setOrientation(LinearLayout.VERTICAL);
        layout.addView(editText);
        layout.addView(listview);
        myDialog.setView(layout);
```

```
        final CustomAlertAdapter arrayAdapter = new
CustomAlertAdapter(MainActivity.this, arraySort);
        listview.setAdapter(arrayAdapter);
    …
```

The customized “OnItemClickListener” is attached to created “ListView” to handle pressing and send the friend request and close the dialog. In this prototype preview it mocks this behavior with toast message shown on the bottom of the screen as shown on the right of Figure 5-12:

```
        listview.setOnItemClickListener(new
AdapterView.OnItemClickListener() {
            @Override
            public void onItemClick(AdapterView<?> parent, View
view, int position, long id) {
                myAlertDialog.dismiss();
                String strName = arraySort.get(position);
                sendFriendRequest(strName);
            }
        });
```

The additional search behavior presented in the middle of Figure 5-12 is used to dynamically filter the list of user names while the user types in the name. It is implemented by attaching a custom version of “TextWatcher” to “TextView” field and implementing its “onTextChanged” method to filter and show the new list of names with every edited character:

```
    public void onTextChanged(CharSequence s, int start, int
    before, int count) {
            editText.setCompoundDrawablesWithIntrinsicBounds(0, 0,
    0, 0);
            textLength = editText.getText().length();
            arraySort.clear();
            for (int i = 0; i < TitleName.length; i++) {
                if (textLength <= TitleName[i].length()) {
                    if(TitleName[i].toLowerCase().contains(editText
    .getText().toString().toLowerCase().trim())) {
                        arraySort.add(TitleName[i]);
                    }
                }
            }
            listview.setAdapter(new
    CustomAlertAdapter(MainActivity.this, arraySort));
        }
```

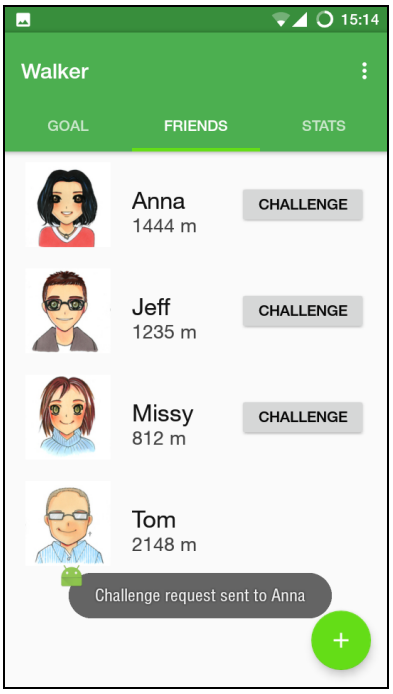

Figure 5-13 Challenging a friend

Challenge button is present on any challengeable friend, as presented on Figure 5-13. To determine which friend is challengeable, simple algorithm is used. User's goal is compared to friend's goal and if it does not differ by more than 500m than the challenge button is presented on the friend entry. This algorithm is implemented in "bind" method inside "FriendSessionViewHolder":

```
if (friendSession.distance < GoalFragment.goal + 500 &&
        friendSession.distance > GoalFragment.goal - 500) {
    mChallengeButton.setVisibility(View.VISIBLE);
}
```

Pressing the button triggers the "onListButtonPressed" listener interface method implemented in "MainActivity" that is supposed to handle the challenge request. For this prototype, only toast message is shown on the screen as shown on Figure 5-13.

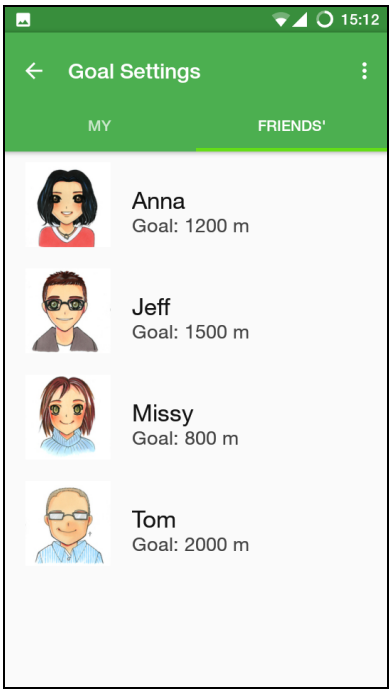

Figure 5-14 Friends' goals

Friends' goals on Figure 5-14 are shown inside of "GoalActivity" as a "GoalFriendFragment" which is created and shown under "ViewPager". It uses "GoalPagerAdapter" and binds "FriendSession" to "FriendGoalViewHolder" instances. The principle is the same as used in the "FriendFragment" explained earlier, except the "goal" attribute is bound to "VievHolder" instead of "distance" which is used in earlier case.

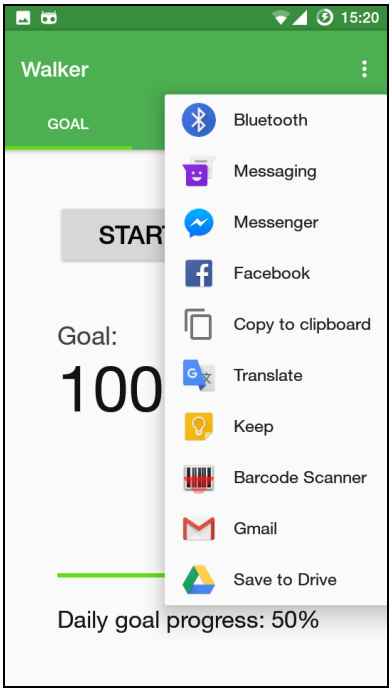

Figure 5-15 Application sharing

The sharing mechanism on Figure 5-15 is accessed via options menu presented on Figure 5-6. It offers possibility of sharing of link to the application installation page in a simple text format, with additional message, using any third party communication software available on user's device.

