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AktiMotBot: A social media chatbot with activity tracker integration for motivating increased physical activity

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"My goal in life is to be as good of a person as my dog thinks I am."

– Unknown

Abstract

The World Health Organization has reported that more than 80% of the world's adolescent population is insufficiently physically active [1]. Up to five million deaths per year could be averted if the global population were more active[1]. The low adherence to physical activity shows the need to implement services that promote physical activity. In addition, it is crucial to educate people on the benefits of being physically active and the negative consequences sedentary behavior imposes.

This thesis proposes a social media chatbot with the integration of an activity tracker that aims to motivate people to increase their daily step count. The chatbot, AktiMotBot, encourages people by implementing behavior change techniques in its messages and functionality. We use popular technology, such as social media applications, to ease access. Further, the use of chatbots has grown. A chatbot gives a service that is always available to the user and is cost-effective. In addition, chatbots have familiar interfaces that ease their use. Finally, activity data is integrated into the chatbot as a motivation and personalization tool, enabling monitoring behavior change.

A thorough investigation of social media applications was conducted to ensure users' privacy and security. A usability study investigated how potential users perceived the system, and the usability of the chatbot was scored as average. The results showed that the chatbot was able to increase the motivation of half of the participants. Finally, the findings from this research are that chatbots could motivate people to increase their physical activity levels and make people more aware of their step count.

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Abbreviations

API - Application Programming Interface

BCT - Behavior change techniques

CUQ - Chatbot Usability Questionnaire

GDPR - General Data Protection Regulation

HTTP – Hypertext Transfer Protocol

HTTPS – Hypertext Transfer Protocol Secure

IDE - Integrated Development Environment

IP - Internet protocol

ML – Machine learning

NLP – Natural language processing

NSD – Norsk senter for forskningsdata

SUS - System Usability Scale

TCP - Transmission Control Protocol

UI - User interface

WHO - World Health Organization

1 Introduction

1.1 Background

Regular physical activity is very beneficial to one's health. One benefit of being physically active is that it can reduce symptoms of depression and anxiety and improve overall well-being [1]. People feel more energetic, sleep better, and are less stressed when physically active. In addition, being physically active reduces the risk of non-communicable diseases such as cancer, type 2 diabetes, and cardiovascular disease [3]. Reducing non-communicable diseases is desirable as it is the reason for approximately 71% of deaths each year globally [4].

Unfortunately, approximately a quarter of the world's population is insufficiently active [1]. Sedentary behavior is not only affecting the individuals, but it could significantly impact the environment [1]. For example, increased sedentary behavior may negatively influence the health system and economic development [1]. Research shows that when countries become wealthier, the physical activity behavior of their population is reduced [3]. People in rich countries often work from behind a desk, drive or take other forms of inactive transportation to work and are more likely to be physically inactive the rest of the day [3].

The World Health Organization (WHO) states that there is a rise in people with chronic diseases globally. At the same time, there has not been any increase in physical activity behavior since 2001 [1]. The low adherence to physical activity shows an urgent need to increase the physical activity behavior of the world's population. It is challenging to change our behavior, and some people may need external support to achieve behavior change. The technology field is evolving quickly, revealing new possibilities that could be used in interventions developed to assist in behavior change.

One of the technologies that have evolved is chatbots, and it is becoming more usual to incorporate chatbots as part of a service. Big companies like Google and Amazon have developed conversational agents in their services [5]. The benefit of chatbots is that they are easy to use and are cost-effective. In addition, people are most likely already familiar with the chatbot interface. The chatbot can work as an educational tool that informs users of physical activity benefits and a motivational tool that encourages users to increase their physical activity behavior.

Personalizing the messages could increase the user experience. By integrating an activity tracker into the chatbot, the chatbot can incorporate the users' activity data into the messages, making each message personally fit each user. Laranjo et al. [6] found that interventions that use mobile apps or physical activity trackers effectively promote physical activity. Further, they also found that the interventions that included physical activity trackers and text messaging were even more effective [6].

Since such a big part of the population is insufficiently active, new interventions should be developed to reach a big part of the population. A possible solution could be integrating a chatbot into a popular social media application. Social media application has large user bases, and most people spend a lot of time daily on social media applications [7]. If the chatbot is accessible through a popular social media application, it could be easier to reach and support a big part of the population. Although the social media application provides a big user crowd, we must ensure that it is still possible to preserve the privacy and security of the users.

Several other chatbots have been developed to increase people’s activity behavior. A literature review conducted as part of a capstone project by Sandsdalen [8] in the autumn of 2021 identified several health interventions that used chatbots. Some chatbots were developed to help people with their mental health, others to assist with diet, and some to increase physical activity. Some studies found in the literature review showed that they successfully increased the activity levels of the study participants by using a chatbot [8].

This thesis proposes a social media chatbot that integrates a wearable activity tracker that aims to increase the users' physical activity by motivating them to walk more. Walking is a safe and accessible activity. Moreover, almost all devices can count steps, making step counts highly available. This thesis presents the design and implementation of the chatbot. Further, the chatbot will be integrated into a social media application to make it accessible. In addition, the physical activity data is integrated into the messages to motivate the user and as a tool to personalize the messages.

Combining the cost-effectiveness and ease of use of chatbots with the popularity of social media applications and activity data from wearable activity trackers allows for an accessible, relevant, and possibly effective tool to influence people’s physical activity behavior.

1.2 Scope and research problem

This project aims to develop a chatbot integrated into a social media application that uses physical activity data tracked using a wearable activity tracker. The system aims to motivate people to increase their physical activity behavior, mainly by encouraging them to increase their step count.

The motivation behind using the users' tracked activity data is to make it possible to personalize and customize the messages to each user. Using tracked data instead of self-reported data reduces the user's work effort, and the application can access the data without relying on the user to report it. Integrating the chatbot into a social media application reduces the user's effort and makes the chatbot more visible and accessible. The motivation for using a chatbot is that it is cost-effective, always available to the user, and can handle conversations with different users simultaneously.

This thesis discusses the design and implementation of a chatbot that uses a social media application as an interface and gets the users' step count from a developed mobile application. Further, this thesis also investigates the system's usability and how it can be improved by having potential users test it.

Main research problem

Main research problem: *"How can a chatbot integrated into a social media application, that is connected to activity trackers, be developed and used to help motivate users to increase their physical activity levels?"*

The task is to develop a chatbot that uses a social media application as an interface and is connected to an activity tracker(s), which aims to increase the user's physical activity behavior. The motivation for using a social media application as an interface is to take advantage of the popularity of social media and the length of time people spend per day on these applications. When people are already using the application frequently, they could be more receptive to interventions. In addition, the user is already familiar with the interface, and they do not need to spend time learning how to use it. The users' activity data is available by integrating a wearable activity tracker. The chatbot will use the tracked data to personalize the messages and possibly display historical data to the user.

From the main research problem, two minor research problems are defined. The first problem addresses privacy and security regarding integrating a chatbot into a social media application.

Further, the second problem addresses the system usability and acceptability and what needs appear through usage by potential users.

Problem 1

Problem 1: *"How can a social media application be used as the chatbot interface and still preserve the security and privacy of the users?"*

Since we aim to integrate the chatbot into a social media application, it is important to investigate different social media applications' privacy and security aspects. In addition to having satisfying privacy and security settings, the social media application should be popular. The increasing popularity of social media applications is a fundamental reason the chatbot is integrated into a social media platform.

Problem 2

Problem 2: *"How do users perceive the developed chatbot, and how can it be improved?"*

The task is to investigate how the users feel when using the chatbot to understand better what the users enjoy and what could be changed to improve the solution. For example, it would be interesting to see if the users get motivated to be more physically active and if they enjoy having a conversation with the chatbot.

1.3 State of the art

This section will briefly describe chatbots developed as health interventions found in the literature review conducted in the capstone project in autumn 2021 [8]. Totally 15 chatbots were found, but only five will be described as these are relevant for this thesis. In addition, a chatbot that was not published at the time of the literature review is also presented.

Maher et al. [9] developed and performed a proof-of-concept study with *Paola*. The chatbot Paola is a virtual health coach that supports users in increasing their physical activity behavior and adhering to a Meditterian diet [9]. Paola used data from an activity tracker, Fitbit, and was deployed on the social media Slack application [10]. The study with Paola showed that the participants increased their activity by 110 minutes a week and lost 1.3 kg after the 12-week study [9].

Further, the chatbot *Assistant to Lift your Level of activity (Ally)*, developed by Kramer et al. [11], is a chatbot that aims to increase the physical activity behavior by focusing on getting the users to walk more. The Ally chatbot is developed as an application that uses activity data from GoogleFit (Android) or HealthKit (iOS).

The chatbot *MYA* was developed by Larbi et al. [12] to increase the users' physical activity levels. The chatbot was integrated into the social media platform Telegram [13] and developed to incorporate data from an activity tracker. Through a usability study, the participants reported that they perceived the chatbot as user-friendly, realistic, and engaging [12].

Healthy Lifestyle Coaching Chatbot (HLCC) is a chatbot Piao et al. [14] developed to motivate people to change their stair climbing habits by choosing to use the stairs more. The HLCC is integrated into KakaoTalk, South Korea’s most popular social media platform. Through an exploratory randomized controlled trial, Piao et al. [14] found that through the use of HLCC, the participants changed their stair-climbing behavior and chose the stairs more often.

The last relevant chatbot from the literature review in the capstone was *Reflection Companion,* a chatbot developed by Kocielnik et al. [15]. The chatbot Reflection Companion is designed to support people to self-reflect on their physical activity behavior. Reflection Companion messages are sent on SMS/MMS and use activity data from Fitbit. Through a 2-week field study, Kocielnik et al. [15] showed that the system successfully got people to reflect on their behavior.

Finally, the last chatbot is from research published after the literature review. *Ida* is a chatbot developed by SmartAI to increase the participants' physical activity levels [16]. To et al. [16] performed a study investigating *Ida’s* feasibility, usability, and acceptability. Ida was deployed on Facebook Messenger and used data from the activity tracker Fitbit Flex 1. The study showed significant improvement in step count and self-reported physical activity [16].

1.4 Structure of the thesis

The thesis is structured as follows:

***Chapter 1 – Introduction* –** introduce the problem and motivation for the research.

***Chapter 2 – Theoretical framework* –** present the technology used in this thesis.

***Chapter 3 – Methods* –** describes the research methods used.

***Chapter 4 – Requirements* –** description of possible functions and behaviors of the proposed system. Functions and behaviors are defined in functional and non-functional requirements.

***Chapter 5 – Design* –** presents the design of the implemented system. The chapter describes the implemented behavior change techniques, other implemented functionality, and user interfaces.

***Chapter 6 – Implementation* –** presents how the system is implemented, the problems, and why it is done.

***Chapter 7 – Result* –** presents the results from usability testing.

***Chapter 8 – Discussion* –** discusses the results, design remarks, strengths and limitations, and future work.

***Chapter 9 – Conclusion* –** concludes the work.

2 Theoretical framework

2.1 Physical activity

Physical activity is any movement initiated by skeletal muscles and requires energy expenditure [1]. Physical activity can be any activity or other action that requires the muscles to work [1]. Any activity is better than none, and when a person goes from no activity to some activity, it is health beneficial.

Although any movement is better than none, the WHO has outlined recommendations for how much physical activity a person should do weekly to be healthy. A person aged 18-64 years old should do at least 150-300 minutes of moderate-intensity aerobic physical activity [1], such as power walking, cycling, swimming, hiking, playing active games, house and yard work, or playing active video games [17]. It can also be 75-300 minutes of vigorous-intensity aerobic physical activity [1], such as running, cycling, jumping rope, cross-country skiing, and sports [17]. It can also be a combination of vigorous and moderate activities.

One of the leading risk factors for mortality and non-communicable diseases is physical inactivity [1]. Being physically inactive increases the probability of death compared to being sufficiently active. Unfortunately, there is an increase in the number of people with non-communicable diseases, and about a quarter of the world's adult population is not active enough [1].

Since 2001, there has been no improvement in global levels of physical activity [1]. Between 2001 and 2016, there was a 5% increase in insufficient physical activity in high-income countries [1]. This sedentary behavior negatively impacts the health system, the environment, economic development, community well-being, and quality of life [1].

2.2 Behavior change

Behavior change is when a person changes their behavior towards something. A behavior is how a person behaves, reacts, or acts. The behavior change could be to start or stop something or do less or more of something, where there is a distinct difference between the two behaviors [18]. Examples of behavior change could be stopping smoking, increasing physical activity, waking up earlier in the morning, drinking more water, or stopping candy consumption. For something to be defined as behavior change, it must be a sustainable change that lasts. For example, if a person stops smoking for one week and starts again, this will not be defined as behavior change.

Changing one’s behavior can be difficult, and some people could benefit from additional support. Behavior change interventions are designed to be an effective tool for helping people change their behavior [8]. These interventions try to influence people's decisions regarding their health [19]. Behavior change can be caused by many different factors such as motivation, health issues, and social environment.

A variety of behavior change techniques (BCT) are often used as part of behavior change interventions [19]. BCTs are implemented into interventions as the “active part” used to influence the person by changing or redirecting their action toward something [19]. There are numerous BCTs with different purposes based on the behavior the intervention aims to change. Some examples of BCTs are action planning, goal setting, self-monitoring, social support, and information about health consequences [18].

Although there are many techniques to influence people’s behavior, it is still challenging to achieve behavior change. When we decide to change our behavior, we must stop acting as we usually would in a given situation and incorporate a new action or behavior in these situations.

2.3 Wearable activity trackers

Tracking a person’s physical activity can be done using wearable activity trackers. A wearable activity tracker is a device that the user wears to track physical activity or other parameters like heart rate and sleep. These trackers could be a smartwatch, pedometer, or smartphone. The tracker is often worn throughout the day and gathers a lot of data about the user's activity levels.

Most wearable activity trackers have a phone application connected to them. The user gets a more extensive report in the phone application, and the data can be visualized in graphs. This application often shows activity history and more statistics.

Smartphones usually have their own health or physical activity application, which gathers data directly via their built-in sensors. These applications and wearable activity trackers make it possible for users to self-monitor their physical activity data.

Research has shown that using wearable activity trackers can motivate users to increase their physical activity behavior [6, 20]. Activity tracking could make people more aware of their physical activity levels [21]. When we are aware of our behavior, we may spend more time thinking and reflecting on it. Awareness of own activity level gives valuable insight and could lead to reconsidering choices and thereby lead to behavior change [21].

Another benefit of using wearable activity trackers is that they record the normal activity levels in the user's daily routines [22]. The trackers can give feedback via vibrations or other notifications reminding the user to move throughout the day. The reminders throughout the day could help raise awareness of one's activity behavior [22].

Continuous use of activity trackers makes it possible to see progress and detect possible diseases through changes in the activity data. In addition, it is possible to give the doctor access to your activity data which could notify the doctor about abnormal data.

Although using wearable activity trackers gives a lot of advantages, some people do not want continuous tracking of their activity. For example, some may feel constantly monitored if they use wearable trackers or do not want their data to be used and shared with others.

Research has shown a lot of positivity toward wearable activity trackers, but it also has negative feedback [23]. Wearable activity trackers could increase anxiety and guilt in the users [23]. For example, if a user gets a notification telling them to walk, but the user does not have the opportunity to get up, it could lead to increased stress and guilt. Users may also reduce the enjoyment of activities because all that matters is the steps or movements recorded by the activity tracker and not the enjoyment of the activity on its own [23].

2.4 Chatbot

Chatbots are computer programs designed to conduct a natural language conversation with a human [24]. These computer programs take natural language input, either voice or text, and process it to give a relevant response [24].

The simplest chatbot has predefined answers and defines the response based on rules. More complex chatbots use machine learning (ML), enabling the chatbot to learn from previous conversations. In addition, some chatbot uses natural language processing (NLP) which makes it possible for computers to understand and process human-generated text [25]. When using NLP, the chatbot can understand the context of human language and generate a response based on the context [25].

Chatbots developed to answer any kind of user query are defined as “open domain chatbots” [26]. In contrast, chatbots developed to answer questions in a specific category are defined as “closed domain chatbots” [26].

2.4.1 Rule-based

Rule-based chatbots respond to a user query based on predefined rules [26]. Rule-based chatbots can either try to recognize specific keywords in the query or recognize specific terms. The chatbot defines the terms, and they are presented to the user as possible input options.

Rule-based chatbots are usually closed domain chatbots because it’s difficult and time-consuming to write rules and responses for all possible inputs. The chatbot cannot answer if a user query does not correspond to any predefined rules [27]. Rule-based chatbots are stateless because they do not keep any state from previous conversations.

The benefit of using rule-based chatbots is that they are simple [27], and it’s easy to include or remove rules from the chatbot. In addition, implementing a rule-based chatbot is more straightforward and takes less time than implementing than using machine learning.

On the other hand, rule-based chatbots will not understand spelling mistakes, slang, or dialects [26]. Moreover, since they cannot generate new responses, they may be perceived as repetitive or boring if they always respond with the same messages in the same situations.

2.4.2 Self-learning based

Self-learning-based chatbots are more intelligent because they use machine learning concepts that enable them to learn from previous experiences [27]. Furthermore, the fact that chatbots can learn from previous conversations makes them adaptive, and they can improve themselves [27].

Natural language processing (NLP) is a much-used tool in self-learning chatbots and makes the chatbot seem more human [27]. When a chatbot uses NLP, it enables it to understand the meaning of the query and, for example, interpret whether the user is angry or happy [28]. In addition, the chatbot can also generate responses based on the input [28] and does not rely on predefined responses as the rule-based chatbots do.

The self-learning-based chatbots that use NLP and ML must often undergo extensive training before deployment. Extensive training is necessary because they must learn to behave appropriately and generate appropriate responses. Therefore, using the correct training data is critical to ensure that the chatbot learns the right content.

One of the benefits of using self-learning-based chatbots is that they may seem less robotic, repetitive, and predictable as they generate new responses. In addition, these chatbots understand the context of the message even with user errors such as spelling mistakes, which make them more human-like.

The negative side of self-learning-based chatbots is that the implementation stage is time-consuming due to extensive training. In addition, if the chatbot has learned the wrong thing, it takes some time to re-train it.

2.4.3 Benefits and drawbacks

Using a chatbot as part of a service gives a lot of benefits. Chatbots are services that can run 24 hours a day, seven days a week, providing a service always available for the user. Services involving human interaction must include many people to offer a 24/7 service handling unlimited user requests. Chatbots used in customer service can handle all customer requests simultaneously. Their efficacy is only affected by the server's power. Since chatbots can handle several requests simultaneously, people will not need to wait in line for an available human because they can talk to the chatbot. Users get faster access to the information they seek with chatbots than human interaction.

Another benefit is that the chatbot interface is almost identical to other messaging interfaces people use through social media applications or by sending messages on their phones. Since chatbot interfaces are familiar, it makes the chatbot user-friendly as the users most likely understand how to use them instantly.

Anonymity is another benefit that users can have when communicating with chatbots [29]. For example, users may feel more comfortable disclosing uncomfortable or intimate details as they do not feel judged because there are no humans on the other end [29].

The use of chatbots gives a lot of benefits, but they also have drawbacks. One of the drawbacks of using a chatbot is that the users may be concerned about their privacy and security [30]. The users may be worried about how the data they provide through the service is handled and stored.