It is implemented by setting "ShareActionProvider" class as "actionProvider" of "Share Application" action, listed as item in "menu_main.xml" layout resource file:

```
    <item
        android:id="@+id/action_share"
        android:orderInCategory="102"
        android:title="Share Application"
        app:actionProviderClass="android.support.v7.widget
.ShareActionProvider"/>
```

In the code, this action is implemented by setting the custom sharing "Intent" to this "ShareActionProvider":

```
    MenuItem item =  menu.findItem(R.id.action_share);
    MenuItemCompat.getActionProvider(item);
    android.support.v7.widget.ShareActionProvider
shareActionProvider =
(android.support.v7.widget.ShareActionProvider)
MenuItemCompat.getActionProvider(item);
    Intent sendIntent = new Intent();
    sendIntent.setAction(Intent.ACTION_SEND);
    sendIntent.putExtra(Intent.EXTRA_TEXT, "Try out this
application: <link>");
    sendIntent.setType("text/plain");
    shareActionProvider.setShareIntent(sendIntent);
```

6 EVALUATION

The evaluation is performed using a developed prototype as an artifact, survey with questions and chosen users from targeted group. The goal of this evaluation was to gain the data about how much the targeted users like or dislike certain features in application, and then use the data collected in the discussion chapter. The evaluation process, data collection and use of data is done according to NTNU research ethic guidelines.

6.1 User selection

The targeted user criteria were developed in order to find the users that could possibly use this application for their own benefit. During concept design time, I stated that the application is intended for older adults. Therefore, the user selection criteria defined by me was to accept participants older than 55 years. The prototype was developed to work with Android devices, so the additional criteria for the participants was that they had to be regular Android device users. Additional criteria were derived from research ethics, so the participant had to give me a consent to collect non personal data, and use it in my research

In order to make the evaluation possible in short time, fewer participants were chosen, but in order to have at least a bit of useful data, I have decided to choose at least two participants. The evaluation is performed in Serbia as I have resided there during the evaluation process and as Serbian language is my native language, the communication with participants was not an issue. The finding of participants was performed by contacting persons I know that met the participants' criteria and offering them to participate in survey if they want.

Two of the contacted users met the criteria and were in possibility to perform the survey at a given time. One of two users was 66 years old, male, Serbian nationality, living in Serbia and user of Android device. Other user was 59 years old, female, Serbian nationality, living in Serbia and user of Android device.

6.2 Evaluation process

The evaluation process was performed on 16 of June, 2016 in Svrljig, Serbia. After meeting with participants and short introduction, they were provided with device with a prototype of "Walking" application installed and a survey papers with questions to answer. The questions and the way it was supposed to be answered, with results of survey are presented in Appendix B: Prototype evaluation survey. No personal information was asked from the participants, and they used about 15 minutes to answer the questions, while using the "Walking" application

prototype as an artifact. Users were asked for a permission to use the data in this thesis, and they accepted. The data is collected anonymously from filled surveys.

The survey and prototype version used during evaluation was in Serbian language in order for participants to understand it since they were not confident in reading and writing in English, but English translation of survey is provided along with this research.

6.3 Results

The results are compiled and presented in the following text. The results contain average rating, and rating range of features where numerical rating is used in survey and additional info in a textual form where only textual answers are given. Numerical results are presented as a rating grade from 1 to 5 where 1 represents useless feature and 5 maximally useful feature.

First half of the results are related to usefulness of certain features in making the application more appealing and easier for using. The application sharing received from a person of trust got average rating of 3.5 (range 2-5). The idea of tracing the walked path on map got average rating of 1.5 (range 1-2). Connection with friends and adding a friend feature got average rating of 3 (range 1-5). Adding a friends from Facebook got average rating of 4 (range 4-4). Anonymous mode feature got average of 1.5 (1-2). User manual feature got average rating of 3 (range 1-5). Pages swiping and tabs navigation got rating of 1(range 1-1). Regarding willingness to pay for the application 50% of results are for paid option and 50% for free application with ads.

Second half of the results are showing the usefulness of application features in increasing motivation level of users. Real-time tracking of walked distance got average rating of 4 (range 4-4). Real-time path tracking on map got average rating of 1 (range 1-1). Real-time goal completion progress tracking got average rating of 5 (range 5-5). Long-term progress chart got average rating of 5 (range 5-5), but all of the participants agreed they would prefer the chart to use distance in meters as a measurement unit instead of percentage of daily goal completion. Short-term history of past sessions got average rating of 4 (range 4-4). Friends' walking session distance tracking got average of 3 (range 1-5). Friend's walking path on map tracking got average of 3 (range 1-5). Challenging a friend feature got average rating of 3 (range 1-5). Setting the goal feature got average rating of 3 (range 1-5). Friends' goal tracking as a tool for figuring out user's own goal setting got average rating of 1.5 (range 1-2). Congratulations message when goal is completed with daily health tips got average rating of 5 (range 5-5).

7 DISCUSSION

The goal of this chapter is to find out how the results of evaluation impact the proposed solutions in problem elaboration chapter by going backward from evaluated features through corresponding concepts developed as a practical implementation of those proposed solutions and see in what extent the problems defined could be or not be solved with those proposed solutions. The idea is to discuss each part of the problem with a corresponding rated feature that represents a solution, and then move to a higher level of abstraction and discuss the possible answers to the research questions.

7.1 Use of assistive systems

To remind ourselves, I have divided the problem with elders using the assistive systems on four concrete issues. Those were: denial of need, stigma, lack of knowledge for system use and cost. The proposed solutions tended to use social aspect in solving those issues.

Denial of need

This issue was addressed by application sharing feature which would help in informational support version of social support given by a person of trust or person of competence. In addition, walked path tracking on map is proposed as something that may be appealing for the user and help in overcoming denial, therefore leading to trying out the application.

Application sharing feature was rated as something between partially useful and very useful, so this result may suggest that application sharing as a social support method is a fairly good solution for this issue, but not the best and probably should be used in combination with some other features.

Tracking of a walked path on a map is evaluated as something between useless and almost useless for making the application appealing to targeted group. Using this information, it can be assumed that this feature is probably a bad choice for addressing this issue.

Stigma

Stigma is addressed with social traces aspect in a form of adding friends feature, and anonymous mode feature. The possibility of automated adding of friends from a Facebook social network is also evaluated.

Adding friends to fulfill social traces aspect is evaluated as partly useful, but with wide range (from useless to maximally useful). This could suggest that some users may benefit greatly from social traces in this form while some others simply do not.

Using the Facebook to fetch friends easier is evaluated as very useful and this suggests that linking to social network could be a good option to support adding friends as a form of social traces.

Anonymous mode feature is evaluated between almost useless and useless, with a low rating range, which means that both those users who liked social traces and those who did not, were not so interested in hiding their info from others. This may suggest that targeted users do not care much about others peoples' opinion.

Lack of knowledge for system use

To address this issue user manual feature is developed as an artifact of informational support and page swiping and tabs navigation is used to make the interface more user friendly and intuitive.

User manual feature is evaluated as partially useful with a wide range, which may suggest that some people prefer to use manuals while others just want to find out how the application works by themselves. Anyway, as this feature seems good to have and if complemented with a possibility to skip it by those who do not need it, I believe it is a good design choice.

Page swiping and tabs navigation is evaluated as useless by all participants. It is not clear why the users do not like this way of navigation, but my assumption is that they just do not think it is important how the navigation is implemented as long as they can reach the features they like. On the other hand, this way of navigation might be confusing and I would recommend trying out different types of navigation for targeted user group to determine if this is really the case.

Cost

To solve the issue of price for the application, it was suggested to use the ads in the application to support development instead of paying.

Half of the user were happier about paying for the application and half of them wanted it for free and did not mind the ads. This problem could be solved by offering both free and paid version of the application to satisfy both types of users.

7.2 Exercise motivation

To increase motivation in elders for daily walking, I have addressed four points that seemed as important steps in dealing with this problem. Those were personal progress monitoring, others' progress observing, goal setting and emotional reinforcement. The proposed solution and

corresponding concepts are trying to utilize both reflection and social aspect in satisfying those requirements.

Personal progress monitoring

This is addressed with utilizing both reflection-in-action and reflection-on-action aspects. Reflection-in-action was implemented in a form of real-time tracking while user is walking and consists of distance tracking, path on map tracking and goal completion progress tracking. Reflection-on-action was implemented as long-term progress chart and short-term recent walking sessions history.

Real-time tracking of walking session as a whole is evaluated as a little better than partially useful. But, since three parts of it were evaluated separately, it seems that the users prefer distance tracking, evaluated as very useful, and goal completion progress, evaluated as extremely useful, over path tracking on map, evaluated as useless. This leads to conclusion that real-time tracking of walking as a form of reflection-in-action aspect is probably beneficial for increase in motivation for most of the users, when distance and goal progress is tracked, while path on map tracking is likely to be a bad idea for targeting this user group.

Long-term progress chart as implementation of reflection-on-action aspect is evaluated as extremely useful feature for motivation, but users also preferred the usage of distance in meters as chart metrics instead of daily goal completion percentage. Short-term history of past sessions way of representing reflection-on-action aspect is evaluated as very useful. Those two evaluations lead to a conclusion that both charts and separate events history of past performance could be a good way of using reflection-on-action to increase motivation for walking in elders, but they may prefer usage of simple metrics.

Others' progress observing

This is addressed with friends' walking sessions tracking feature which is an implementation of social traces form of social aspect and consists of tracking the distance and path on map of last friend's session. The idea was to encourage both cooperation as social aspect by providing a way of finding the company for walking certain paths width, but also competition as another social aspect by providing a challenge feature.

Friends' walking sessions tracking was evaluated as partially useful with very wide range on both distance and path on map tracking. This may be a clue that some of the users are highly motivated by social traces type of social aspect while others are not.

Challenging a friend feature was evaluated as partially useful, the same as friends' walking sessions tracking feature and with the same wide range. This may be a confirmation that, also, the competition as a social aspect is motivating for some users while not for others.

If the assumption deducted earlier, stating that targeted users do not care much about others' opinion, is correct it could be a good idea to integrate a feature utilizing social support so the ones that are motivated from it could have benefits and those who do not should not have any negative impact on motivation because of it.

Goal setting

Goal setting was addressed with a custom goal setting feature and friends' goal tracking feature that utilizes social traces.

Setting the custom goal feature was evaluated as partially useful with wide range. Having in mind that all the users rated goal progress tracking as extremely useful, it can be assumed that while all users like to have a daily goal for walking, some of them like to have a direct control over it while others prefer some kind of automated system for goal setting.

Friends' goal tracking is evaluated between useless and almost useless. This can lead to conclusion that utilizing the social traces in this way may not be useful for both motivation and setting the goal aid in targeted group.

Emotional reinforcement

This is addressed with congratulations message concept which was evaluated as extremely useful. It is not clear if emotional reinforcement message or health tips contributed more toward achieving a good usability but it can be concluded that this type of positive reflection-on-action could be a great motivation tool for elders.

7.3 Research questions revision

Having in mind all the conclusions from previous discussion, I tried to compose answers to the research sub-questions first and then build up a single, summarizing answer to the main research question.

SQ1: Can elder's resistance toward using assisting devices and innovative technology be decreased by using social interaction aspect in playful way?

Social aspect seems to be useful in designing the system used to assist elders in daily walking, in case of using informational support to help with installation and in case of using social traces, collaboration and competition by providing connectivity with other users, where second case is

likely to be beneficial for roughly half of the users while other half is not affected. Use of playfulness is not confirmed to be beneficial in a form of tracing walking path on the map, but it could be effective if applied in different form.

SQ2: Can motivation for city walking in elders be increased using reflection and social interaction aspect in playful way?

Motivation for city walking in elders seems likely to be positively affected by utilizing reflection aspect as both reflection-in-action, especially when tracking walked distance and daily goal progress, and reflection-on-action in a form of charts with simple metrics and recent walking sessions history. Positive reflection-on-action in a form of emotional reinforcement reward for certain exercise achievement could also be helpful in increasing motivation levels. Regarding social aspect, usage of social traces in a form of presenting friends' walking sessions to a user is good motivator for some of the users while it does not affect others.

MQ: How to design and produce ubiquitous ICT system both appealing and motivating for elders in fall prevention through city walking?