Chatbots can also be perceived as repetitive, monotone, and dumb, negatively impacting usability. The chatbot may not understand the user queries, which may cause the user to become irritated or frustrated. Users may also not understand which questions to ask the chatbot and thereby not utilize it to its full potential. If the chatbot does not understand the user queries, the user may feel like they are wasting their time chatting with a chatbot instead of directly with a human.

Although using chatbots for customer service saves money in terms of personnel, technical personnel must be available to develop and maintain the chatbot. Developing and maintaining the chatbot could be time-consuming, depending on the kind of chatbot. Although rule-based chatbots are more straightforward to implement, they may cause more frustrated customers because they may not understand the customer. Chatbots that rely on machine learning better understand user queries, but they require a more extended development phase, including learning, and may be more challenging to implement.

2.5 Encryption

There are different ways data can be encrypted while transferred through the network. In addition, various encryption techniques and algorithms can be used, and which type of encryption is used influences who can access the content.

Encryption is transforming plain, readable text into unreadable content [31]. End-to-end encryption and encryption in transit are two techniques used in messaging services to transfer content from one device to another securely. The two techniques are equal in that the plain-text messages are encrypted before leaving the source device, but they differ in who can decrypt the message.

2.5.1 Encryption in transit

Encryption in transit means that the content is encrypted while transmitted through the network [31]. **Figure 1** shows encryption in transit. The steps are as follows:

1. The user creates content that is encrypted before leaving the device.
2. The encrypted message is sent from the source to the third party server.
3. When the message arrives at the third party server, it is decrypted.
4. The message is encrypted while transferred from the server to the destination device.
5. When the encrypted message reaches the destination device, it is decrypted.

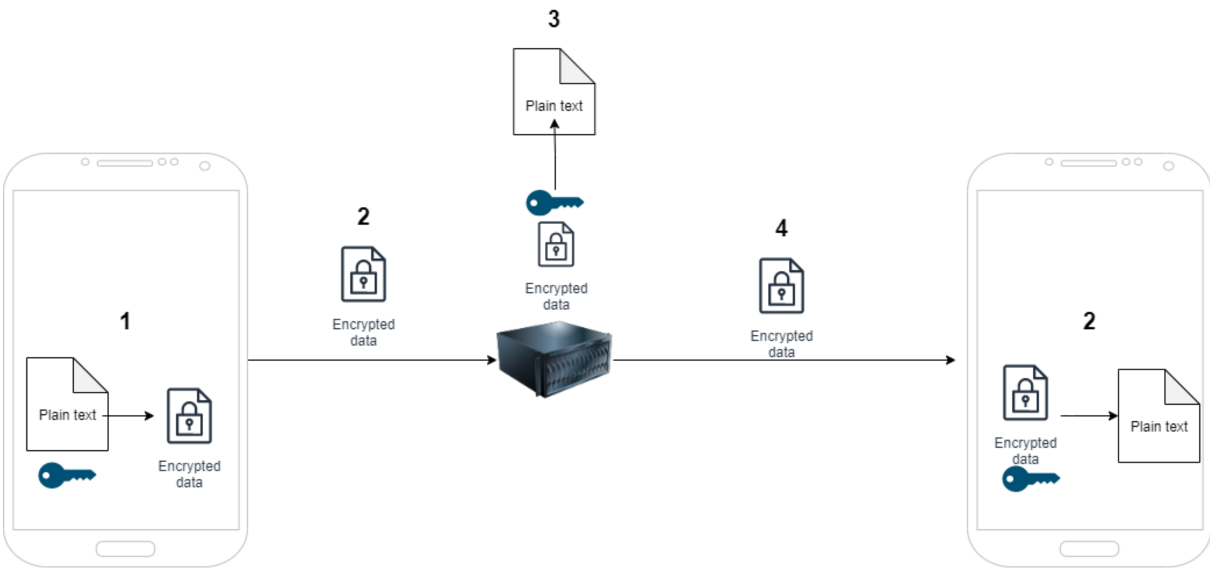

***Figure 1**: Encryption in transit*

When encryption in transit is used, the data is protected against cyber-attacks while being transmitted through the network [31]. The third party that owns the server where the message is redirected can access and understand the content of the message since the message is decrypted when received at the server. Since the user's data is accessible and understandable by the third party, they may use the content as they wish. Through terms of service and data privacy, the company must state which data is collected and how it will be used.

The content transmitted using encryption in transit is often stored encrypted on third-party servers.

2.5.2 End-to-en encryption

Using end-to-end encryption means that the content is encrypted from it leaves the source device until it reaches the destination device [31]. End-to-end encrypted messages are only accessible to those with decryption keys and protect the content from being modified or read by any other [32]. **Figure 2** shows how end-to-end encryption is, and the steps are as follows:

1. The data is encrypted before leaving the source device.
2. The encrypted data is transmitted to the server
3. The data is **still** encrypted when reaching the third party server
4. The data is encrypted when transmitted from the server to the destination device
5. The data is decrypted when reaching the destination device.

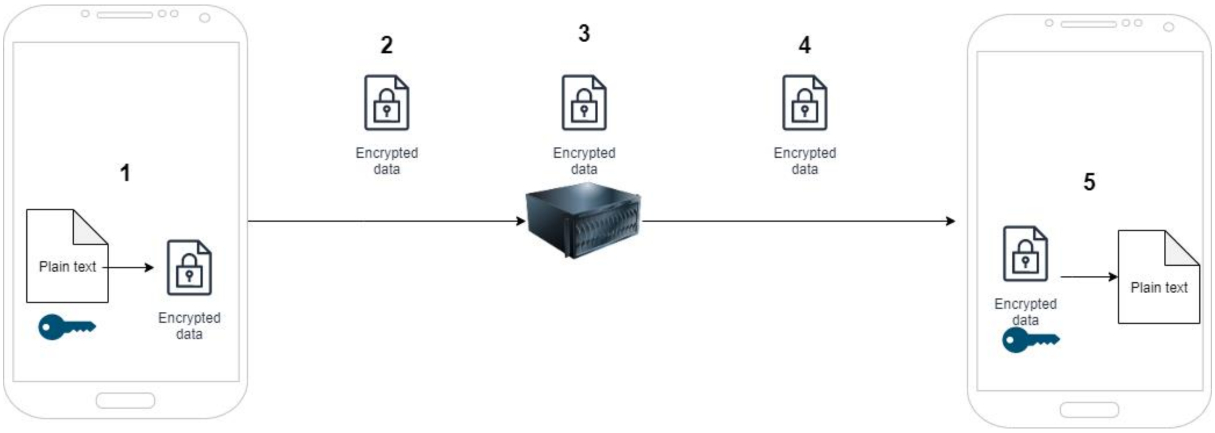

Figure 2*: End-to-end encryption*

When using end-to-end encryption, the devices that participate in the conversation are the only ones that have the decryption key and can decrypt the message. In addition, the owner of the server does not have the decryption key and can thereby not decrypt the message and get access to the content [32].

When end-to-end encryption is used, the content transmitted is often not stored on third-party servers. Therefore, the message may only be accessible on one device unless the messages are shared across devices.

3 Methods

3.1 Design

The design outlines the components and interfaces used to develop the system. The system consists of a mobile application, a database instance, and a server that handles requests from the mobile application, stores data, and processes chatbot messages. The design is outlined based on the results from the questionnaire and the literature review from my capstone project in autumn 2021 [8], discussions with supervisors, and feedback from testing through the iterative development process. Further, security and privacy aspects have impacted the choices made.

The “Volere Requirements Specification Template” [33] has been used to outline the system’s requirements. This template is used by people worldwide to declare the functionalities and requirements of the product they produce. In addition, the template has been outlined through many years of practice, consulting, and research in requirements engineering and business analysis [33].

This project will focus on the functional and non-functional requirements presented in the “Volare Requirements Specification Template” [33]. Functional requirements describe what the end system must do, which rules apply, and what processing actions it must take [33]. Non-functional requirements describe the properties that the functions in the functional requirements must have [33].

3.2 Development process

The development process has been following an iterative model [34]. An iterative model consists of several steps repeated in cycles. Each iteration could include additional features and fixing bugs detected in the previous iteration.

The first iterations have been development and testing. When the development stage is finished, the students in my research group have tested the system. After the testing is done and feedback received, the development of new features or bug fixes is started, and that cycle is followed.

After some iterations with development and testing, the testing stage was changed to a different testing stage. The new testing stage was with my supervisors, where the Think-Aloud method was used. An iteration of Think-Aloud testing was testing with one supervisor.

The product was further developed before doing the next Think-Aloud test. **Figure 3** shows the development process with first development and testing and then development and Think-Aloud testing.

The testing was essential throughout the development process to get feedback and other points of view to ensure that other users would understand how to use the system.

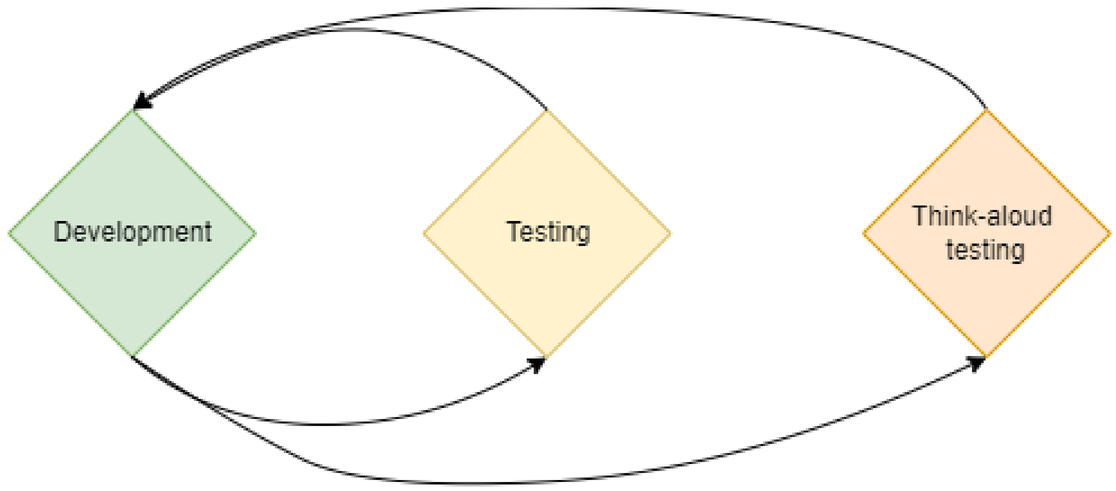

***Figure 3**: Development process*

3.3 Tools

Visual Studio Code [35] is a code editor used when writing the server code using the programming language Python.

Android studio [36], the official Integrated Development Environment (IDE) for android app development, has been used to develop the mobile application. The programming language used was Kotlin [37].

MongoDB [38] is a document model NoSQL database. The data is stored in documents in JSON-like format, and the documents are arranged in a collection [39]. Operations that are possible to perform on the documents are: create, read, update, and delete [40]. The create operation creates and inserts a new document into the collection. The read operations fetch the document from a collection. The update operation makes it possible to update existing documents in a collection. Finally, the delete operation removes an existing document from the database [40].

The application must be connected to a MongoDB instance, either on a local machine or a remote machine, to use MongoDB. The communication between the application and the

MongoDB instance is conducted using Transmission Control Protocol (TCP)/ Internet protocol (IP) socket.

MongoDB has various drivers that are official libraries for different programming languages to connect an application to MongoDB instances [41]. These drivers connect the application and the MongoDB instance and are responsible for their communication.

3.4 Discussion with experts

The developed system aims to influence the behavior of the users. Therefore two of my supervisors, a psychologist, and a Ph.D. candidate who might use the chatbot in her project, have assisted in outlining the messages that implement the different behavior change techniques (BCT). In addition, the supervisors have also helped pick the BCTs that could be most effective in this kind of system.

The BCTs are implemented in the chatbot to influence the behavior of the users. They are implemented through the content of the text messages and some of the features in the chatbot, like goal setting (presented in Section 5.3.2).

The document outlined by the psychologist and the Ph.D. candidate is found in Appendix I . First, the document defines four phases: reaching the goal, nearly reaching the goal, increasing the step goal, and decreasing the step goal. Then, for each of the four phases, various messages are defined. Defining several messages for each phase enhances variety and reduces repetitive behavior. Finally, each message is mapped with the BCT it implements. In addition, physical activity facts, benefits of physical activity, recommendations, and good practices statements are also defined in the document. The user receives these messages when they ask for benefits, recommendations, or good practices.

3.5 Analyzing privacy and security in social media applications

The popularity of social media has increased a lot in the latest years. People tend to use a lot of time on social media applications. We want to take advantage of the popularity of social media by using a social media application as the user interface of the chatbot. Integrating the chatbot into a social media application reduces initial user effort as people do not need to download or learn how to use new applications. Furthermore, when the chatbot is available through a popular channel, it may be more accessible. People may be more receptive to interventions than they would have with a standalone application.

Social media applications are beneficial in terms of usability and accessibility. Although we benefit from using social media applications, the data that the users provide through the interface must be processed securely and kept private. The data should not be sold to other companies, and it should not be used for ad targeting or shared with others in any way.

Before choosing a social media application to be used as an interface, a thorough investigation of the security and privacy aspects of the different social media applications is conducted. The social media application included in the analysis is based on results from the capstone project and other social media applications that we know value privacy.

This investigation is done by carefully reading the various social media application's privacy and security documentation. The essential elements analyzed were what you agree to when using the application, what and how data are gathered, what the data is used for, and if it is shared with others. In addition, it was also important to find out how messages are transferred from one device to the other device participating in the chat and how the messages are stored.

3.6 Testing

Testing of the system was conducted in two phases. The first was a pre-testing phase where my fellow students and supervisors tested the chatbot. The second phase was a usability study where a small group agreed to test the chatbot in their daily lives.

3.6.1 Continuous testing

As a part of the iterative development process, the system was tested each iteration. When new features or bug fixes were implemented, the students in my research group tested the system and interacted with the chatbot.

This testing was essential to enlighten bad design choices, find bugs, enlighten how other users may think and act when interacting with the chatbot, and try to break the system to find the vulnerabilities.

3.6.2 Think Aloud method

The Think Aloud method [42] was used as a tool in the testing phase with my supervisors. It is a cheap and flexible method. Testing using the Think Aloud method is conducted by having users interact with the system by performing a list of outlined tasks while they talk and verbalize their thoughts [42].

With the Think Aloud method, no equipment was needed, several testing sections could be done on the same day, and the system could be tested throughout the development phase as it does not need to be a finished product.

Bugs, grammatical errors, message length, and bad design choices were found through the testing. In addition, I got an insight into how other users interact with the system and how the functionality could be improved.

There are some restrictions to using the Think Aloud method. For example, it is not normal to say our thoughts out loud, and therefore the users may filter what they say, which could lead to important perceptions being lost as the user does not tell all their initial thoughts.

Think Aloud testing

The rounds with Think-Aloud testing were a cycling process. After finishing one test with one of my supervisors, the system was changed based on the feedback before the test with the second supervisor.

First-round

The first round of Think-Aloud tests was done with two of my supervisors, one from the computer science field and one from the psychologist field. The supervisors were asked to perform tasks that tested the functionality of both the chatbot and the mobile application while I observed and took notes. The tasks are defined below in **Table 1** and **Table 2**. The tasks were outlined to test all the implemented functionality to get feedback and understand how others interacted with the chatbot and how they perceived the mobile application.

Table 1*: Tasks to test the functionality in the chatbot for Think Aloud testing*

Nr.	Task
1	Finish the set-up with guidance from the chatbot
2	Ask the chatbot about your step-goal
3	Change your step goal
4	Ask the chatbot about your step count
5	Ask the chatbot about the benefits of physical activity
6	Report steps to the chatbot
7	Report other activity to the chatbot

***Table 2**: Tasks to test the functionality in the mobile application for Think Aloud testing*

Nr.	**Task**
1	Log in to the mobile application
2	Log out of the mobile application
3	Log in to the mobile application by requesting a new password from the chatbot
4	Send the current step count to the server
5	Delete the data that has been shared with the server

Since there is a cycling process, the system was changed based on the feedback before the test with the other supervisor. The cycling process is beneficial because many participants often find the same and most obvious mistakes in the first testing phase. When the obvious mistakes are fixed before starting a new test, the participant is more likely to find other mistakes or other things to change.

The main feedback from the supervisors in the first round was mainly about the content, structure, and length of the messages. In addition, they also suggested some functions that could be included to increase user satisfaction and how to describe better what the chatbot does and how the interaction will be.

Second round

The second testing round included the same two supervisors and another supervisor from the computer science field. This round started when all the changes based on the feedback from the first round were implemented. This round was conducted in the same manner as the first round, with the same tasks and observations.

The feedback from this testing phase was mainly small changes to the users' button options, some grammatical errors that the chatbot had, and cleaning up the information displayed in the mobile application.

Most of the changes from the feedback were implemented before the usability study. However, some functions that caused grammatical errors were not solved due to the limited time. To make the grammatical errors more acceptable to the users, the words that most likely were grammatically wrong were displayed in quotation marks in the text messages.

3.6.3 Usability testing

The system was tested with potential users in an everyday environment. The users were asked to use the system for a week. This testing was done to get feedback from potential users about the usability of the chatbot.

Recruitment of users

Recruiting people for the usability study was done by asking colleagues, friends, and family if they could participate. My supervisors also asked some of their friends, family, and colleagues to participate. Some of the design choices made to have the time to make a working demo of the system limited potential participants to users with a Samsung phone that could be no older than 2017.

To participate in the usability study, the users had to fulfill the following inclusion criteria:

- Have a Samsung phone no older than 2017 (Android O operating system)
- Use the Samsung Health application or be willing to log into it.
- Have a Telegram account or be willing to make a Telegram account.

Testing phase

The participant was provided with an information sheet and a file to install the AktiMot application. The information sheet explained the project's purpose, who and what was included, and that the testing was anonymous. Further, the information sheet had a detailed description, with pictures, of setting up and starting the testing. Lastly, the information sheet explained how to remove the application and delete their account on Telegram. The complete information sheet is displayed in Appendix II .

Alpha testing

The alpha tester started using the system a few days before the beta testers. The alpha testers were people that had the necessary knowledge to give feedback on the technical aspects of the system. The alpha testers followed the information sheet and downloaded the application on their phones.

Since the system had extensive testing throughout the development process, the big and apparent bugs were fixed before starting the alpha testing phase. The main bug revealed through the alpha testing was that the mobile application stopped sending hourly updates during the night. In addition, a few other things were fixed or added before the beta testers started using the system.

Beta testing

The beta testers got an updated information sheet based on the feedback from the alpha testers and a newer version of the mobile application that included a fix to address the problem revealed by the alpha testers. Before answering the questionnaire, the beta testers were asked to use the application for a week.

3.7 Security and privacy assessment in regards to usability testing

Throughout the testing phase, it was important to ensure the anonymity of the data, which means that it is impossible to identify a person directly or indirectly based on the data. Therefore, a concrete assessment was conducted to ensure anonymous data and establish which data were stored and collected.

Firstly, the data stored in the database are not personal information, and it will not be possible to identify a person based on the data. The data stored in the database are step count, step goal, weekly step count, conversational identifier, a username, and some other technical attributes. The user will be asked to pick a username that is not their real name. The mobile application stores the step count of the day, the user's username, and the conversational identifier. The identification number used in the database and the mobile application is the conversation-id from the social media application. The conversational id is not displayed in the chat and is only accessible through retrieving messages from the Telegram server, which you need a token to access.

When the testing phase is finished, the feedback from the users will be gathered using a questionnaire. This questionnaire is built and designed using Nettskjema.no, a tool that makes it possible to conduct an anonymous questionnaire. It is a tool developed by the University of Oslo and used by researchers all over the country to collect data anonymously. Nettskjema.no does not gather any IP address or other information about the participants that answers the questionnaire. The questions in the questionnaire will not ask for any personal information or additional information that makes it possible to identify a person based on the responses or an aggregation of the responses. The questionnaire will ask how the user perceived the system and their experience with it.

To summarize, the mobile application and the database do not store personal information or other information that enables the identification of a physical person based on the data. The questions in the questionnaire will not ask for any personal information or additional information that makes it possible to identify a person directly or by an aggregation of the answers. The questionnaire will collect data using Nettskjema.no, a safe tool that does not gather personal data.

3.8 Ethics

To ensure that the usability study was conducted securely and legally, the data protection officer of the *University of Tromsø* (UiT) was contacted to clarify if we had to apply to *Norsk senter for forskningsdata* (NSD) [43]. The email to the data protection officer described the project's purpose, what kind of data to be stored, and how the feedback from the users would be collected. The email to the data protection officer can be found in Appendix III .

The data protection officer informed us that we had to assess if it were possible to process anonym data in the project or if it would be possible to identify the participants in any part of the project. If we, through the anonymity assessment, decided that it would not be possible to process anonymous data in the project, we would have to apply to NSD. We concluded that it was possible to process the data anonymously in the project and that it would not be collected personal data through the questionnaire or on the server. Therefore, we did not need to apply to NSD. Section 3.7 above contained the complete assessment of anonymity in the project, which is the basis of our decision. The response from the data protection officer at UiT is found in Appendix IV .

3.9 Evaluation - Questionnaire

In the usability study, the users were asked to complete a questionnaire at the end of the testing period. This questionnaire investigated how the participants perceived the system, the ease of use and if the user felt any change in motivation or physical activity behavior. The complete questionnaire for the usability study can be found in Appendix V .

A question investigating the physical activity behavior of the participants was retrieved from the Tromsø Study [44]. The question is from “The Saltin-Grimsby Physical Activity Level Scale” and measures leisure time [44]. The translated version to Norwegian was retrieved from a questionnaire [45] from the Tromsø Study [46].

The other questions were outlined with my supervisors investigating how the user perceived the system if they used it throughout the testing period, demographics, and questions about user motivation and behavior through the testing phase.

Further, To investigate the usability of the implemented chatbot, the Chatbot Usability Questionnaire (CUQ) [2] was included in the questionnaire. The CUQ is a questionnaire outlined by an interdisciplinary team from Ulster University measuring the usability of chatbots [2]. The questionnaire consists of 16 statements where every other statement is a positive and a negative feature of the chatbot. The statement asks about chatbot personality, onboarding, user experience, and error handling. The participants give a score from 1 (strongly disagree) to 5 (strongly agree).

The English version of the CUQ has been validated as part of a Ph.D. study at the Ulster University in Northern Ireland in 2019 [20]. The English validated version of the CUQ is shown in Appendix VI . However, the CUQ has not been translated and validated into Norwegian, and therefore the CUQ used in the questionnaire is a direct translation into Norwegian. If the translation is not accurate, it could lead to misperceptions by the participants in the usability study, which could influence the results.

3.10 Data analysis

CUQ calculation tool

The interdisciplinary team from Ulster University provides a calculation tool to facilitate quick and easy calculation of CUQ scores [2]. The CUQ scores are calculated out of 100. This calculation tool is used to calculate the CUQ scores from the questionnaire.

Interpret scores

Holmes et al. [2] designed the CUQ to be comparable with the system usability scale (SUS) [47]. The SUS assesses system usability and consists of 10 statements the user can rate from 1 (strongly disagree) to 5 (strongly agree) [47]. Since the CUQ was designed to be comparable with SUS scores [2], the benchmark for the SUS score, which is 68 [48], can also be used to assess the CUQ score. A score of 68 is at the center of the range and can be thought of as a “C” [48].

4 Requirements

4.1 Process of defining requirement

This chapter describes and outlines the requirements of the system. The definition of the requirements is based on findings from the results of a literature review and the results of a questionnaire conducted in autumn 2021 [8]. Further, discussions with the supervisors and testing throughout the development process have also formed the requirements. Lastly, discussions with a psychologist who is also one of the supervisors for this thesis and the Ph.D. candidate were the basis for outlining the system's behavior change techniques and psychology.

4.2 Functional requirements

The functional requirements describe the system's behavior and what the system should do, and the functionality it must have [33]. The requirements below describe which actions the chatbot should have when the development of the chatbot is completed.

Functional requirements for the server and the mobile application are listed according to priority in **Table 3** and **Table 4**, respectively. The server is responsible for handling chatbot messages, storing data, and managing the mobile application requests. The table's structure is based on a subset of the definition of functional requirements from the “Volare Requirements Specification Template” [33]. Each requirement is described with:

- **Requirement number (Req. nr) –** a unique identifier for each functional requirement
- **Description –** this attribute describes what the functional requirement should do
- **Rationale –** why this functional requirement is needed in the final product
- **Originator –** the source of the functional requirement
- **Fit criteria –** how the product should be tested to determine if the final product has this functionality.

***Table 3**: Functional requirements for the server*

Req. nr	**Description**	**Rationale**	**Originator**	**Fit criteria**
1	The server must store user data in a database	If no data is stored in a database, all data will disappear if the server restarts	Author	The data should survive a restart of the chatbot server
2	The chatbot engine in the server must be able to process user generated text	If the chatbot engine cannot answer user queries, it does not work	Author, supervisors	The chatbot engine should be able to answer any message
3	The user must have the option to ask for their current step count	The chatbot engine in the server must be able to retrieve and send the user step count	Author, supervisors	A request for step count should be responded to with the user's step count
4	The user must have the option to ask for their step goal	The chatbot engine must be able to retrieve and send the user step goal	Author, supervisors	A request for a step goal should be responded to with the user step goal
5	The user should be able to ask the chatbot to change their step goal	The user must have the option to change their step goal	Literature review	When the user requests the chatbot to change their step goal, it should suggest a new step goal
6	The user should be displayed with predefined answers/questions to choose from	To ease the use of the chatbot, the user should have the option to select predefined answers/questions	Literature review	The user should be displayed with predefined answers/questions when entering the chat

7	The chatbot must send messages to the user to motivate them throughout the day	The user should receive messages from the chatbot	Literature review	The user should receive at least one message throughout the day from the chatbot
8	The chatbot should be able to suggest new step goals based on the user's previous step count	To motivate the user to increase their activity levels by slowly increasing their goal	Author, supervisors	The chatbot should suggest new goals based on calculations of the user's previous step count
9	The chatbot must send a complimenting message when a user reaches the step goal	As a motivation tool, the chatbot should compliment the user when they reach their step goal	Author, supervisors	The chatbot should send a positive complimenting message to the user shortly after reaching the step goal
10	The user must be able to report steps not tracked by the counter to the chatbot	The user should be able to get all their steps counted, and if the step counter has not tracked all, the user must have the option to add	Literature review	The user should be able to add steps through a command, free text, or other actions
11	The user must be able to tell the chatbot about other performed activities that could be converted into steps	The user should be able to tell the chatbot about other activities that could be included in the step count to register all user activity	Supervisors	The chatbot must accept the user telling about other activities and respond with the number of steps it is calculated as
12	The user must choose if the steps converted from other performed activities should be added to their step count	The user should choose if other performed activity that is converted to steps should be added to their step count or not	Author, Supervisors	When the user tells about other activities or the chatbot asks and responds with the number of steps, the

				user should be able to choose yes or no to include this in their step count
13	If the chatbot receives messages out of the scope, it should inform the user about the context	The chatbot must answer queries it does not understand	Author, supervisors	Even if the chatbot does not understand the context, it should respond
14	The chatbot should inform about physical activity benefits or recommendations	The chatbot should inform the user about the benefits of physical activity as it is a behavior change technique	Supervisor	The chatbot should send messages that inform about benefits or recommendations for physical activity
15	The chatbot should incorporate tracked/self-reported data in the messages	The messages get more personalized and more motivating by using the user's data	Author, supervisors	Some messages should include activity data of some kind
16	The chatbot must be able to ask the user for other performed activities and convert this to steps	The chatbot can ask for other activities that could be included in the step count to register all user activity	Supervisors	The chatbot should send a message asking for other performed activities and respond with how many steps it counts as
17	The chatbot should include historical data to motivate the user	By using historical data, the user could be inspired to try to beat its previous data	Literature review	The chatbot can send messages with data, for example, the same day last week where it had a higher step count, to motivate the user to beat it

18	The chatbot should ask for what activities or how the user plan on reaching their step goal	Action planning is a form of behavior change technique	Literature review	The chatbot can send messages asking how the user plans to reach the step goal.
19	The chatbot should recommend activities for the user	If the chatbot recommends activities, it may be easier for the user to do it	Literature review	The chatbot could send messages telling the user about great weather for a walk or run
20	The chatbot should display some statistics in the form of figures	Displaying historical data to the user could be motivational	Literature review	The chatbot should be able to display graphs to the user about historical data
21	The chatbot should ask the user about what can be done to increase their step count	If the chatbot asks the user, it may get the user to reflect on their behavior	Author, supervisors	The chatbot should ask the user if they struggle for a long time

***Table 4**: Functional requirements for the mobile application*

Req. nr	**Description**	**Rationale**	**Originator**	**Fit criteria**
1	The user must be able to log in by inputting a password	If the user does not log in with a password, it is not possible to connect the user data in the chat	Author	The user must be displayed with a login screen the first time opening the application
2	The mobile application should display the username of the logged-in person	The username stored in the chatbot server application should be	Author	The user should see its username in the application

		displayed in the app to ensure that it is the correct application		
3	The mobile application must display the step count of the user	For the user to be able to check its step count	Author	The mobile application displays the step count
4	The user should be able to log out of the application, which tells the server that they stop receiving activity data	The user should be able to decide if the application sends data or not	Author	The application should include a log out button
5	The user should be able to delete their shared data	The user should be able to delete the shared activity data	Author	The application should have a delete button that tells the server to delete the data
6	The mobile application should send the user step count to the server every hour	The mobile application must keep the server updated with the tracked data	Author, supervisors	The application has a counter that is reset each time the step count is sent
7	The user should be able to send their step count to the server at any time	If the user wants to include the most recent data in the conversation with the chatbot, they should be able to do it themselves instead of waiting	Author	When a user presses a button, the mobile application should display “Sent data to the server” to confirm to the user that the data has been sent

4.3 Non-functional requirements

Non-functional requirements are attributes that describe which properties the system's functions must have, such as performance, security, and latency [33]. These requirements define the quality of the system and how it should work.

Security

It should not be possible for others to retrieve the messages the users send to the chatbot through the social media application. In addition, the server must be the only one that can receive and send messages to and from the users.

Data passed between the social media application, and the server must be transmitted securely by, for example, using hypertext transfer protocol secure (HTTPS). Further, the content produced during a conversation between the user and the chatbot through the social media application must be encrypted if stored at the company’s server. User data should not be shared with other users or other people.

Privacy

The user must consent that the mobile application can access and use the activity data and that the mobile application can share the tracked data with the server. The user also needs to consent that the collected data from the mobile application can be used in the chatbot.

It should not be stored and gathered any personal information that makes it possible to identify a physical person. In addition, any additional data not needed for the system to work should not be collected. The user should also be able to stop sharing their data and delete the data that has been shared.

If the data gathered have the potential to reveal a physical person, the person must give a written consent that they allow you to collect and use the data, can delete the data, and all the General Data Protection Regulation (GDPR) [49] must be followed.

Availability

The chatbot should always be available for the user. The chatbot must answer queries that it does not understand with an apologetic message.

The mobile application must reach the server regardless of where it is and which network it is connected to.

Performance

The user should not have to wait more than 30 seconds for a response from the chatbot. If the chatbot uses too much time to answer user queries, the user may think that the chatbot is unavailable. The users will most likely not interact with a chatbot that uses too much time to answer, and they could also try to send the same message multiple times if the response time is too long.

Chatbot personality

The chatbot must have a friendly and positive personality. The chatbot should be nice and welcoming when greeting and interacting with the user. In addition, the chatbot must positively present itself and try to make a connection with the user.

Usability

It should be easy to use the chatbot. The messages sent by the chatbot should not use complicated words that are difficult to understand or possibly misunderstood. In addition, the users should be able to choose predefined questions/answers to ease the use.

The mobile application should be easy to navigate and explain the purpose of the application.

User interface

A social media application should be used as an interface. The chatbot must be integrated into a social media application and use the social media application as the connection point with the user. Users should communicate with the chatbot similarly as they do with others.

Wearable activity tracker

A smartphone, smartwatch, or other wearable activity trackers should be integrated into the chatbot. By integrating an activity tracker, the chatbot can use the data to personalize the messages and use it to motivate the users. Wearable activity trackers are most often worn throughout the day.

Scalability

The chatbot should be able to conduct a conversation with several users simultaneously. Therefore, users should not experience delays or loss of messages due to other users conversing with the chatbot simultaneously.

Emojis

The messages sent to the user should include different emojis. Emojis could be a powerful tool to reinforce the positivity in the messages and build a connection with the user. Attitude, enjoyment, and confidence can benefit from using emojis in conversational agents [50]. In addition, emojis can help users process the message's content and work as powerful symbols [51].

5 Design

5.1 Design approach

This chapter describes the design of the developed system. The design was initially based on discussions with supervisors, results from the analysis of privacy and security of social media applications, and results from the survey and literature review performed in the capstone project autumn of 2021 [8]. In addition, the iterative development process has also influenced the design through continuous testing and feedback.

5.2 Analysis of Privacy and Security in Social Media Applications

The following section describes the security and privacy aspects of five different social media applications. The privacy and security investigation was conducted to determine if we could still preserve the users' privacy and security when integrating the chatbot into a social media application. **Table 5** below summarizes each social media application's security and privacy attributes. Each social media application is further discussed in the following sections.

***Table 5**: Social media applications' privacy and security properties*

Application	**Does it have end-to-end encryption?**	**Does it have encryption in transit?**	**Is the chat history stored encrypted?**	**Does the company have access to the messages?**	**Is data shared with other parties?**
Facebook Messenger	**Yes** – not by default	**Yes**	No information	Yes	Yes
Slack Application	No	**Yes**	**Yes**	Yes	Yes
Telegram messenger	**Yes** – not by default	**Yes**	**Yes**	Yes	**No**
Signal	**Yes**	**Yes** – through end-to-end encryption	**No data stored**	**No**	**No**
WhatsApp	**Yes**	**Yes** – through end-to-end encryption	**No data stored**	**No**	Yes

5.2.1 Facebook Messenger

Facebook Messenger [52] is a popular messaging platform developed by Meta [53]. The application has existed for a long time and has a large user base worldwide. Facebook Messenger [52] has two types of conversations: normal and secret.

In normal conversation, the default conversation mode, the message is encrypted using encryption in transit. Since normal conversation mode uses encryption in transit, Facebook can use the content at its discretion. Furthermore, the Facebook terms state that they own all the data that the user provides through the use of their services [54].

Several documents and sources were visited to determine how Meta stores the data. Unfortunately, I could not find any sources that stated if the content is stored encrypted or not. They are most likely storing the content encrypted to protect it from intruders or other attacks.

The secret conversation mode uses end-to-end encryption[55]. The user must explicitly start a new and separate conversation and enable the secret conversation. With end-to-end encryption, only the participating devices can decrypt the messages because they have the decryption key. Meta will not be able to decrypt it and therefore cannot understand the content.

Meta does not store the data from secret conversation mode. The chat history and other data from the secret conversations are only stored on the participating devices. Since Meta does not store the conversations, it is impossible to access the secret conversations on other devices than where the conversation originated.

The Meta terms of service [54] and data policy [56] are extensive. Their data policy describes the kind of data they collect and what these data are used for [56]. Meta gathers a lot of information about its users through the information the user provides while using the service, for example, while using Facebook Messenger [56]. Meta also collects information about the user through what other people provide, the user's network and connections, payments, device information, and more [56].

5.2.2 Slack application

Slack [10] is an application developed mainly for people in companies and teams to collaborate and share knowledge. Slack has a lot of security certifications and attestations, and they state that they meet and exceed some of the broadly recognized security standards [57].

Slack only has encryption in transit and does not provide other conversation modes. Therefore, Slack has access to all data provided through its system. In addition, slack encrypts and stores all data on its servers.

Slack collects and receives customer data. It collects metadata, account details, log data, and other kinds of metadata [58]. The data gathered by Slack is used to provide, update, maintain, and protect their services, websites, and business, develop and provide search, learning, and productivity tools and additional features, and send emails and other communication [58].

5.2.3 Telegram Messenger

Telegram [13] was developed and designed for speed and security [59]. Like Facebook Messenger, Telegram provides two conversation modes: normal and secret chats.

The normal conversation, default mode, uses encryption in transit [59]. Telegram uses a distributed infrastructure to secure the data from normal conversation mode, which is not end-to-end encrypted [59]. The distributed infrastructure means that the data are stored in multiple different data centers all around the world. The decryption keys that can decrypt the data are split into several parts, stored in various data centers, and never stored in the same place as the data it decrypts [59].

The secret chats use end-to-end encryption, and the secret chats mode must be explicitly chosen as with Facebook Messenger. Telegram does not store data from secret chats on its servers. The data from the secret chats are only stored on the participating devices and are therefore not a part of Telegram's cloud and not accessible through any other device than where the conversation originated [59].

Since Telegram was developed with an emphasis on security, it is odd that they do not use end-to-end encryption by default. The developers of Telegram have written an article stating why the application is not end-to-end encrypted by default [60]. The article states that they do not use third-party companies for cloud storage to store their backups. They only use their own dedicated servers [60]. Other companies rely on big cloud companies to store their data, and the transmission of the data to the cloud provider may not be end-to-end encrypted. Hence, the data is not as well secured as sending end-to-end encrypted messages [60].

The privacy policy of Telegram states that they do not use the user's data for targeted advertising or sell the data to other companies [61]. Telegram may collect metadata such as IP address, device, username history, and other metadata [61]. The collected metadata can only be kept for 12 months [61].

5.2.4 Signal

Signal [62] is another messaging application developed for privacy. The conversations in Signal are always end-to-end encrypted [63]. Signal's terms and privacy policy state that the application is designed to never collect or store any sensitive information [64]. In addition, the messages sent using the Signal application are only stored on the participating devices. Signal does not store any chat history on their servers [64].

Technical information such as randomly generated authentication tokens, keys, and other material is stored on the Signal servers [64]. They state that the data stored at their servers is necessary to establish calls and transmit messages. They limit this additional technical information to the minimum to operate the services [64]. Signal does not sell the data they collect [64].

5.2.5 WhatsApp

WhatsApp [65] is used by more than 2 billion people worldwide [65]. WhatsApp joined the Meta community in 2014, but it is still a separate application [65].

The messages exchanged on WhatsApp are end-to-end encrypted by default [66]. This end-to-end encryption prevents third parties and WhatsApp from accessing plain text messages [66].