It is not clear what is the most correct answer to this question, but results of this research suggest that when concerned with appealing of the system. some forms of social interaction as informational support could be beneficial for most of elders, when integrated into the system, while some other forms of it, like social traces, collaboration and cooperation, could benefit only portion of older adults using the system without affecting the rest of them. When it comes to motivation, both reflection-on-action and reflection-in-action forms of reflection seems beneficial for increasing motivation levels in elders, while social traces form of social interaction is likely to be beneficial for some users while others are not affected. In addition to this, providing the user manual in a proper way and offering the system in both paid and free versions looks helpful to help users start using the system, and featuring a goal to meet seems as an important motivational trigger, both for users who prefer it to be set by system and for those who like direct control over it, especially when combined with emotional reinforcement as a reward for completion. The aspect of playfulness, on the other hand, could be a tricky to implement properly as what some of the elders find useful and interesting may be useless and bothering for others, so the designer may need to be extra careful during the implementation of this aspect.

8 CONCLUSION

This chapter offers a short summarization of the goal, methodology and achieved results. My contribution, opinions about work on this thesis and reflection are described along with suggestions for future work in this topic.

8.1 Summary

This project and accompanying research was developed with a purpose of discovering useful aspects in designing software systems for elders, used to encourage daily walking as a fall prevention. The idea was to try to utilize social and reflection aspects into the software system design process, while also incorporating playfulness and some other guidelines for intuitive design, in order to produce both appealing and motivating software for the elders.

In order to discover how to make the software more appealing and motivating for elders, two problems were elaborated. One was a possible barrier in use of assistive systems and innovative technology in elders and the other was a barrier in motivation for daily walking. Four specific issues that could apply to software system were extracted from the first and four from the second problem. Then, the solution proposal is written, trying to deal with all of those specific issues by utilizing social and reflection aspect incorporated into the idea of the system. The ideas of how to utilize social aspect in order to deal with a barrier in use of assistive systems, and about how to use both social and reflection aspects to increase motivation are developed, based on the literature review done by me in specialization project on this topic, creative thinking and brainstorming with goal to produce useful solution ideas.

Proposed solutions and insight gained from related work are then used to develop corresponding software system concepts that were supposed to represent those ideas in a more practical form and be used as a bridge between proposed solution and system prototype that was developed later. Concepts are presented with drawings and explanations of how software should look and feel like from the perspective of a designer. Initial concepts are then evaluated with an expert in this field and received feedback was used in redesign process to improve the existing concepts.

Software engineering methods, guidelines and standards are used in prototype development in order to, first, define requirements specifications based on the final concepts, then make an architectural description as a form of software architecture engineering process in order to figure out how to incorporate all requirements into a single software in a form of mobile application and in the third phase, prototype implementation is performed according to

requirements and architectural decisions resulting in an Android application prototype that could be used as an artifact for demonstrating proposed solutions to the elders as end users.

Evaluation of prototype is performed with users using survey, and the resulting data is collected anonymously and presented. The resulting data is then used to discuss about how and why certain features as representations of proposed solutions, are useful or not useful in dealing with issues described in the beginning.

Results suggested that social support and information support types of social interaction could be beneficial in making the software system more appealing in some elders, while reflection-in-action and reflection-on-action forms of reflection aspect could be beneficial for increasing the motivation for walking in elders and adding a social traces suggested even further motivation levels increasing in some of the users. Playfulness concept developed in this project gave a bad result in making the software appealing, as evaluated users did not like it. However, some additional features, as having a user manual, offering both free and paid version of the software, including a goal that can be worked on and achieved and providing emotional reinforcement as reward, seem to be a useful feature to think about when designing this type of software.

8.2 Contribution

My contribution in a form of this research and project is reflected in suggesting some guidelines for software system designed to encourage walking in elders as a user group. Some of my ideas are developed and evaluated, like the way of presenting an unordinary chart for long-term reflection, some of them are borrowed from existing concepts or software with goal to evaluate them in a use with elders, like presenting ads in a free version of the software, and some ideas are just confirmed.

Prototype as an artifact for evaluation with its code base is developed by me, and since the application project is made from scratch, I believe it is a unique contribution.

Since the guidelines for software systems are presented in countless number of forms in today's era, some official, most of them not, but still widely accepted, and not all with clearly defined scope and application, it is hard to claim that any of the resulting knowledge gained from this research could make a scientific breakthrough, but I believe that I still have contributed in a way of making even a tiny addition toward expansion of knowledge in this field.

8.3 Reflection on work

I believe this master thesis is a success for me as it was meaningful in a multiple way. It allowed me to express and utilize my knowledge in a field of information systems that I have studied, experience in Android development which is my profession and my passion and interest in a software and game design. It also pushed me to learn about research methodology and allowed me to get a personal experience as a researcher, designer, developer and evaluator.

Regarding this paper, I believe that some parts of it are done better than others. The problem elaboration, might had been underrated by me in the beginning and am not satisfied with the quality of barriers in use of assistive devices and systems elaboration, as it was not using sources that were of optimal relevance to the problem, but the elaboration of barriers in motivation for walking was more satisfying and it showed as more useful latter. Related work probably should have had more references, but I brought conscious decision to accept the compromise in order to assign more time to concept and prototype development process, a I felt I already have a rich knowledge base developed in specialization project report that I have written on the same topic. I am satisfied with the concept development process with its evaluation and also with prototype development as that was rather fun and easy to do since it was something I am familiar with and have interests in. Prototype evaluation with the users was challenging since I wanted to do it in a relatively short time period, so only small number of targeted users were able to participate. However, I have tried to perform the whole evaluation process according to protocols and ethics it the extent I was able to get familiar with them. The data collected from evaluation is barely usable because of low number of participants, but I have found it useful in discussion as it helped me demonstrate a deduction and conclusion process which is something that I liked. The first priority for me was to complete the research and project, before improving the existing chapters, in order to deliver a whole and meaningful thesis without extending the deadline and I think I have succeeded in that.

Inexperience in researching and unfamiliarity with the whole process made this one of the hardest projects I have worked on so far in my life as I had to both learn basics about researching and do the research itself at the same time, while also developing the software as an artifact for evaluation. And unfamiliarity with evaluation processes and protocols is the topic for itself. But having in mind the time I have used to work on this thesis since I had to work part time during the whole time of writing, and since I had to take a few unplanned breaks, I am satisfied with a result. On the other hand, my part time work as Android developer helped me in rapid development a prototype in a limited time.

8.4 Future work

This thesis opens up multiple paths for further research, and also have a lot of room to be improved itself.

The first thing I have in mind is better evaluation of the software system developed in this thesis, with greater number of users. This would give a more accurate feature evaluation data, and more accurate conclusions could be derived.