The chat history is not stored on WhatsApp servers but only on the participating devices [66]. Users will have access to their chat history on other devices that they register through WhatsApp [67]. When a new device is registered, the chat history is sent to the new device using end-to-end encryption [67]. It is also possible to have end-to-end encrypted backup on iCloud [68] or Google Drive [69] [70]. With end-to-end encrypted backup, the data stored in the cloud are secured by a password or a 64-digit encryption key [70].

WhatsApp collects information about usage, log, device, connection, location, and other information [71]. The collected data are shared with third-party services, providers, and other Meta companies [71].

5.2.6 Choice of social media application

Several aspects were considered before choosing the social media application best suited as an interface for the chatbot. The most important aspect is security and privacy. In addition, the social media application's popularity must also be considered. The final criterion was that it must be possible to integrate a chatbot into the social media application, and it is beneficial if the company provides documentation on how to do this.

A survey conducted in autumn 2021 [8] revealed that Facebook Messenger was the most popular social media application used for communicating among Norwegian volunteers aged 18-65 years. The popularity of the social media application is relevant because using a popular social media application as an interface will make it easier to reach a large population.

Although Facebook Messenger was reported as the most popular messaging application through the survey, it will not be chosen as the interface for the chatbot. The extensive data policies and terms of service state that Meta owns all the data that the user provides through the use of their services. Meta sells and shares its collected user data with other companies. Facebook Messenger cannot be used as the interface based on the bad security and privacy aspects. Slack will not be used as an interface because of its lack of privacy for the user content.

Signal, WhatsApp, and Telegram are all applications that value security. Signal and WhatsApp both have end-to-end encryption by default, while Telegram has the option to enable this.

WhatsApp would seem like a good option for the interface as it values security and has many users worldwide. However, since Meta now owns WhatsApp, the information collected must be shared with the Meta company and other associated Meta companies. Therefore, since WhatsApp shares data with the Meta company, they were eliminated as a candidate.

Signal seems like the best candidate because they have end-to-end encrypted communication by default. However, both Signal and Telegram were developed with an emphasis on security, and they both do not share any data with third parties. Therefore, although Signal is the best candidate, since it does not allow the integration of chatbots into their application, it eliminates Signal as a candidate.

The social media application that is best suited as the interface for the chatbot is Telegram. Telegram provides APIs and documentation for the integration of chatbots into their application. It is possible to have end-to-end encrypted conversations, but Telegram states that its application does not need end-to-end encrypted to be secure. The reasoning for this is that third-party companies are not used for storing data, and the data is heavily encrypted when stored, making it inaccessible to others. Telegram neither shares any information with other companies nor uses the data for targeted advertising or other things.

It is important to emphasize that Telegram does not meet the popularity criteria. Telegram is not a well-known and used application in Norway. The popularity of the social media application is important to reach a large population who are already spending a lot of time daily on the application. Although Telegram does not provide these benefits, it will be used in this thesis to fulfill the security and privacy requirement, which are important.

Messaging interfaces are often similar because of their simple design, and this is an advantage because Telegram messaging interface is much like Facebook Messenger. **Figure 4** shows the chats' interface in Facebook Messenger (left image) and Telegram Messenger (right image). Here we see that the two interfaces are similar with the name at the top, the messages in the middle, and the keyboard at the bottom. We also see that both have an icon for the emojis.

Since Telegram has a similar design to other more popular messaging applications, users will likely recognize the interface and understand how to use it. Hence, the initial user efforts are minimal since they are already familiar with these messaging applications.

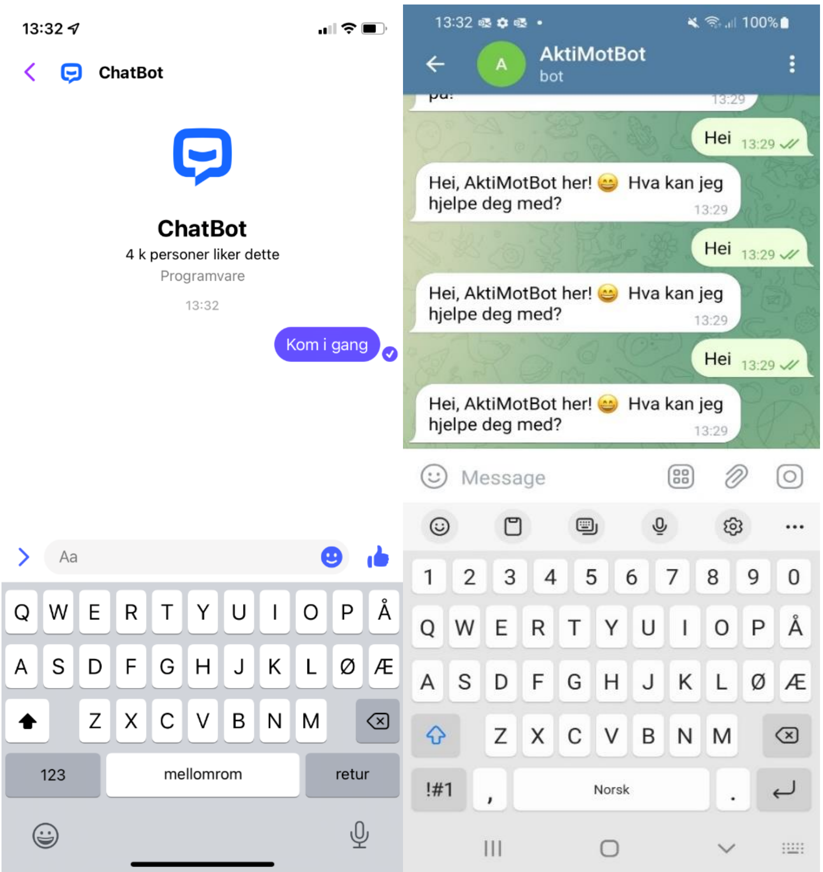

Figure 4: *Facebook Messenger and Telegram interfaces.*

5.3 Main architecture

The implemented system consists of three components, a server, a MongoDB instance, and AktiMot, a mobile application. The primary user interface (UI) is the Telegram Messenger application, where the user and the chatbot communicate in the Norwegian language. The server is responsible for storing user information in a MongoDB instance, fetching messages from the Telegram server, answering or sending messages to the user through the Telegram server, and handling incoming requests from the mobile application. **Figure 5** shows all the components in the system and the data flow. The following sections describe each element of the architecture.

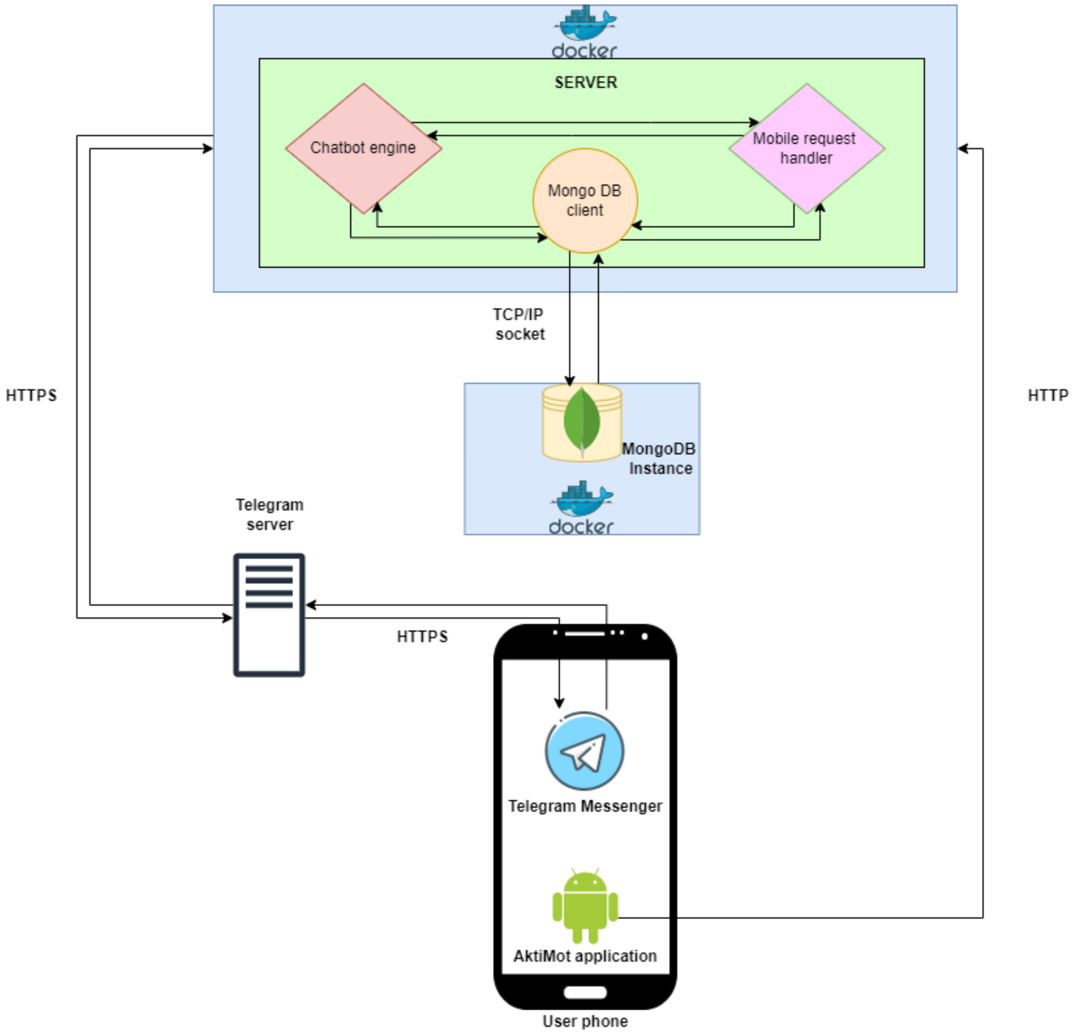

***Figure 5**: System architecture*

5.3.1 User interface

The user interface is the social media application Telegram Messenger. The chatbot's name is AktiMotBot (Aktiv Motivasjon Bot/Active motivation bot). **Figure 6** shows the standard Telegram interface where the users will communicate with the chatbot.

The interface is a static view, but the input method varies between the alphabetic keyboard and a button keyboard . It can either be a standard keyboard shown to the left in **Figure 6** or buttons with predefined questions/answers that the user can choose from shown to the right in **Figure 6**. The buttons vary depending on the chatbot's actions determined by the user input. When there is no ongoing activity, the user is displayed with the “menu”, which consists of all the actions the user can do in the chatbot. This menu is shown to the right in the figure below.

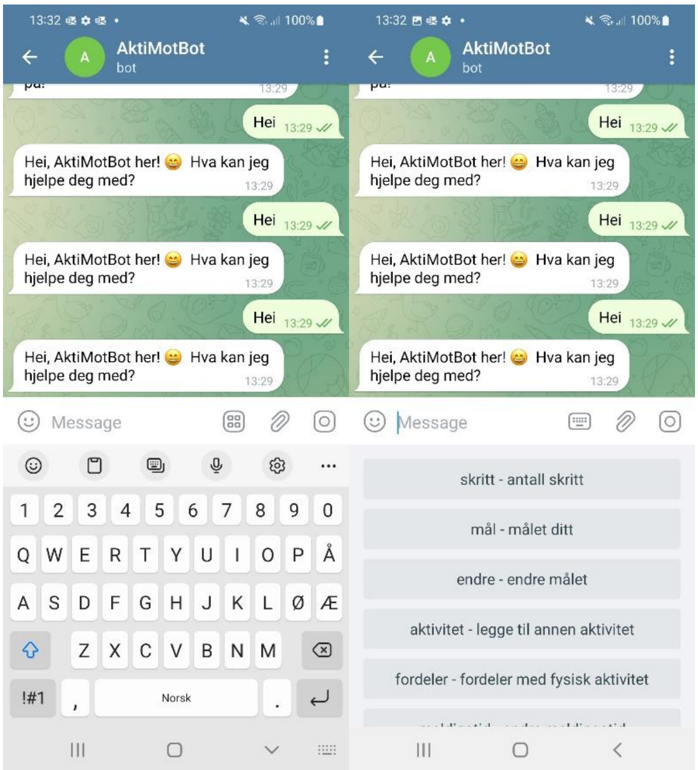

Figure 6*: Telegram interface standard keyboard (left) and buttons (right)*

5.3.2 Server

The server is comprised of three main components. When the server receives messages from the Telegram server, the chatbot engine is responsible for processing and responding to these messages. The mobile request handler is responsible for handling incoming requests from the AktiMot app. Finally, the MongoDB client is responsible for communicating with the MongoDB instance to store user data.

MongoDB Client

A MongoDB instance is used to store the user data. At startup, the server instantiates a MongoDB client responsible for communicating with the MongoDB instance. The MongoDB client initiates a TCP/IP socket connection with the MongoDB instance, leaving an always open connection.

The application stores a username, daily step count, weekly step count, step goal, and other relevant metadata for each user. All the user data stored is displayed in **Figure 7**.

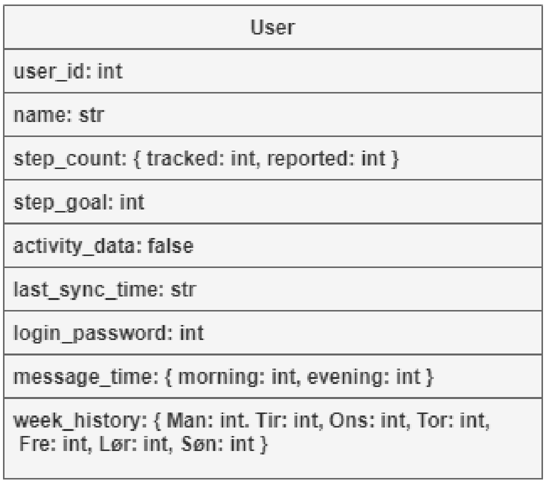

Figure 7*: Data in a document*

Mobile request handler

The mobile request handler is responsible for handling incoming requests from the mobile application, ensuring that the incoming data is stored in the database, and evaluating if the chatbot engine should send a message to the user. The communication between the AktiMot application and the server is through hypertext transfer protocol (HTTP) requests. The AktiMot app has five events that could trigger a request to the mobile request handler: when the user logs in to the application, logs out, deletes the data, manually update step count, and hourly automatical update of step count.

Chatbot

The chatbot aims to motivate users to increase their physical activity behavior by increasing their step count. Furthermore, the chatbot aims at influencing the user by using various behavior change techniques (BCT) to change their attitude and behavior toward physical activity. Finally, the chatbot also seeks to inform the user about physical activity and the effects of increased physical activity on their physical and mental health and social and environmental consequences.

The user communicates with the chatbot, AktiMotBot, through the Telegram interface. The chatbot engine in the server is responsible for fetching the messages from the user, which are temporarily stored on the Telegram server. Further, the chatbot engine is responsible for processing the input and responding.

The rule-based chatbot engine uses predefined responses to reply to user queries. In addition, information such as the users' step count and other tracked or reported data are fetched from the database. The chatbot is limited to answering user queries that it is defined rules for and therefore is limited to a series of queries. Queries deviating from the predefined rules are responded to with an apologetic message and displaying the button menu, as depicted to the right in **Figure 6** above.

All communication between the chatbot engine and the user is transmitted through the Telegram servers. In addition, the Telegrams intermediate server, which the implemented server communicates with, is responsible for encrypting the messages [72].

Behavior change techniques

The messages defined for each BCT are outlined with help from experts in the field, as presented in Section 3.4. The messages displayed in the pictures below are from the use of the chatbot and are in Norwegian. Some of the messages will be displayed in this section, but most messages are available in English in Appendix I .

Goal setting

The goal-setting action can be done in two different ways. Either the user chooses their own step goal, or the user can ask the chatbot to suggest a new step goal. Goal setting is used to get users to reflect on their capabilities and increase their physical activity in small steps.

When the user has chosen their step goal, the chatbot gives different responses based on whether the user has increased or decreased the goal. The top message in **Figure 8** below shows an example of a message the user can receive when the step goal is increased. Some messages include the previous and new step goal, while others complement the user for increasing the step goal. The bottom message in **Figure 8** gives one example of a message the chatbot sends if the user has decreased their step goal.

Figure 8*: Response messages: User increased goal(top) and decreased goal (bottom)*

Discrepancy between current behavior and goal

Disparency between current behavior and goal is a BCT that reminds the users that their current behavior does not meet their previously chosen goal. In our case, the chatbot will inform the user about their step count and remind them that they are close to or have not reached their step goal yet. Informing the user that they have not reached their goal is done to influence the user to see that they have to do an activity to fulfill their goal. Including the users' step count in the message will compliment them and remind them about their behavior and goal discrepancies.

Figure 9 shows two examples of messages that users can receive when they ask about the number of steps they have taken or the number of steps they lack to reach their goal. Messages similar to these will be sent in the afternoon to motivate the user to, for example, go for a short walk to reach their step goal.

***Figure 9**: Messages informing about the current number of steps or remaining steps*

Social reward

Social reward is one of the behavior change techniques implemented. When a user has reached the step goal for the day, the chatbot compliments the user by sending a positive and rewarding message. The user will only get this social reward if he/she has reached the step goal, which implies that they have made an effort to do so.

Figure 10 shows two messages the user can receive when their goal is accomplished. These messages are positive and compliment the user for the effort made.

Figure 10*: Messages when the user reaches his/her goal*

Information about health consequences

This BCT is implemented by providing the user with information about the health consequences of physical activity. The chatbot focuses mainly on providing information about the benefits of physical activity instead of presenting the negative health consequences of sedentary behavior. Focusing on providing the user with the benefits of physical activity is done because we want to highlight the positive aspects of physical activity instead of focusing on the negative aspects of their current behavior.

The top message in **Figure 11** gives an example of a benefit message the user receives when asking for the benefits of physical activity. In Appendix I a list of benefits of physical activity is defined in English. A corresponding Norwegian list is used in the chatbot to enhance variety and increase the chatbot's knowledge.

Information about emotional consequences

Through this BCT, the user is informed about the emotional consequences of physical activity. In addition, the chatbot informs the user about the effects physical activity has on mental health, including improved self-confidence and reduced symptoms of depression and anxiety. The middle message in **Figure 11** shows an example of a message about the emotional consequences of physical activity.

Information about social and environmental consequences

This BCT is implemented to inform the user about sedentary behavior's social and environmental consequences. The chatbot informs the user how their behavior can impact the environment around them. The bottom message in **Figure 11** below shows one example of a message the user receives about the effects of sedentary behavior on the environment.

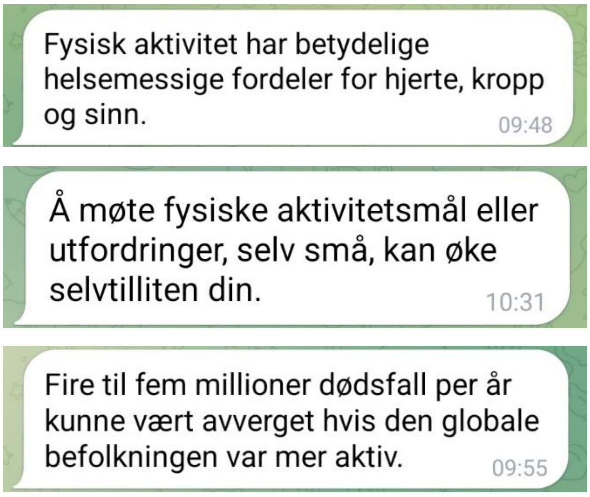

Figure 11: *Benefits (top). Emotional conseq. (mid). Environmental conseq. (bottom)*

Message events

Different situations automatically trigger the chatbot to send a message to the user throughout the day. Depending on their behavior, the user can receive up to three or four messages a day. The messages are chosen from predefined messages to ensure variety.

The first message event is in the morning, and all users will get a message in the morning. The morning message should remind the user about being active and update them on their previous behavior. Personalization is implemented here by allowing the user to choose which time between 07 AM and 10 AM they want to get the message. The user will receive different messages depending on whether they completed their daily goal the previous day. The top message in **Figure 12** is an example of a message the user will get in the morning if they achieved their step goal the previous day. The bottom message in **Figure 12** displays a morning message the user will get if they did not reach the step goal the previous day.

Figure 12: *Morning message: Reached goal (top), not reached the goal (bottom)*

The second situation that could trigger the chatbot to send a message is when the user walks more than 1000 steps in less than 50 minutes. The user is then rewarded with an encouraging message. An example of this can be seen in **Figure 13**.

Figure 13*: Message received if they walked more than 1000 steps in less than 50 minutes*

Further, the third situation is when the user reaches their step goal. The chatbot sends a message to the user if the mobile request handler detects that the user has reached their step goal after a step count update from the AktiMot application. **Figure 14** shows two examples of messages the user can get when they reach their step goal.

Figure 14*: Examples of messages the user receives if they reach their step goal*

The last situation that could trigger the chatbot to send a message is in the afternoon. The user will only get this message if they have not completed their daily goal. **Figure 15** gives an example of a message the chatbot sends in the afternoon.

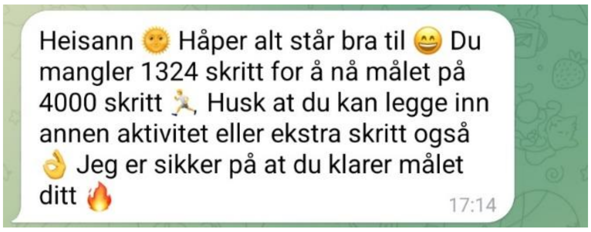

Figure 15*: Examples of afternoon messages*

When the morning and evening messages are sent, the chatbot engine simultaneously checks how long time has passed since the last time it got an update of the user step count from the AktiMot app. For example, if the AktiMot app has not updated the server since 3 AM, the chatbot sends a message asking the user to open the app in the morning. The additional message the user receives in the morning that asks them to update manually is depicted in the top message in **Figure 16**.

In the afternoon, the server checks if the mobile application has sent an update that is newer than three hours. If the update time was more than three hours ago, the afternoon message is replaced with a message telling the user to manually send an update, the bottom message in **Figure 16**. When the user manually sends an update to the server through the AktiMot app, the user will get an update on their current step count by AktiMotBot in Telegram.

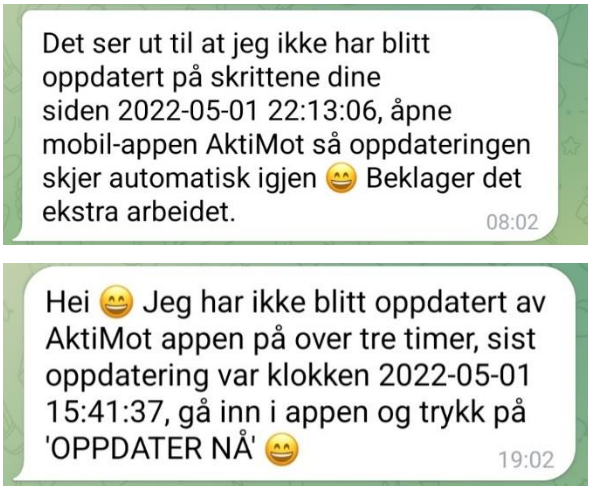

***Figure 16**: Morning message to update (top) and afternoon message to update (bottom)*

5.3.3 Mobile application

The mobile application, AktiMot, is implemented for Samsung Phones using Android Studio to work as a passive sensor. It is a simple application that only accesses a user's step count and updates the server with this information. The architecture of the mobile application is depicted in **Figure 17**. The AktiMot app communicates with the implemented server by sending HTTP requests.

The AktiMot app connects to the Health Platform to read the user step data. The Health Platform gathers the user's step count from the Samsung Health application. AktiMot sends the step count to the server hourly or if the user manually triggers it.

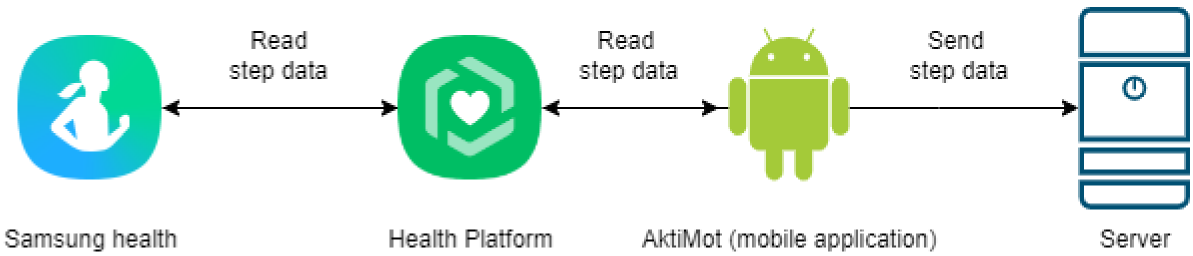

***Figure 17**: Mobile application architecture*

Permissions

The user must permit the mobile application to access the physical activity data. The first time the user opens the AktiMot application, the user will be asked to allow the AktiMot app to retrieve the physical activity data, as shown to the left in **Figure 18**. Further, it has to ask for permission that the Health Platform can send activity data to the mobile application, as shown to the right in **Figure 18**. If the mobile application doesn't get these consents, it will not have access to the user's step count.

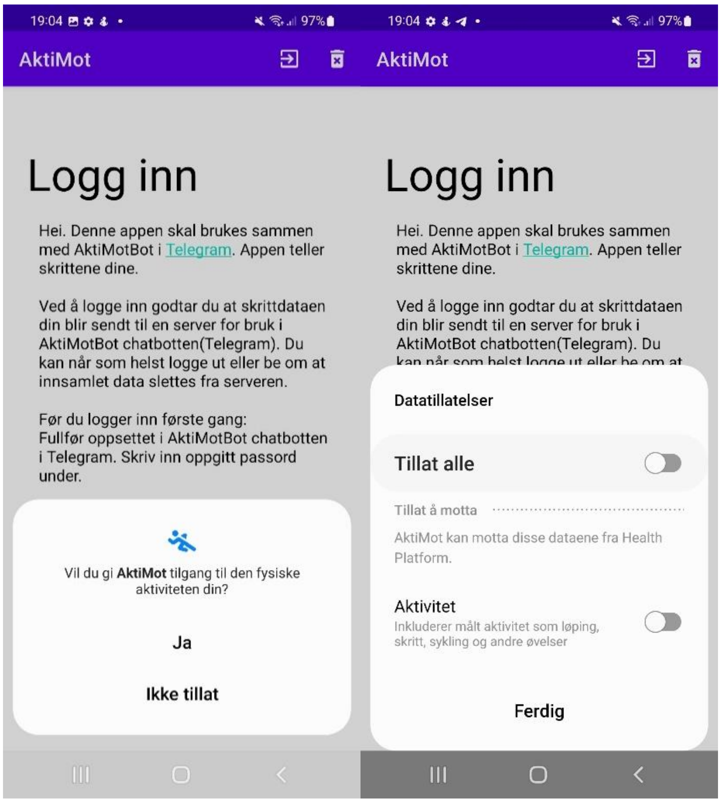

Figure 18 *Permission for physical activity data (left). Permission to receive data from Health Platform (right)*

After the user has permitted the required permissions (described above), the user can log in with a password they receive from the AktiMotBot in Telegram. The login screen, seen to the left in **Figure 19** below, states what the user agrees to when logging in to the application and that their step data is shared with the server. After the user has logged in, the chatbot (AktiMotBot) will send a message in Telegram verifying that the user has logged in and that the server is receiving the user's activity data.

When users log in, they are directed to the home screen, to the right in **Figure 19**. The home screen is a simple interface that explains how the app works and displays the step count and username. The user can log out or ask to delete their content. When the user has logged into the AkiMot app, it will send an update to the server hourly. If a user presses the log out or delete button, they will be prompted with a pop-up window asking them to confirm the action, as shown in **Figure 20**. The mobile application will stop sending hourly updates when the user logs out.

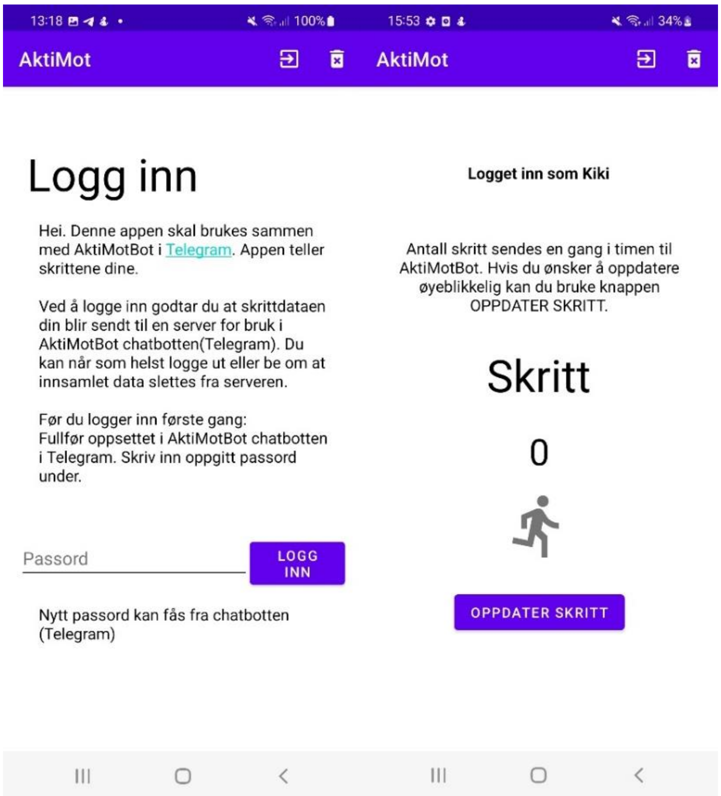

Figure 19: *Login screen (left). Home screen (right)*

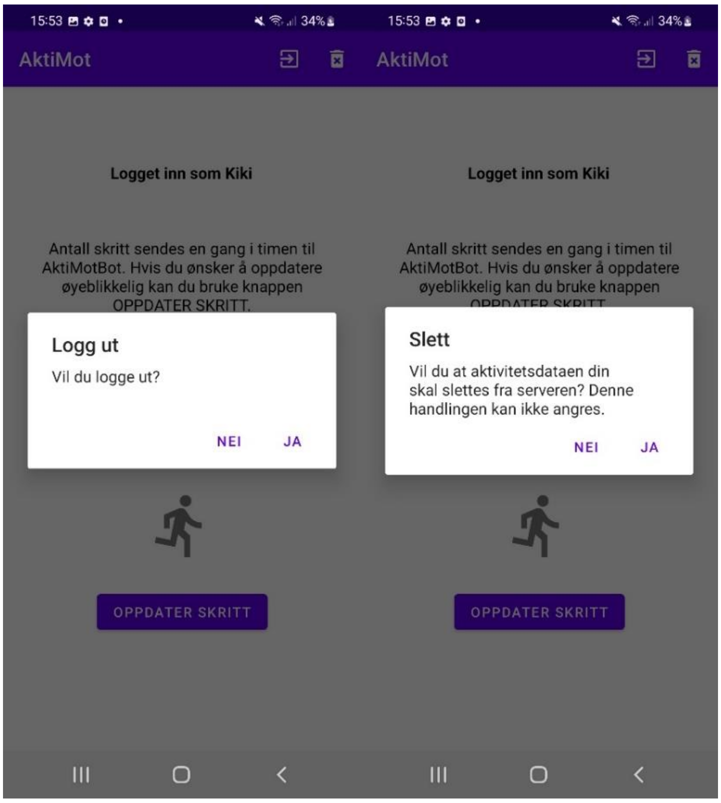

Figure 20: *Log out pop-up (left). Delete pop-up (right).*

6 Implementation

6.1 Requirements implemented

This chapter will describe most of the implemented features. The 15 first functional requirements of the server, defined in **Table 3** in Section 4.2, are implemented. Further, all functional requirements for the mobile application are implemented, listed in **Table 4** in Section 4.2.

The non-functional requirements: security, privacy, and the user interface is fulfilled by using Telegram as the social media application. Further, availability and scalability requirements are not relevant until deployment but were fulfilled in the usability study. Finally, the chatbot integrated the smartphone as a wearable activity tracker, and emojis were incorporated into messages.

6.2 Mobile application

6.2.1 Health Platform

Health Platform was an app developed by Android that provides developers with an application programming interface (API) [73]. The Health Platform API was a single interface for reading, writing, and sharing the user's historical fitness data [73]. Through the Health Platform API, the users could choose which apps have access to their health data and read and update their health data.

When the AktiMot app was implemented, the API version was 1, but the Health Platform was deprecated as of the 11th of May 2022 [73]. The API version used was only compatible with Samsung Health on selected Samsung devices. In addition, the Samsung device had to run the operating system Android O or newer.

6.2.2 Activity data collection

The mobile application, AktiMot, initializes a HealthDataClient, an entry point into the Health Platform. The AktiMot app requests permission to read step data from the Health Platform at initialization. The user must allow the Health Platform to send data to the AktiMot app. Since the user can revoke the read permission, the AktiMot app checks that it has the required permissions each time it tries to get the step count from the Health Platform. If the app is missing the required permission, it will request the permission.

Since the Health Platform was in alpha, most people have not connected Samsung Health and the Health Platform to allow Samsung Health to send data to the Health Platform. Moreover, since it is not possible to ask for permission on behalf of other apps, the connection between Samsung Health and the Health Platform had to be done manually through the Samsung Health settings. The Health Platform had to be added as connected services through the Samsung Health settings.

6.2.3 Periodic work request

AktiMot is implemented to send an update request to the server hourly. The update request sent to the server has both the user's current step count and the step count for the previous day for simplicity. Always including the step count for the previous day was done not to make another request sent at exactly midnight, but rather always have the step count for the last day in the request to have only one periodic request.

The application initializes periodic work managed by Androids Work Manager [74] to handle the hourly update. When the work is initialized at startup, it is enqueued, and each time the work finishes, the same work is enqueued again. Finally, the task of the periodic work is to send a broadcast. The main activity receives this broadcast and then sends the update request to the server. The flow is shown in **Figure 21**.

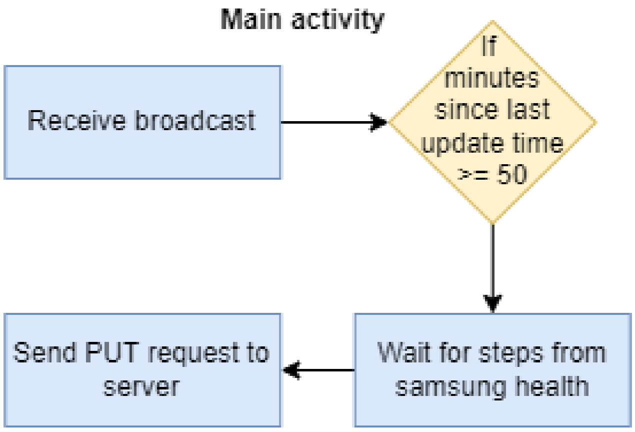

Figure 21*: Flow of periodic work*

Initially, the worker was responsible for sending the update request to the server. However, it was difficult to retrieve the new step count and insert this into the worker as it was already queued. As a result, the update request contained old data. Therefore, the choice was made to alter the periodic work to send a broadcast to which the main activity subscribed, triggering an update request.

6.2.4 Initial implementation

The AktiMot app was initially developed as a step counter that would work on any Android-based phone with a hardware step sensor. The mobile application was implemented in such a manner that an event was sent to the application for every detected step. The mobile sensor is only reset in the event of a phone reboot.

The problem with the initial solution was that when the phone was in idle mode, which happens when it is not used, the mobile application stopped being notified about steps. An option was to force the phone to wake up to ensure that the steps were counted, but this would drain the phone battery, which is not desirable. Therefore, the initial solution was rejected due to inaccuracy, and a new application using the Health Platform API was implemented.

6.2.5 Why not directly connect to Samsung Health?

A question that most likely will be asked is why the mobile application did not get the activity data directly from Samsung Health. For an application to access the Samsung Health data directly, the application has to be an accepted partner app of Samsung [75]. To become a partner app, you must apply for a partnership.

For the moment, Samsung has stopped accepting any applications for the Partner Apps Program [75]. Therefore, it would not be possible to apply and get accepted to use Samsung Health.

6.3 Server

6.3.1 Mobile request handler

The API endpoints in the mobile request handler are defined in **Table 6**. The mobile request handler handles all incoming requests from the AktiMot application.

***Table 6**: Definition of API endpoints*

Method	URL	Description
PUT	/identification	Request to log a user into the mobile application
PUT	/logout	Request to log user out of mobile application
PUT	/steps	Request that update user’s step count
DELETE	/deleteuser	Request to delete user data from the server

Steps request

The most frequent request is the "PUT /steps" request that the mobile application should do every hour. **Figure 22** below describes the event flow of a "PUT /steps" request. We can see that several possible situations can be triggered from the figure. When the request arrives at the server, it is first checked if the user has a step goal. Further, an action is triggered if the user has reached their step goal since the last update. Finally, if the user has not reached their step goal, it further checks if the user manually triggered the update, and if not, it checks if the user has increased their step counts a lot since the last sync to send a complementing message.