Experimentation with different implementation of playfulness in the software for elders in order to determine what they like more or less could be an interesting topic to think about and research.

Deeper research in usefulness of certain features that have been rated as possibly good design decision by this thesis, with application in elder users, could lead to finding out more about how to design a better software for elders.

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Appendix A: Concept evaluation guide

Introduction

The goal of master thesis is to justify/prove some ideas in application design, regarding usability in elderly fall prevention, using walking exercise in the city as main method. The specific research questions that I am trying to answer are:

1. RQ1: Can elder's resistance toward using assisting devices and innovative technology be decreased by using social interaction aspect in playful way?
2. RQ2: Can motivation for city walking be increased using reflection and social interaction aspect in playful way?

The idea is to develop an application prototype that would use social interaction and reflection design aspects, in playful way, trying to help in solving those two problems and then evaluate the application and find out if any of proposed solutions are correct, in order to answer two mentioned research questions. The application should use city maps and GPS to playfully approach the walking exercise.

In the problem elaboration process, I have extracted some concrete issues for both of those problems and then proposed solution ideas for each issue based on literature reviews and my knowledge of the topic. They are describing how I am intending to use social interaction and reflection aspect to solve the issues, without technology specific details.

In the initial concept design process, I have used those solution ideas to develop a concept for a mobile application design. Those concepts are supposed to incorporate solution ideas into the application design guidelines and high level user interface and functionalities specifications. Initial concepts, all together, should give an idea of how the product will look like and how it will concretely deal with specified issues.

This intention of this evaluation, is an attempt to review all the concepts with person who has more knowledge on the topic in hope to gain useful feedback for improving the initial concepts before moving on to software development process. The questions below concept sketch and description should be helpful in guiding us through the evaluation process.

Exercise motivation concepts

For increasing the motivation, I have tried to meet following extracted requirements: personal progress monitoring, others' progress observing, goal setting and emotional reinforcement

Personal progress monitoring

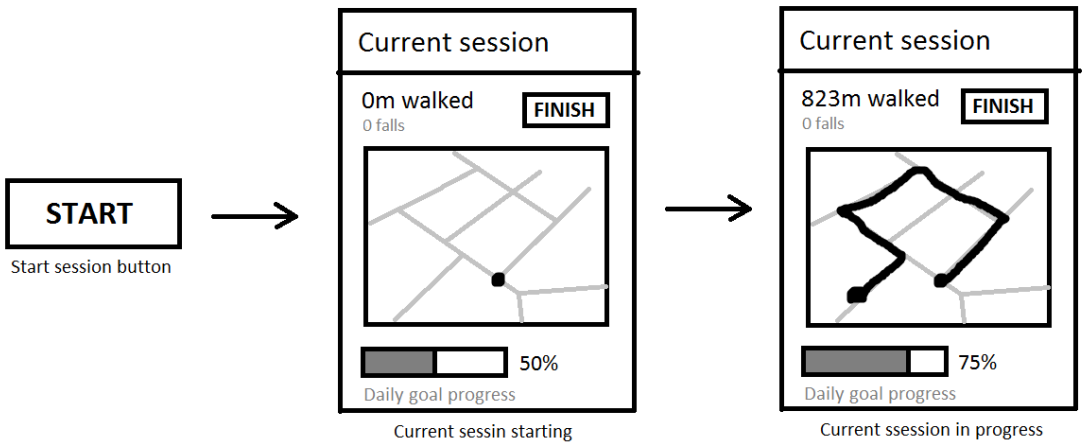

Figure 1-1-a Reflection in action

Concept 1.1.a – Reflection during the walking. User press start at the beginning of walking session. Distance walked, path walked on map and completion progress are updated real-time and falls are detected. In case of fall, after session is finished, the user is asked to provide the cause.

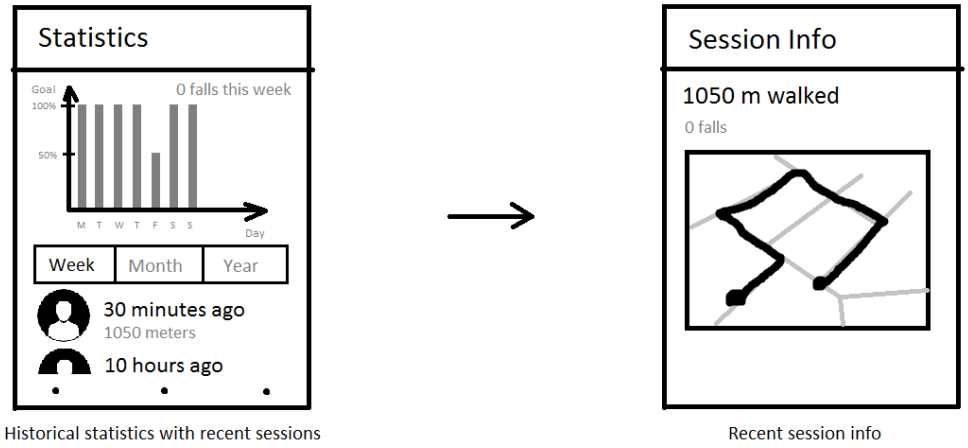

Figure 1-1-b Reflection on past performance

Concept 1.1.b – Reflection on past performance. (Reflection-in-action, Reflection-on-action) Three things: First, Chart-like representation of long term daily goal completion statistics that shows past days' goal completeness in %. Second, list of most recent walking sessions and details on open (right screen). Third, number of falls for time period chosen under chart and reflection screen for past falls on open with available details for each fall. (Figure 1-1-c)

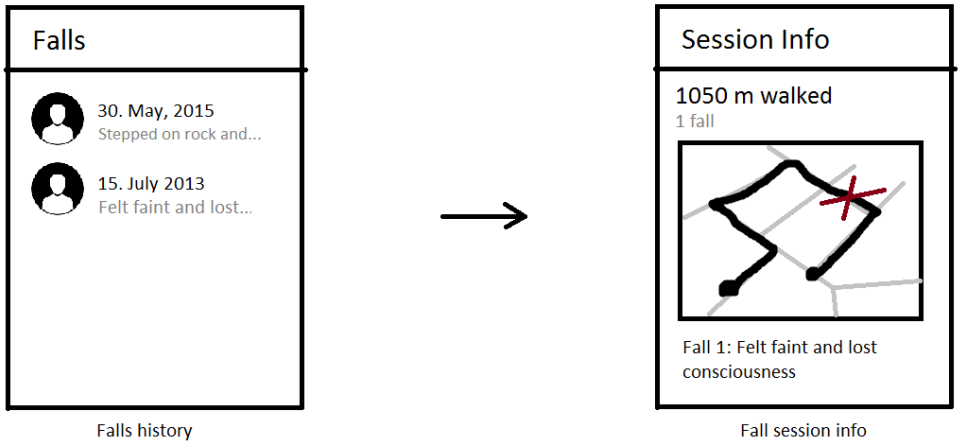

Figure 1-1-c Reflection on falls concept

Questions:

1. Is this way of reflecting on falls a bit too much (scary) for the user. What would be a better way to use reflection on falls in fall prevention?