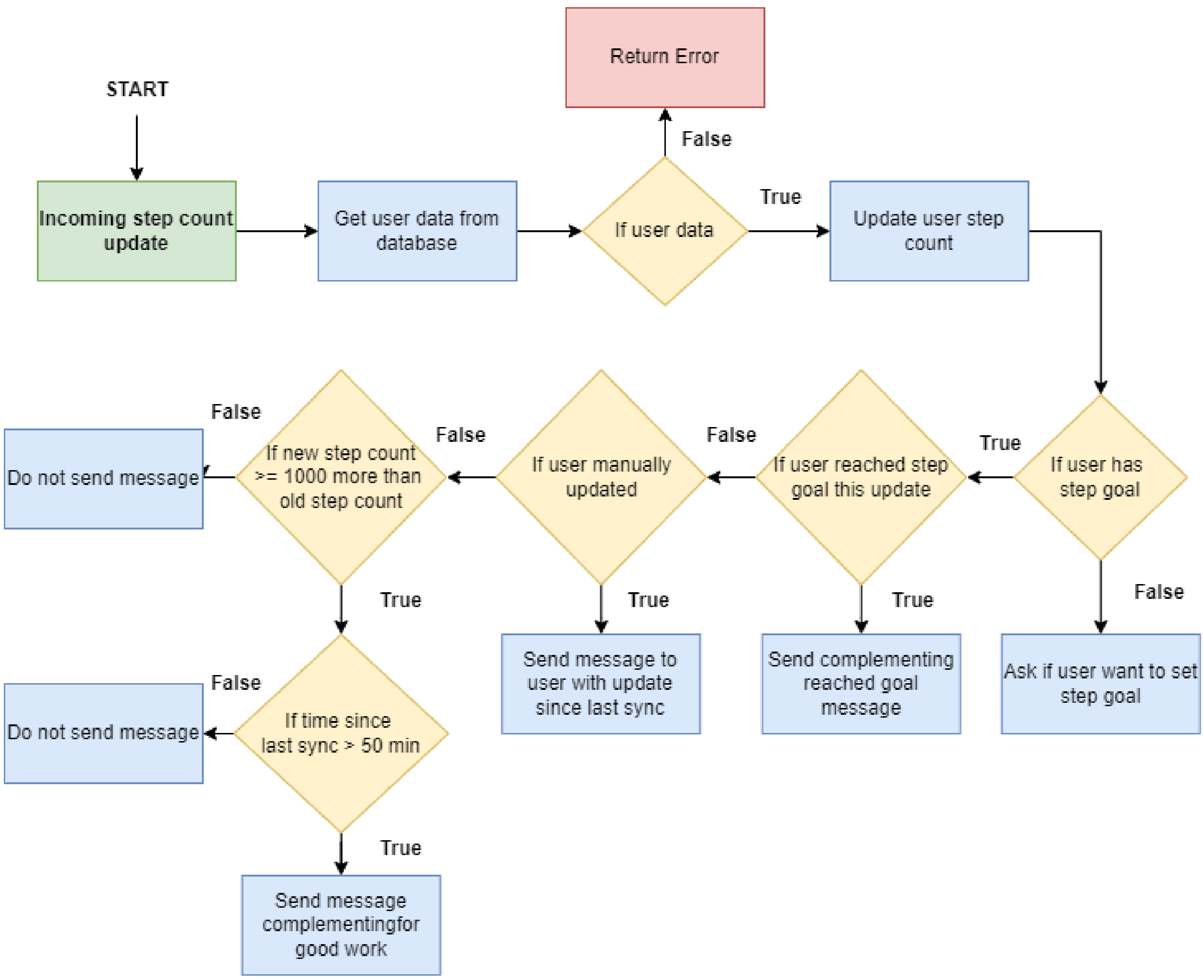

***Figure 22**: Flow chart for incoming PUT /steps request*

Login request

When the user logs in to the AktiMot application, the app sends a request to the server that contains the password that the user got from AktiMotBot in Telegram. Next, the mobile request handler assesses if there are any users in the database with that temporary stored password. If a user is found and has a username, the user is successfully logged in, and the user gets a message in the AktiMotBot verifying that they are logged in. On the other hand, if the user has no username, they receive a message telling them to set a username first. If the user login successfully, the password field in the database is reset, and the temporary password can no longer be used.

Log out request

When the user logs out of the AktiMot app, the server will stop getting hourly updates and should not get a message telling them to go into their app due to inactivity. The user will also receive a message from the AktiMotBot telling the user that they have been logged out and that it will stop receiving update messages. The flow from a log-out request is depicted in **Figure 23**.

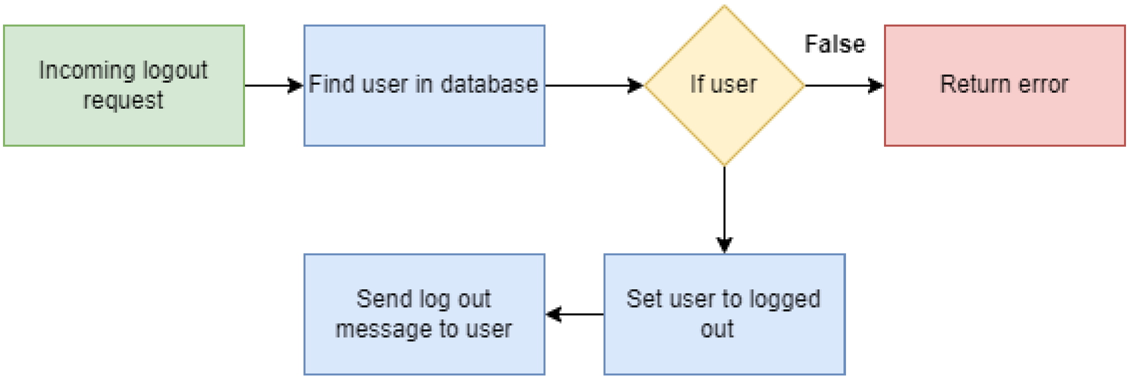

***Figure 23**: Log out request*

Delete request

Lastly, the user can ask the server to delete the data shared from the AktiMot app. The mobile request handler gets a “DELETE /deleteuser” request and deletes the user from the database. After the user is deleted from the database, the user will receive a message in Telegram informing about the deletion and tell the user how they can add themselves again. The flow from a delete request is shown in **Figure 24**.

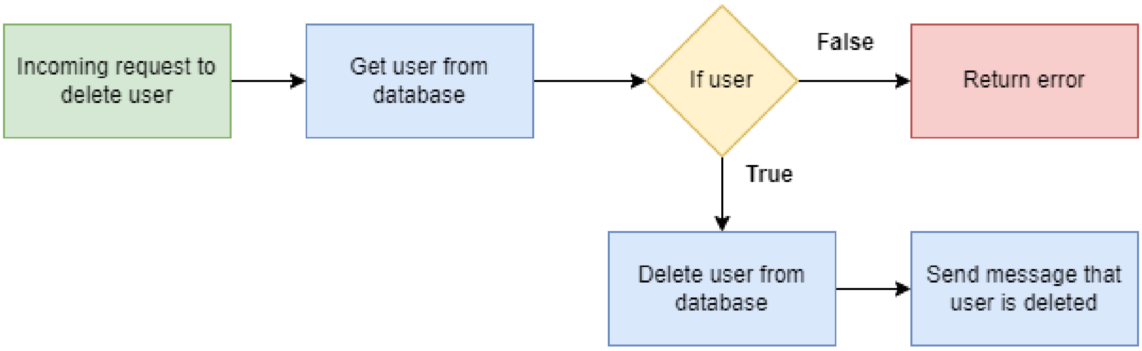

***Figure 24**: Delete request*

6.3.2 Message scheduler

The server has a dedicated thread managing scheduling of morning and evening messages. The scheduler is a thread that is checking the time. The thread is responsible for triggering the chatbot engine to send the morning and evening messages and reset the step count at midnight.

The thread checks if the current time is any of the morning message times between 07 AM and 10 AM, evening message times between 4 PM and 8 PM, or midnight. If the time is either morning message or evening message time, the scheduler invokes the chatbot engine to send messages to the users. The users can choose which time they want to receive the messages in the morning, and therefore the chatbot sends a message only to the users opting to receive the message at the current time. The chatbot engine also checks how long it has been since it received an update from the mobile application and sends an additional message to the user if the step count has not been updated.

Finally, if the current time is midnight, the scheduler is responsible for resetting all the users' step counts and setting the step count for the previous day in the week's history. The flow chart of the scheduler is shown in **Figure 25** below.

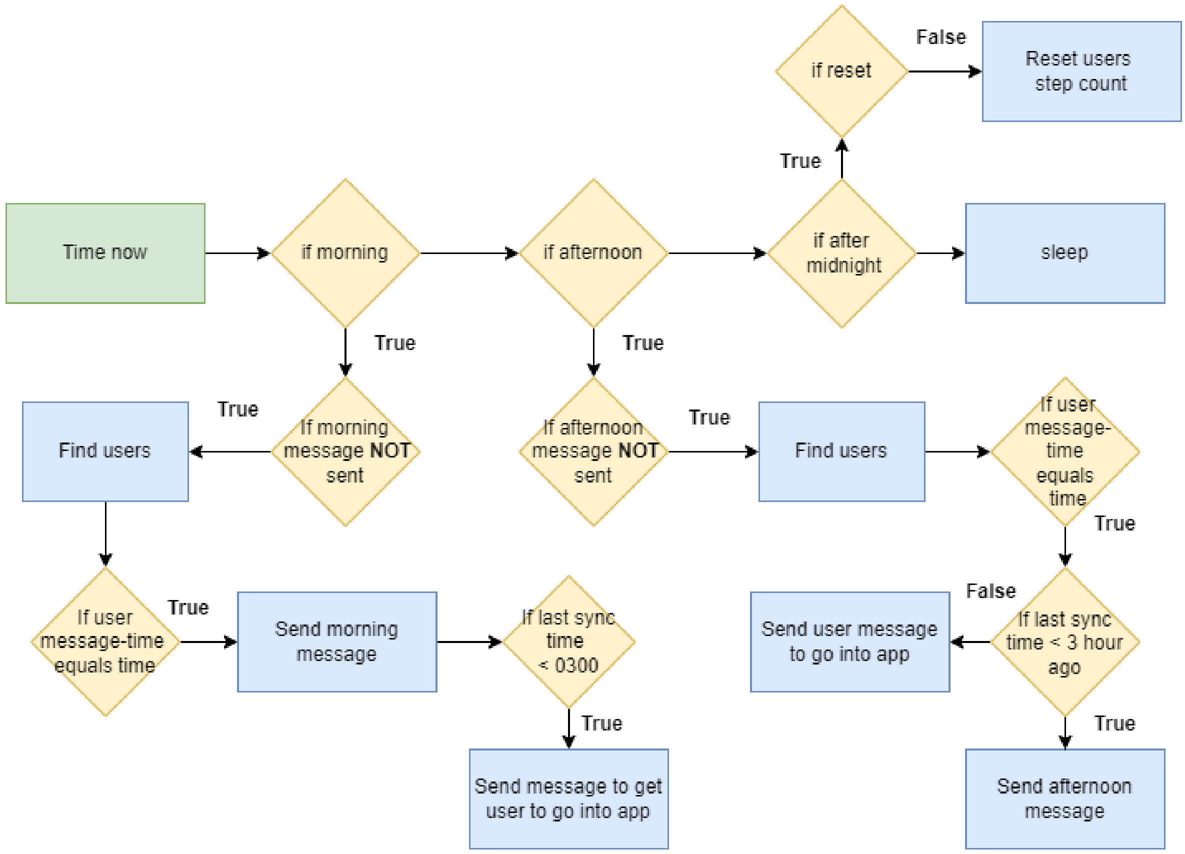

***Figure 25**: Control flow of scheduler*

6.3.3 Chatbot engine

Telegram connection

The chatbot engine uses the library Telebot [76], a Python implementation of the Telegram Bot API [77]. Each request to the Telegram Bot API must be sent over HTTPS, and the path must be formatted as follows: “https://api.telegram.ord/bot<token>/METHOD_NAME”. The token is generated when the bot is created, and you must have the token to be able to fetch or send messages to the bot.

Getting updates

The chatbot must fetch the updates from the Telegram servers. The messages sent to the chatbot from users are stored at the Telegram servers until the chatbot engine fetches the messages. When the chatbot engine fetches the messages, they are deleted from the buffer. Telegram holds messages for 24 hours if the chatbot engine does not fetch them.

The chatbot engine uses long polling to receive new messages instantly. Long polling keeps a connection open between the chatbot engine and the Telegram server. Using long polling makes it possible for the Telegram server to send the message to the chatbot engine as soon as it receives a message.

Sending messages

The standard request for sending messages to the Telegram server is the “Normal” URL shown in **Figure 26**. The chat id variable defines which chat Telegram should forward the message, and the text is the message text. When the formatting option is defined, the “parse_mode” option is added to the request, shown as “Formatted” in **Figure 26**. Finally, if the user should be prompted with a keyboard, the keyboard is added to the request shown as “Keyboard” in **Figure 26**. It is also possible to combine Formatted and Keyboard to format the message and have a keyboard. The request will then include both parse mode and reply markup.

```
Normal:     “https://api.telegram.org/bot<<bot_token>/sendMessage?chat_id={chat_id}&text={text}”
Formatted:  “https://api.telegram.org/bot<<bot_token>/sendMessage?chat_id={chat_id}&text={text}&parse_mode=parse_mode”
Keyboard:   “https://api.telegram.org/bot<<bot_token>/sendMessage?chat_id={chat_id}&text={text}&reply_markup={keybaord}”
```

***Figure 26**: Request format in different situations when sending messages*

The messages sent by the chatbot are sent to the Telegram server, which is then forwarded to the appropriate user based on the conversation id. The user will then receive a notification about a new message in Telegram if they have allowed Telegram to send notifications.

Handling user input

Since the chatbot is rule-based, all input has to be defined in the chatbot for it to be able to understand and act correctly. Therefore, all other user input that does not have any defined rules will be answered with an apologetic message telling the user that the chatbot did not understand. The chatbot engine is stateless and handles input by having programmatically static if-statements.

The chatbot provides the user with keyboards that have different options defined. Therefore, rules for all possible keyboard options must exist to ensure that the chatbot engine has an action for each option it provides the user. In addition, the keyboard options that trigger the same action are reviewed in the same if-statement.

To try to capture free-text events, different lists of words are declared. These lists contain synonyms of a word or other words that could represent the same action. **Figure 27** below shows two examples of lists of words: the theme is “change,” and the other is “greetings”. These lists are used to perform keyword matching to capture the context of a message that does not match the button options. In addition, if the user is currently performing any actions, like changing their goal, they will be added to a list to ensure that the chatbot engine can put the message in the context of the action the user is currently doing. For example, like in **Figure 27**, if the user is deciding on their own step goal, they are added to the list “change_goal_self” such that the chatbot engine understands that the incoming message should be the user's new step goal.

When the chatbot gets input from the user, the chatbot engine will assess the input with predefined rules, as if-statements, like the pseudo-code example in **Figure 27**. For example, “endre – endre mål” is one of the keyphrases defined in the buttons on the keyboard. Furthermore, the lists containing users currently performing an action are checked in the if-statements. If the user is not currently performing any action, keyword matching and keyphrase matching are performed to determine the context of the message. Finally, the action the chatbot engine does depends on the triggered if-statement.

```
change = ["endre", "forandre", "bytte", "forbedre", "redigere", "skifte"]
greetings = ["hallo", "hei", "god morgen","god ettermiddag", "heisann"]
changing_goal_self = []
reporting_additional_acitivty = {}

if input_text == "endre - endre mål" or any word in input_text in change:
        self.handle_change_step_goal()

elif input_text == "hjelp":
    self.respond_help()

elif user_id in reporting_additional_acitivty:
    self.handle_reporting_additional_activity()

elif any word in input_text in greetings:
    self.respond_greeting()

elif user_id in changing_goal_self:
    self.handle_user_decide_goal()

else:
    self.send_do_not_understand_message()
```

***Figure 27**: Pseudo-code for handling user input*

Goal actions

The user can ask for their current step goal, or they can request to change it. When the user requests to change their step goal, the chatbot will assess whether the user has reached their step goal and choose a message that fits the situation. The message the user gets either tells the user about their step goal or compliments them for reaching their goal if they have reached it. If the user has not reached their goal, the message contains the goal, but it could also include the current step count and how many steps remains to reach the goal.

When the users want to change their goal, they can trigger the change goal action through the menu or free-text messages. The chatbot will check if any incoming messages contain a “change” keyword or similar words as part of the rules. When a change goal action is triggered, the user is provided with three options shown to the left in **Figure 28**. The messages from the chatbot are in white, while the user messages are in light green.

If the user chooses to change the goal themselves, the chatbot asks them to input their new goal. As long as the user does not input a number, the chatbot waits for a number, and if the user writes anything else, the chatbot will ask the user to write again. The right part of **Figure 28** depicts the user choosing their own step goal.

***Figure 28**: Change goal action – user chooses*

If the user chooses that the chatbot should suggest a goal, option two on the keyboard in **Figure 28**, the user gets two options: to increase or decrease their goal shown to the left in **Figure 29** below. If the user chooses to reduce or increase, the chatbot will add or subtract 2000 from the old goal and suggest it to the user. When the chatbot has proposed a goal, the user is provided with three options, as shown in the middle of **Figure 29**. If the user accepts the goal, the chatbot responds with a message that fits the situation if the user increases or decreases their goal.

However, suppose the user chooses to increase or decrease the proposed goal. In that case, the chatbot will suggest three new goals where the first option is added or subtracted 500 from the first suggestion, and each suggestion is increased with or decreased by 500 from the previous suggestion, shown to the left in **Figure 29**. The flow of the change goal action with chatbot suggestions and two times increase is shown in **Figure 29**. The same flow happens if the user asks to decrease the goal.

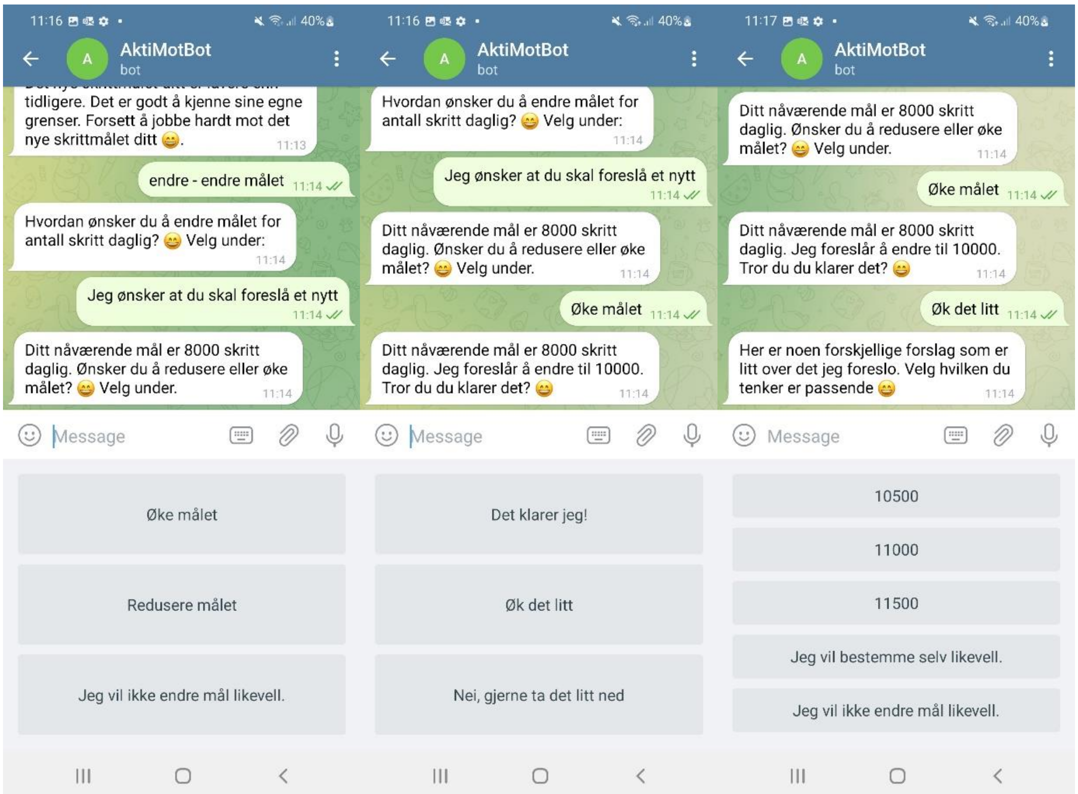

***Figure 29**: Change step goal flow – chatbot suggests the goal*

Change message time action

An action to personalize the chatbot is that the user can choose to change the time they receive a message in the morning and the afternoon. When the user triggers the change message time action, the chatbot will ask which time the user will change. The user can choose between the options shown to the left in **Figure 30**. If the user only selects morning or afternoon, they will be displayed with the possible message times. The middle picture in **Figure 30** shows the user's options when changing the morning message time. If the user chooses afternoon, the same action will be triggered, but the user is presented with different time options. To the right in **Figure 30**, the chatbot informs the user about their new message time.