2. When having long term progress, very old people may benefit of just maintaining daily walking distance or even slowly decreasing the distance. For those, regular daily distance increase over time chart might show depressing results, so I am using goal completion over time chart to compensate. Is this idea good, or maybe there is a better way?
3. General thoughts on how to improve this concept?

Others' progress observing

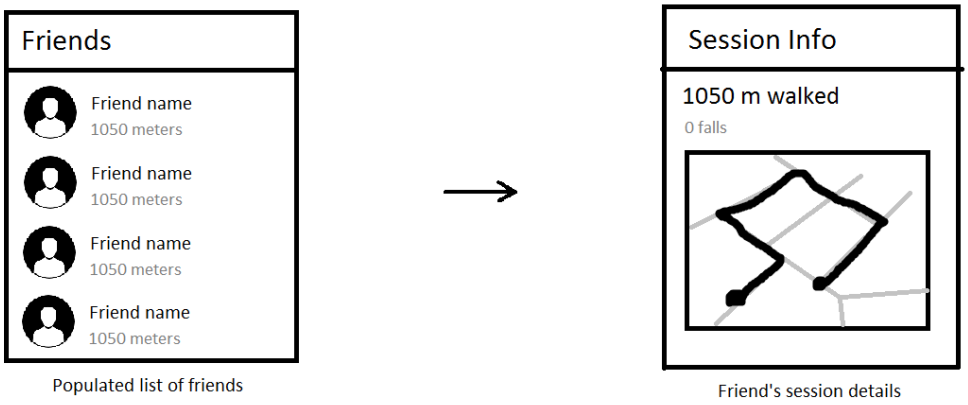

Figure 1-2 Others' progress observing concept

Concept 1.2 – Others' progress observing. (Reflection-on-action, Social traces) Shows list of friends fetched through social network when user connects to it. Each entry shows picture, name

and walked distance in last session for that friend. On open, get session details (right screen) like distance, and path walked on map.

Questions:

1. What data from friends might the user be interested in seeing?
2. General thoughts on how to improve this concept?

Goal setting and completion

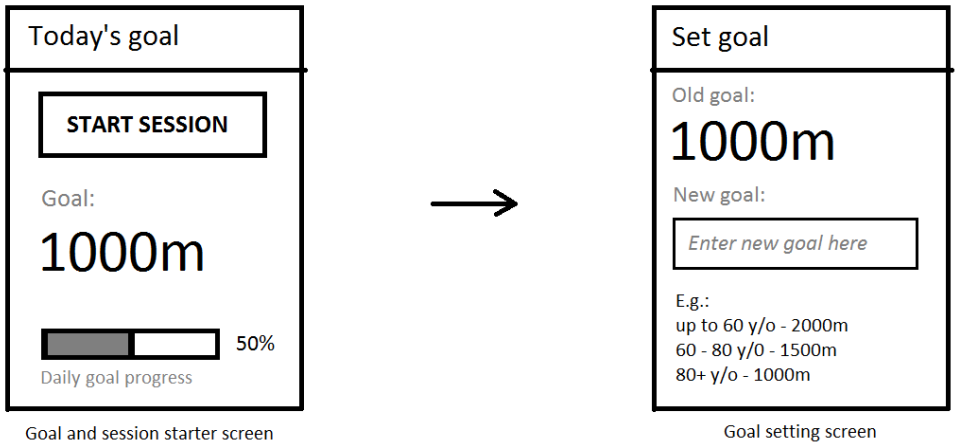

Figure 1.3 Goal setting and completion concept

Concept 1.3 - Goal setting and completion. (Reflection) On click on goal, new screen appears so user can set the new goal in meters. Tips at the bottom should help new user set the goal for the first time. Goal completion progress is monitored using concept 1.1.

Questions:

1. What would be the best simple way to assist the user with goal setting without involving complex schemes like intelligent adaptation to user?
2. General thoughts on how to improve this concept?

Emotional reinforcement

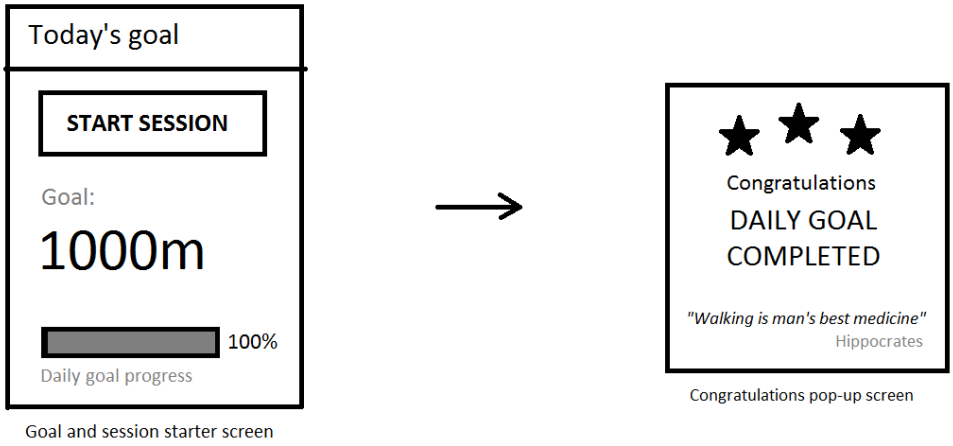

Figure 1-4 Goal completed congratulations concept

Concept 1.4 – Emotional reinforcement. (Reflection-on-action) On 100% goal completion, user gets a pup-up dialog in a form of congratulations message. The random motivational quote is presented on the bottom of dialog.

Questions:

1. When it comes to emotional reinforcement messages, is there anything that I should consider having in mind that I am designing for elders?
2. General thoughts on how to improve this concept?

Use of assisting devices/systems concepts

Targeted problems: denial of need, embarrassment, lack of knowledge for system use and cost.

Denial of need

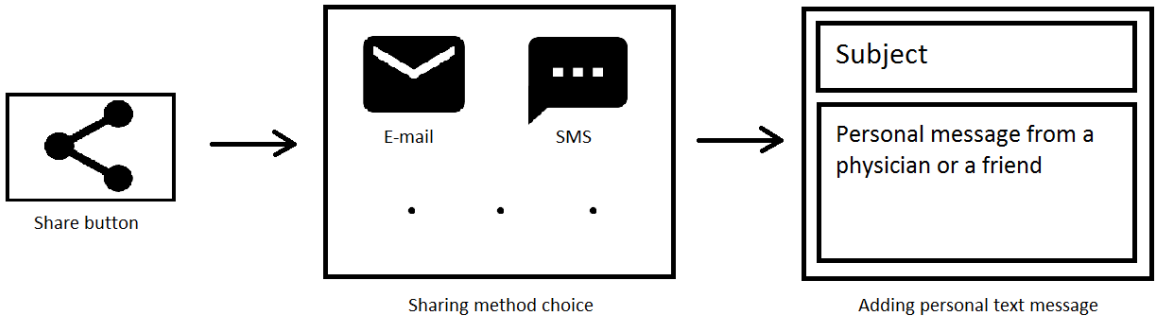

Figure 2-1 Sharing concept

Concept 2.1 – Sharing the application. (Informational support) This concept is not directly solving the problem, but rather assists in solving. Proposed solution is to use person of trust (Physician) to prescribe this application for user and the person can use sharing feature to invite user. Sharing consists of choosing share method (e-mail, SMS, etc.) and writing a personal text message.

Questions:

1. Is there any other way to help with denial of need for use of this system/application by elders?
2. General thoughts on how to improve this concept?

Stigma

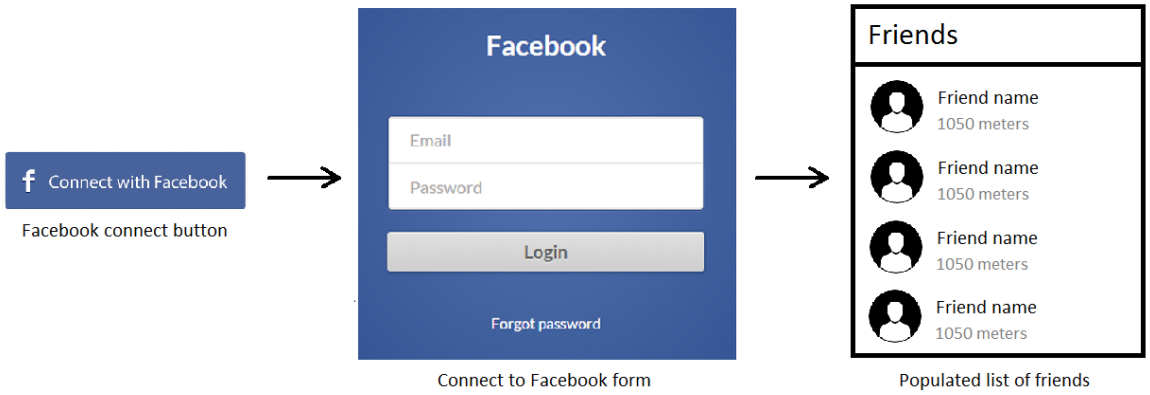

Figure 2-2 Connection with social network concept

Concept 2.2 – Connection with friends. (Social traces) User have to connect this application with Facebook in order to fetch friends list. Then he can see their last session's performance as described in concept 1.2. User can choose to be anonymous.

Questions:

1. Is using Facebook to connect user with friends a good option for elders, or they might benefit more if the application itself would provide adding friends?
2. General thoughts on how to improve this concept?

Lack of knowledge for using the device

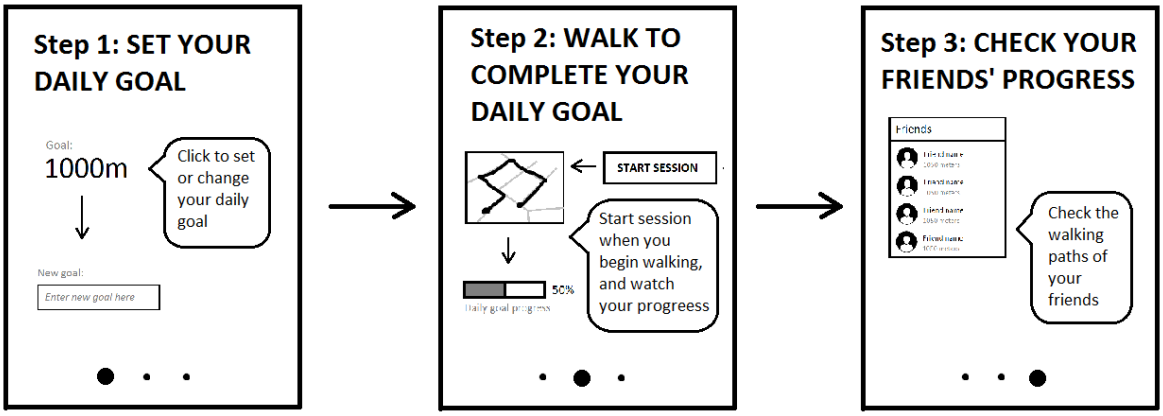

Figure 2-3-a Fist time user guide concept

Concept 2.3.a – First use guide. (Intuitive design guidelines) When user opens the application for the first time, the short user manual is shown with tips of how the application should be used.