If the user asks to change both times, they will first choose the morning time followed by the afternoon.

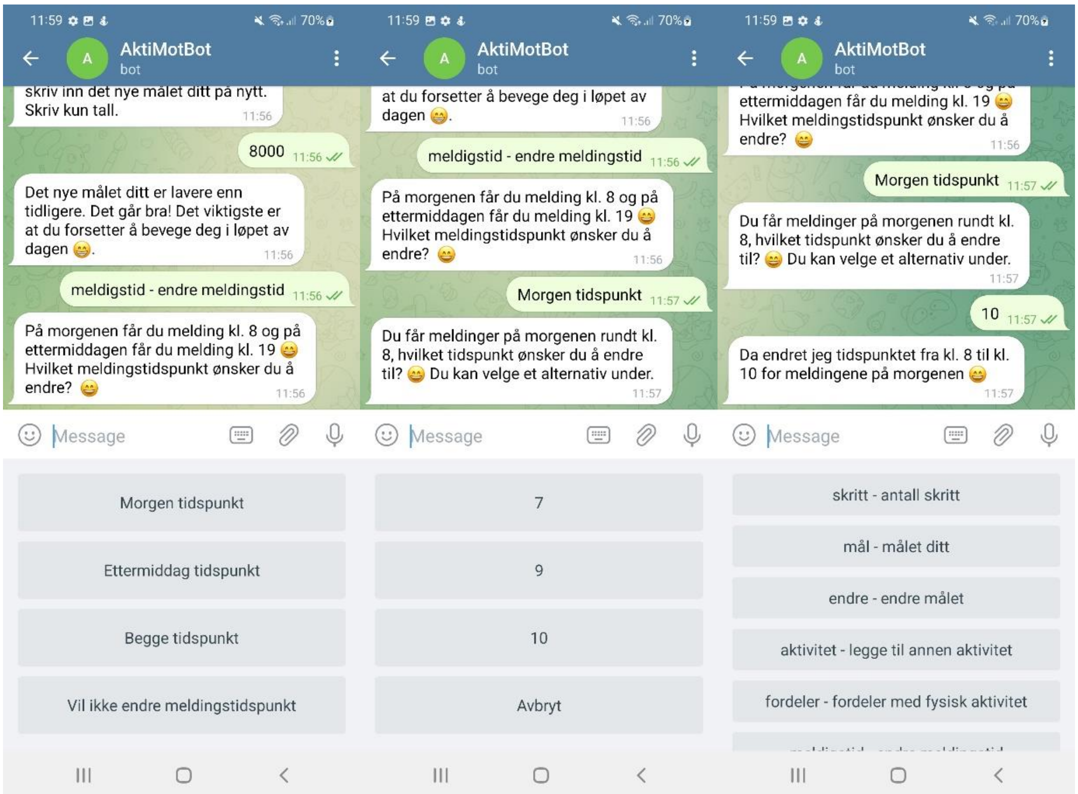

***Figure 30**: Change message time action flow*

Step action

The user can request their current step count by selecting from the menu or trying to write free text. The chatbot will check if the user has reached their step goal or not and respond with a randomly picked message depending on their goal progress.

Activity actions

Since the implemented mobile application only gets the steps reported by the mobile phone, the users can add additional steps or inform about other physical activities they have performed throughout the day. The users can trigger the activity action through the menu or free text. The user can, for example, write “jogged 20 min”, “squash 30 min”, “Walked 2000 steps,” or “I have played tennis” to the chatbot. If the user triggers the action through the menu, the user gets options to add steps or other activities.

If the user chooses the action from the menu, they have three options, as shown to the left in **Figure 31**. First, if the user decides to add steps, the chatbot asks the user to write the number of steps, and then the chatbot asks the user if they want to add those steps to their step count, as shown to the right in **Figure 31**.

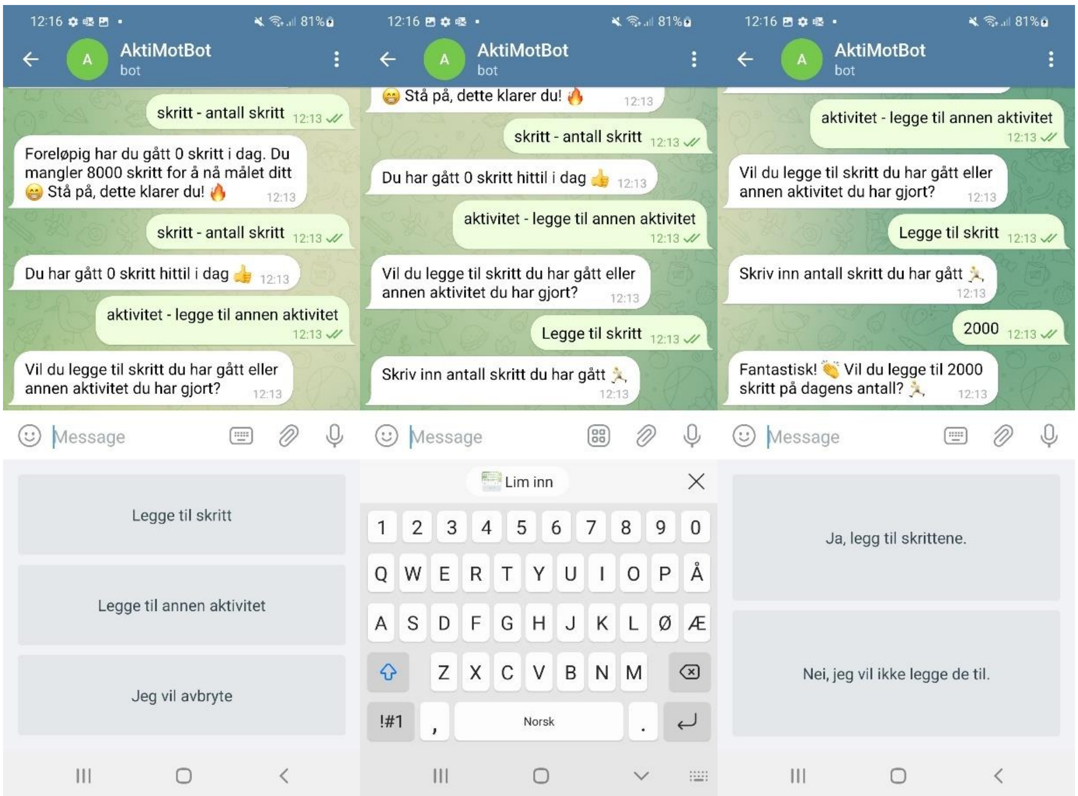

***Figure 31**: Activity action flow - add steps*

Further, if the user chooses to add another activity, the chatbot will tell the user to write the activity followed by the duration and give some examples, as shown to the left in **Figure 32**. The user writes their activity, and the chatbot asks the user if it is the correct activity and duration, also shown to the left in **Figure 32**. The chatbot engine will only recognize activities defined in the list of activities. If the user writes an activity not defined in the chatbot engine, it will not recognize it and keep asking the user which activity they have performed. If the user says that it is correct, the chatbot will tell the user how the conversion from activity to steps is done and ask the user if they want to add them, as shown in the middle picture in **Figure 32**. To the right in **Figure 32**, the chatbot tells them that they reached their step goal and their total step goal.

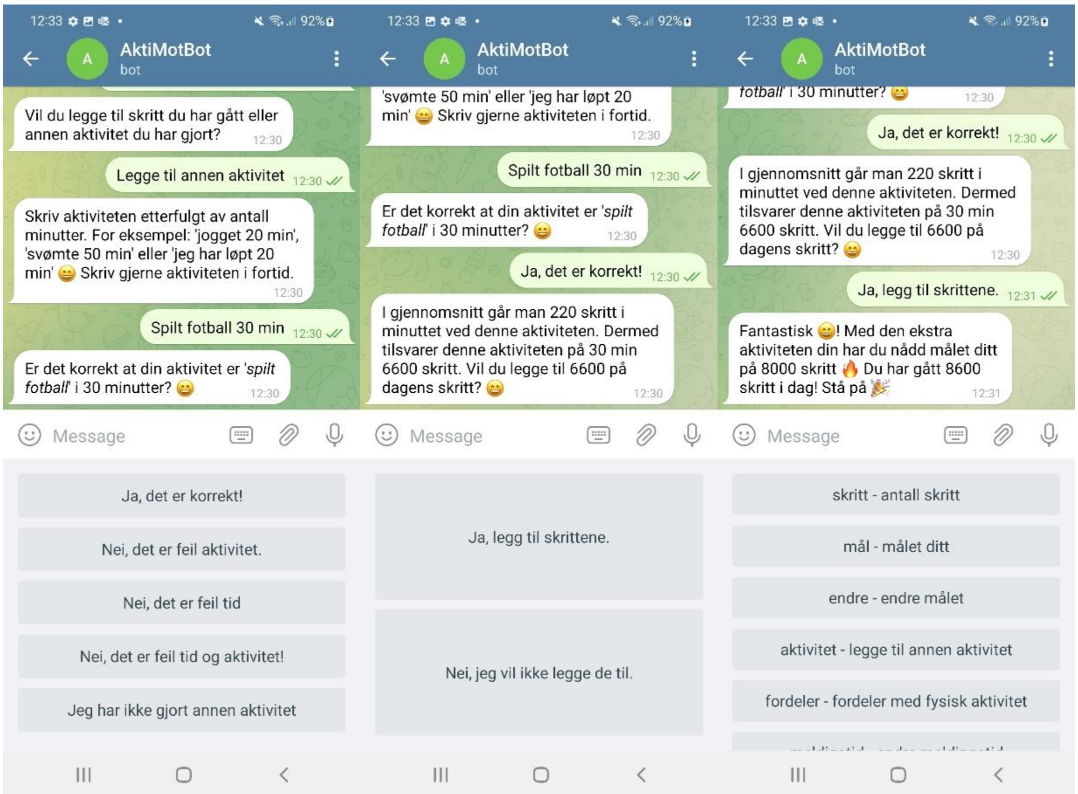

***Figure 32**: Activity action flow - add activity*

A list of activities in different word inflections is defined in the chatbot engine. If the input text contains any activities from the list, the chatbot asks the user if they have performed the detected activity and the time. If the user only provides an activity and not the duration of that activity, the chatbot will ask the user about the duration of the action. If the chatbot does not understand the activity or time, it asks the user to try again.

Figure 33 shows three different free text options that the chatbot detects. For example, to the left, the user tells the chatbot that they have jogged for 30 minutes, and the chatbot recognizes it as an activity and asks the user to verify it. In the middle, the user requests to add 3000 steps, and to the right, the user asks to add 2000 steps, which the chatbot recognizes as add steps activity.

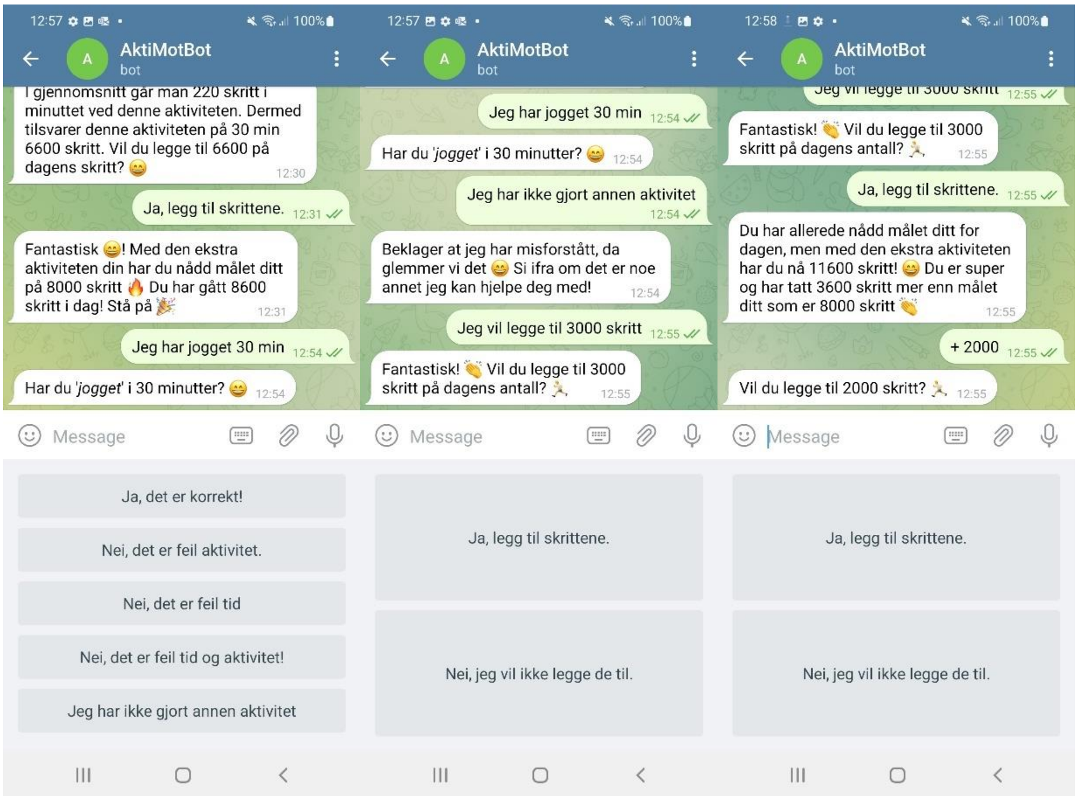

***Figure 33**: Free text input to add steps and activity*

Step conversion

A step conversion chart made by Health Enhancement Systems[78] has been used to convert the activities and duration into steps. The steps and or minutes in the chart are estimates and not actual steps. The number of steps depends on the activity, how intense the activity was, the length of the person's leg, and fitness level [78]. Health Enhancement Systems has also added the conversion for non-step activities, and then they use intensity to give an estimate on steps. The chatbot does not ask the user about the intensity of the activity. If the chart has defined various intensity levels for an activity, only one intensity level was selected to be utilized by the chatbot.

Password action

The user must get a password from the chatbot to log in to the mobile application. When the user requests a password, either through the command in the menu or by writing "password", the chatbot engine generates a random 5-digit number. This five-digit number is temporarily stored in the database connected to the user and sent to the user. The rest of the login flow was described above in Login Request in Section 6.3.1.

Benefit action

When the user triggers the benefit action, the chatbot engine randomly chooses one of the messages defined in a list of messages for physical activity benefits. Therefore, the user will most likely get a different benefit in the following message. Still, we do not entirely remove the possibility of sending the same message with only a few messages.

7 Results

7.1 Questionnaire findings

The results from the questionnaire used in the usability study are presented in the following sections. In addition, a graphical representation of each question can be found in Appendix VII Graphical representation of questionnaire findings.

Twelve people participated in the usability study and answered the questionnaire. An equal number of men and women participated in the study. Further, 16.7% (2/12) were in the age group 18-25 years, an equal number were in the age group 26-35 years, and most participants, 66.6% (8/12), were in the age group 36-45.

The distribution of participants' physical activity behavior is shown in **Figure 34**. Two of the participants (18.2%) had sedentary behavior. Half of the participants, 50% (6/12), were somewhat active, while 4/12 (31.8%) were active to very active.

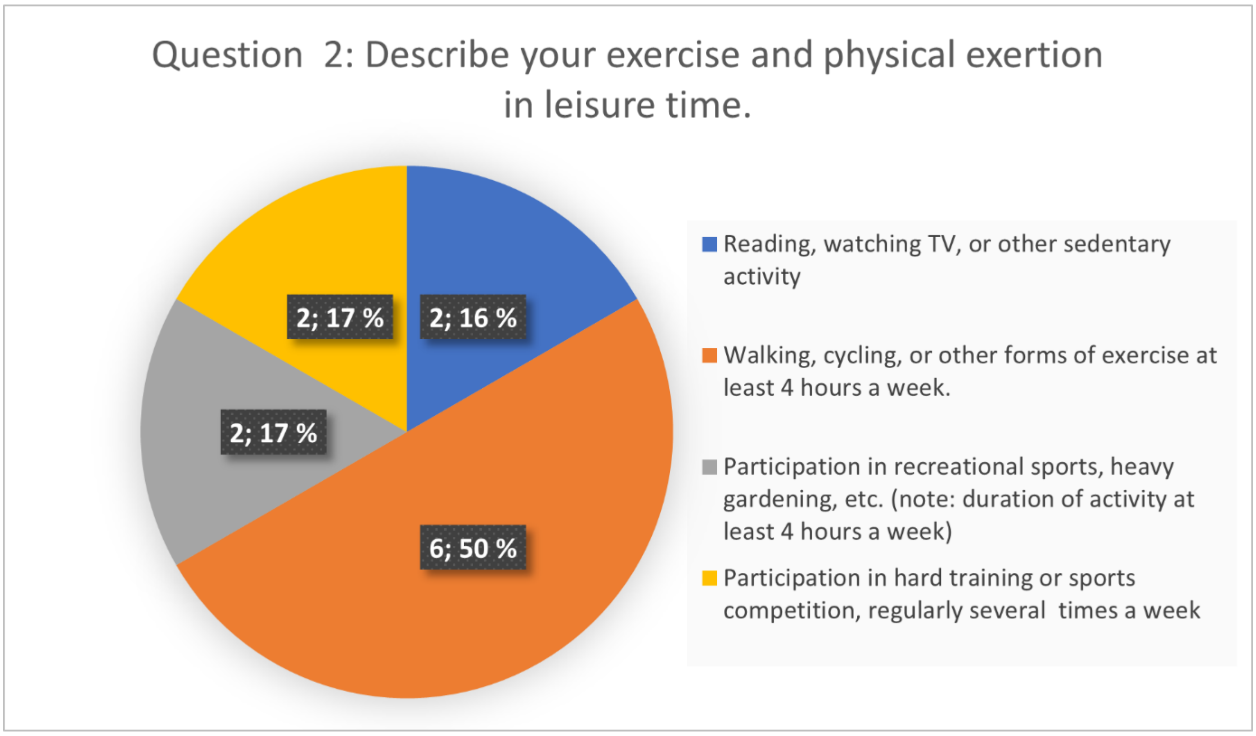

***Figure 34**: Results from question 2*

7.1.1 Chatbot Usability Questionnaire scores

Figure 35 depicts the aggregated results for each statement in the chatbot usability questionnaire (CUQ) used in the questionnaire provided to the participants. Each column represents a statement, and each color in the column represents the answer from one participant. The column with odd statement numbers represents statements about the positive features of the chatbot, while the columns with even statement numbers represent statements about the negative features of the chatbot.

Statement 1, statement 3, and statement 5 received high scores, which means that people perceived the chatbot’s personality as realistic and engaging, welcoming during setup, and explained its scope and purpose well. The positive feature statements were highly rated, but the statement “the chatbot coped well with errors or mistakes” received a relatively low rating.