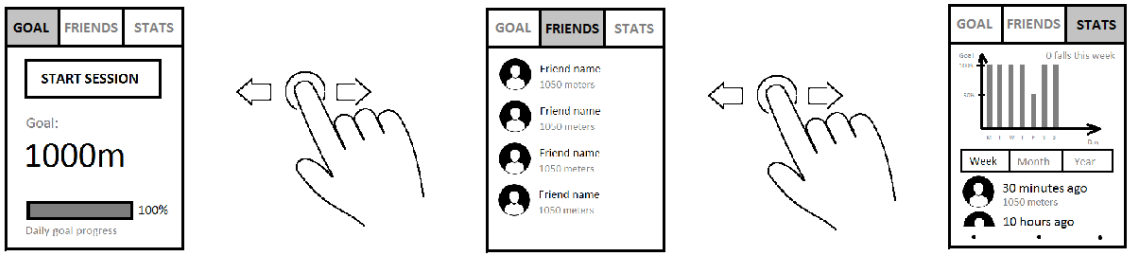

Figure 2-3-b Easy navigation concept

Concept 2.3.b – Easy navigation. (Intuitive design guidelines) Navigation to any major part of the app is done by swiping or clicking on the tab.

Questions:

1. Any idea of how to utilize social interaction to deal with this problem,
2. General thoughts on how to improve this concept?

Cost

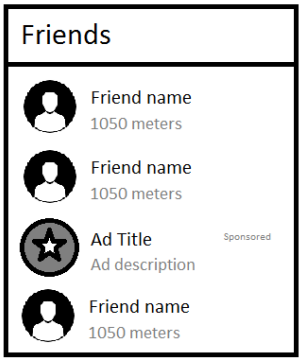

Figure 2-4 Native ads concept

Concept 2.4 – Native ads. Showing native advertisements in the application as least intrusive way of in-app advertising. Using advertisements so the application itself can be free.

Questions:

1. Could showing the advertisements confuse elders, is it worth it in order to make the application free of cost?
2. General thoughts on how to improve this concept?

Appendix B: Prototype evaluation survey

Introduction

This is survey questions for application prototype evaluation with targeted users. Contains questions to help rating of features in prototype, and answers provided by two users who participated in survey. Survey is originally performed in Serbian language and hereby is the translated version in English.

The users were asked to rate certain features from 1 to 5 with following meaning: 1 - useless, 2 – almost useless, 3 – partially useful, 4 – very useful, 5 – maximally useful. Besides that, certain questions needed to be answered with "yes" or "no" or to choose one of the answers provided in question. Users were allowed not to give an answer to any of the questions if they didn't want to or were not using the technology referenced in question.

The answers below the questions are presented as A1 and A2 (answer 1 and answer 2), and are collected from the two anonymous surveys.

Questions

Question 1:

a) If a person advised you to try out new application with purpose to help you walk more every day for health benefits, would you rather accept an advice from friend, family member, physician or refuse the advice anyway?

A1: Family member, A2: Friend

b) If a person you chose in a) recommended you and application named "Walking", and send you a message with link which, when touched, leads to the application installation web page, how much would that be useful, from 1 to 5 for you in trying out the application?

A1: 5, A2: 2

c) If application features automated drawing and tracking of your walking path on electronic map, during your daily walking, and possibility to track walking paths of your friends, how appealing or useful does that sounds to you from 1 to 5?

A1: 1, A2: 2

Question 2:

a) If an application would feature connectivity with friends in order to track their progress in daily walking, possibility to see their walking paths on the map and related information, but also allow them to track your progress in the same way, how much would that be useful from 1 to 5 in making the application more appealing for you.?

A1: 1, A2: 5

b) If you have the Facebook account, how much from 1 to 5 would be useful for you if application could use automated process of connecting you with all your friends from Facebook that are also using the application?

A1: -, A2: 4

c) How useful for a more pleasant use of application, from 1 to 5, would be an option to activate "Anonymous mode", which would prevent showing you and your data to any of you friends?

A1: 1, A2: 2

Question 3:

a) In your opinion, how much is the user manual inside application "Walking" useful for getting familiar with the application from 1 to 5?

A1: 5, A2: 1

b) How much is navigation using page swiping and tabs useful for you to easily reach the wanted functionality in the application "Walking", from 1 to 5?

A1: 1, A2:1

Question 4:

a) Would you rather use a paid application or would rather download application for free that would show advertisements during use time?

A1: Paid, A2: Free

Question 5:

a) How much the functionality of tracking a distance crossed during the walking, featured by "Walking" application, seems useful for you from 1 to 5?

A1: 4, A2: 4

b) How much the functionality of drawing your walking path on map during the walking, featured by "Walking" application, seems useful for you from 1 to 5?

A1: 1, A2: 1

c) How much the functionality of tracking your daily goal progress during the walking, featured by “Walking” application, seems useful for you from 1 to 5?

A1: 5, A2: 5

d) How much the functionality of long term tracking of performance of your daily walking, in a form of chart featured by “Walking” application, seems useful for you from 1 to 5?

A1: 5, A2: 5

e) Would you prefer if the chart, instead of percentage of daily goal completed, uses daily distance walked in meters?

A1: Yes, A2: Yes

f) How much the functionality of tracking short-term history of your past walking sessions in last 7 days, featured by “Walking” application, seems useful for you from 1 to 5?

A1: 4, A2: 4

Question 6:

a) How much the functionality of tracking distance walked in latest walking session by your friends, featured by “Walking” application, seems useful for you from 1 to 5?

A1: 1, A2: 5

b) How much the functionality of tracking path on map walked in latest walking session by your friends, featured by “Walking” application, seems useful for you from 1 to 5?

A1: 1, A2: 5

c) How much the possibility to challenge a friend with similar daily goal to compete in walking distance, that is offered by “Walking” application, seems useful for you from 1 to 5?

A1: 1, A2: 5

Question 7:

a) How much the functionality to set a daily goal in a form of distance to walk daily, that is offered by “Walking” application, seems useful for you from 1 to 5?

A1: 5, A2: 1

b) How much the functionality to see your friends' daily goals, that is offered by "Walking" application, seems useful for you in figuring out your own goal from 1 to 5?

A1: 1, A2: 2

Question 8:

a) How much the functionality of showing a congratulation message with short tips related to improving health and walking, that is updated daily, seems useful for your personal motivation from 1 to 5?

A1: 5, A2: 5