The negative features all have lower ratings compared with the positive ones. The negative features that most participants agreed with were statement 2, statement 8, statement 10, and statement 16. The participants perceived the chatbot as robotic. In addition, they felt it would be easy to get confused when using the chatbot and that the chatbot failed to recognize a lot of their inputs. Finally, the chatbot was very complex.

Figure 36 shows the total CUQ scores per participant. The highest score was 87.5, while the lowest was 42.2. The mean score was 68.4 (standard deviation = 13), and the median score was 69.5.

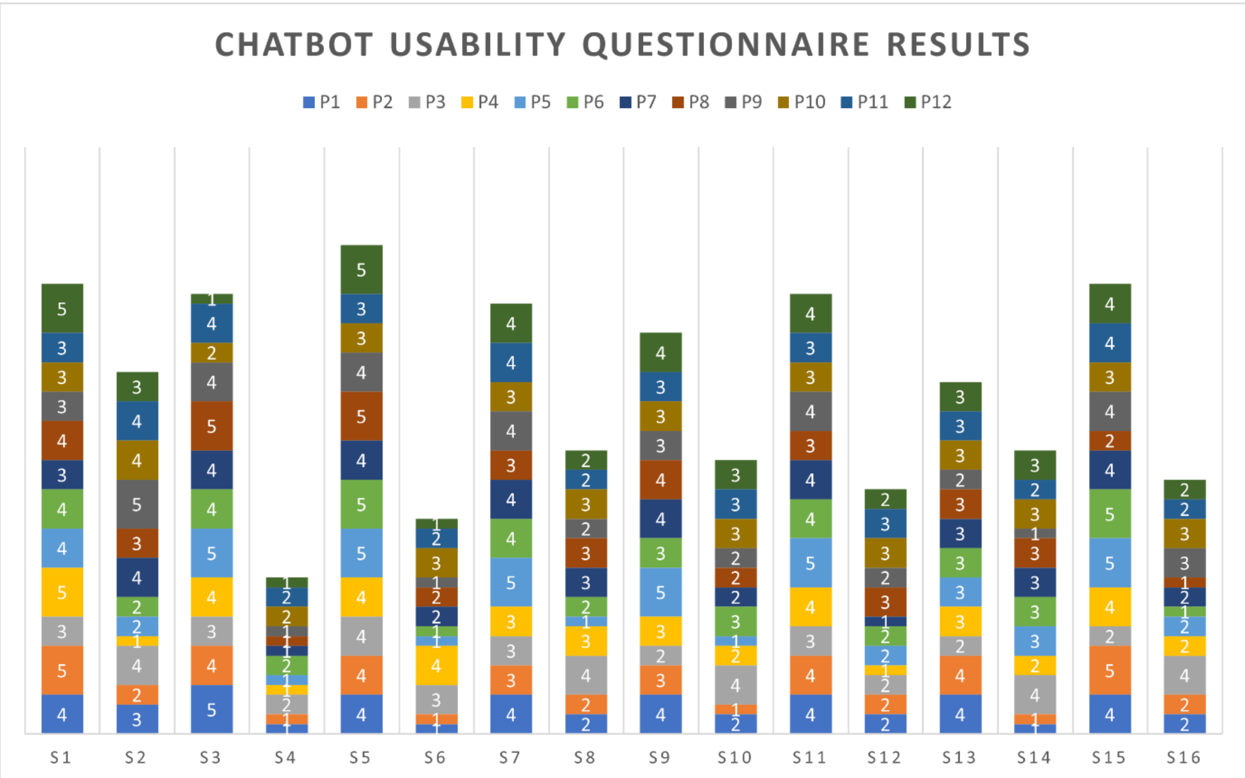

***Figure 35**: Aggregated results for CUQ per participant*

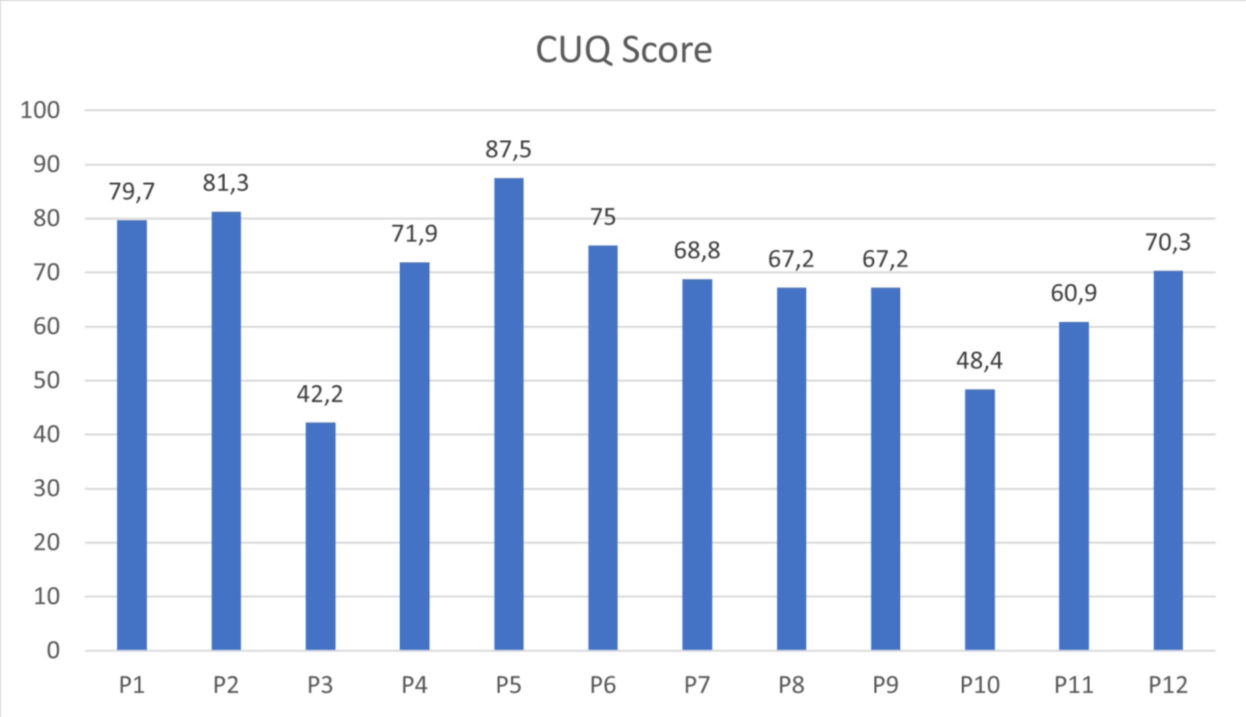

***Figure 36**: Chatbot usability questionnaire scores per participant*

7.1.2 Chatbot

Approximately 58.3% (7/12) said they would **maybe recommend** the chatbot to friends or family, while two participants (2/12; 16.7%) said they **would recommend** it to friends or family. Three of the participants (3/12; 25%) said they would **not recommend** the chatbot to friends or family.

Some participants (5/12; 41.7%) stopped using the chatbot before the end of the testing period of one week. **Table 7** lists the feedback from the participants on why they stopped using the chatbot before the end of the testing period. The original feedback and a translated version into English are in the table. Three of the five participants stopped using the chatbot due to inaccurate step count or because it did not work.

One participant felt like the chatbot was pushy and that it had enough notifications from other social media applications and preferred using their activity watch for daily activity. Finally, one participant did not feel like they needed this kind of follow-up.

Table 7: Statements from participants as to why they stopped using the chatbot before the end of the testing period of one week

NR	Feedback in Norwegian (original)	Feedback translated into English
1	"Den er ikke akkurat på skrittene mine"	"It does not count my steps accurately."
2	"Opplever det som litt "masete" å ha en slik app installert på mobilen. Har nok med å henge med på all annen aktivitet på mobilen (mail, sosiale medier, sms, m.m.). Foretrekker heller å benytte meg av aktivitetsklokken min til trening/daglig aktivitet (Garmin)"	"Experienced it as a bit pushy to have such an app installed on the phone. I have enough to keep up with all other activities on the phone (email, social media, SMS, etc.). I prefer to use my activity watch for training/daily activity (Garmin)."
3	"Fungerer ikke" and "Virker ikke."	"It does not work."
4	"Trenger ikke denne oppfølgingen."	"Do not need this follow-up."

Figure 37 shows the results from question 5, "Do you think the number of messages the chatbot sent per day was appropriate?". Half of the participants (6/12; 50%) would reduce the number of messages per day. About 41.7% of the participants (5/12) thought the number of messages was appropriate. Only one of the participants (1/12; 8.3%) would increase the number of messages per day.

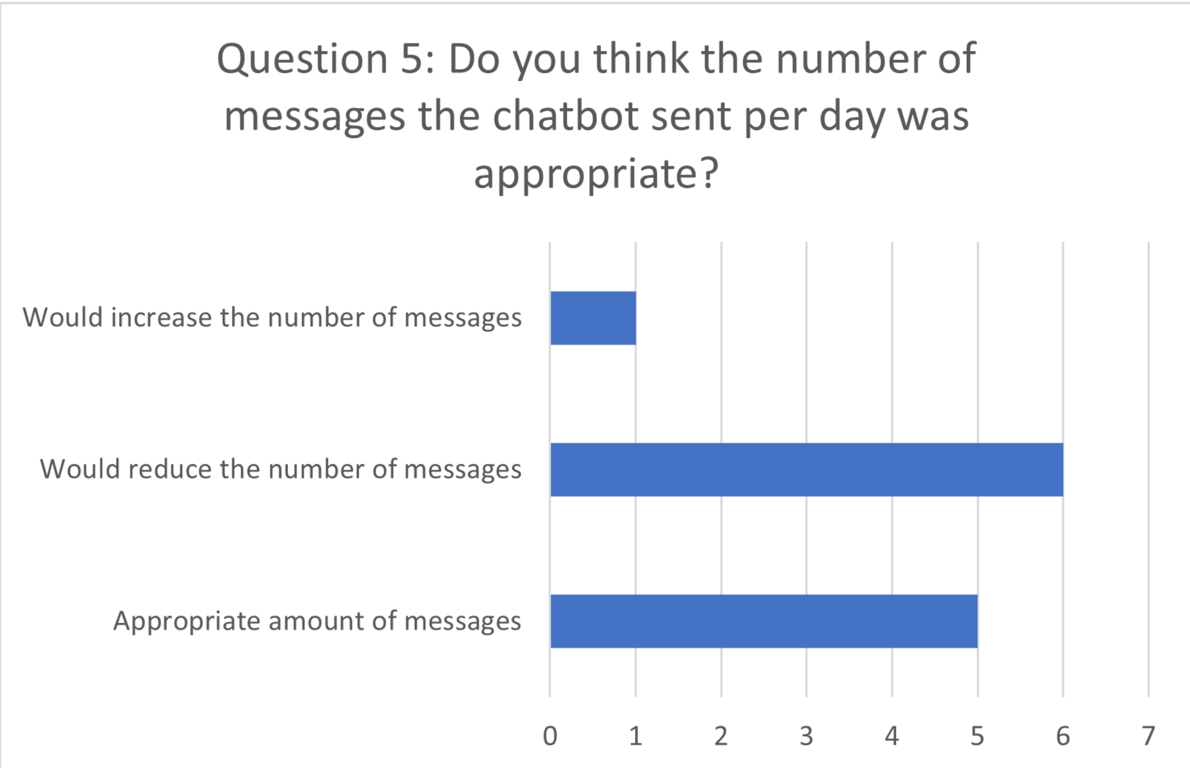

***Figure 37**: Results from question 5*

7.1.3 Physical activity and motivation

For question 6: “Were you more aware of your daily steps when you used the chatbot than before using the chatbot?”, 66.7% (8/12) of the participants answered that they were more aware of their step count after using the chatbot, while for 33.3% (4/12) of the participants, it did not make a difference. Further, 50% (6/12) of the participants reported that they felt increased motivation when using the chatbot.

The questionnaire asked participants to elaborate on how and why the system influenced their motivation. **Table 8** below lists the feedback on how the participants felt the system influenced their motivation. The three first statements describe why they felt increased motivation, while the last two are why they did not feel increased motivation.

One of the participants said that they got increased motivation by the chatbot informing them how many steps they lacked to reach their goal. Further, one participant reported increased competitive instincts and a wish to reach their goal, and one was more aware of their daily steps.

One of the participants who did not feel increased motivation reasoned that they were already active before using the chatbot. Further, one participant said they got decreased motivation since they got the wrong step count at the end of the day even though they had reached their step goal.

***Table 8**: Statements from some participants on how the system influenced their motivation.*

NR	Feedback in Norwegian (Original)	Feedback translated into English
1	“Økt motivasjon kom som regel etter chatbotten informerte om skritt ift. dagens mål hvor jeg ville nå målet mitt.”	“Usually got increased motivation after the chatbot informed me about steps in relation to today’s goal where I wanted to reach my goal.”
2	“Opplevde økt motivasjon til en viss grad. Får nok litt mer konkuranseinstinkt og et ønske om å nå sine daglige mål for antall skritt. Men over tid ville jeg foretrukket sportsklokke …”	“Experienced some degree of increased motivation. I probably get a litte more competitive and get a desire to reach the daily goal for the number of steps. But over time, I would prefer a sports watch….”

3	“Hadde et større forhold til mine daglige skritt.”	“Was more aware of my daily steps.”
4	“Jeg ble umotivert fordi jeg jobbet hardt og fikk feil tall på slutten av dagen selv om jeg hadde nådd antall skritt for dagen.”	“I was not motivated because I worked hard and got the wrong numbers at the end of the day, even though I had reached the number of steps for the day.”
5	“Jeg var allerede aktiv før jeg brukte chatbot.”	“I was already active before using the chatbot.”

Figure 38 shows the results for question 8: "Were you happy/motivated by the positive feedback from the chatbot if you reached your goal?". Most of the participants (7/12; 58.3%) enjoyed the positive feedback from the chatbot. However, 16.7% (2/12) of the participants did not get the message because they did not reach the goal and 25% (3/12) were not motivated or happy when getting feedback from the chatbot.

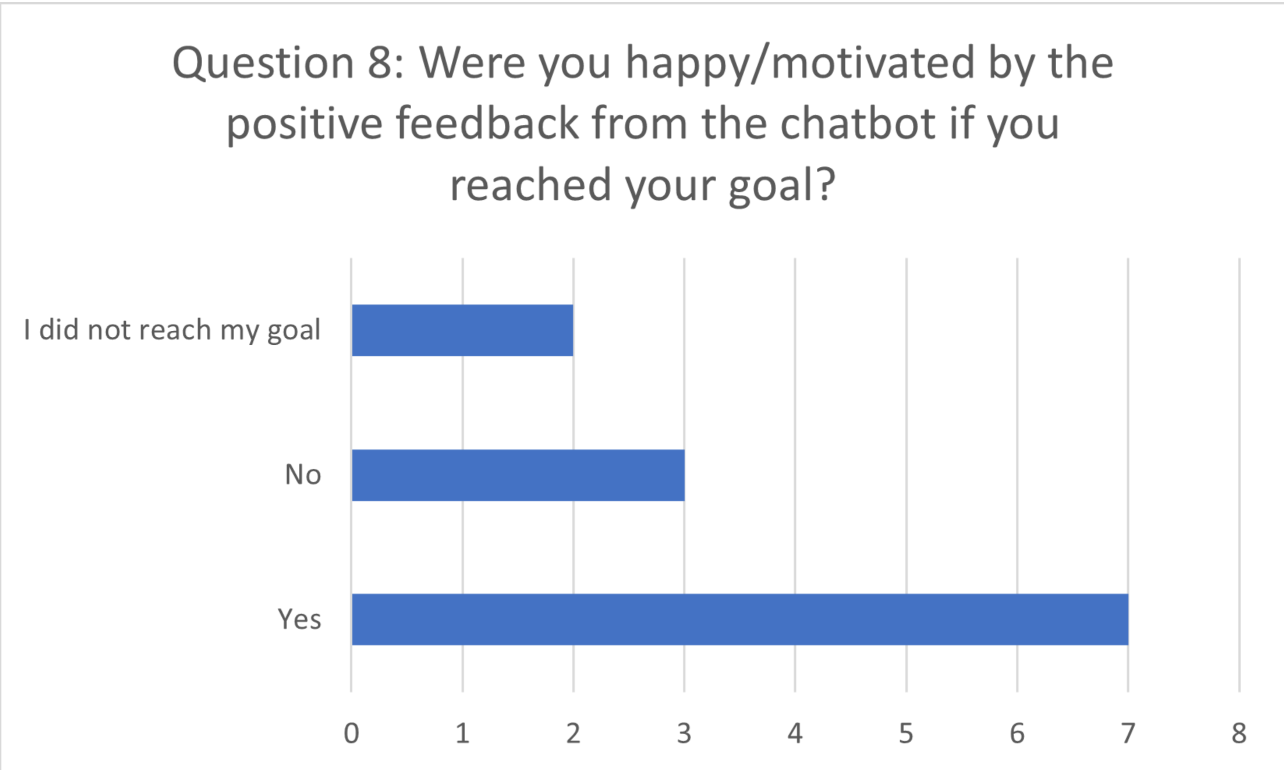

***Figure 38**: The results from question 8*

Only 33.3% (4/12) of the participants reported that they made additional effort to reach their step goal based on the afternoon message from the chatbot. The rest (8/12; 66.7%) did not do anything extra to reach their goal.

7.1.4 Other feedback

At the end of the survey, it asked the participants for suggestions for improvement or other feedback. **Table 9** lists other feedback and suggestions for improvements from the participants.

Most of the participants mentioned the problems with the AktiMot application. For example, it did not automatically update the chatbot, it had an inaccurate step count, and the participants had to update manually. Further, one participant mentioned that they could not carry their phone at work, and therefore it did not count the steps. Finally, one participant reported that smiley emojis looked like laughter emojis, and thereby it felt like the chatbot "laughed" at the user when they did not reach their goal.

Some of the suggestions from the participants were that the chatbot could extract physical activity data from, for example, Fitbit to detect other activity instead of reporting it themselves. Another suggestion was to make it possible for the user to write free-text and use emojis. Further, one suggested that the chatbot gives the user challenges and rewards. In addition, it should either be the AkitMot app that sends notifications to update or make it possible to open the application from a Telegram message.

***Table 9**: Other feedback and suggestions for improvement from participants in the usability study*

NR	Feedback in Norwegian (original)	Feedback translated into English
1	"Var litt tungt å selv måtte sende inn data siden appen ikke gjorde det av seg selv. Var også veldig begrenset bruk av å selv legge inn økter (squash, løping, etc.) Hadde vært veldig bra om appen kunne hente inn data fra aktivitetsmålere (Fitbit, Apple Watch, etc) for å automatisere den siste biten."	"It was a bit demanding to submit data since the app did not do it by itself. There was also minimal use of entering additional activities yourself (squash, running, etc.) It would have been very good if the app could retrieve data from other activity trackers (Fitbit, Apple Watch, etc.) to automate the last bit. "
2	"Den må være nøyere på å telle skritt"	"It must be more accurate in counting steps."

3	“Mye trøbbel med kobling mellom Telegram og den andre appen (overføring av skritt)”	“A lot of trouble with the link between Telegram and the other app (step transfer)”
4	“Bør være lett å installere.”	“It should be easy to install.”
5	“Bot klarte ikke å oppdatere skritteller. Måtte oppdatere bot manuelt fra app for at skritt skulle registreres.”	“Bot failed to update step counter. Had to update the bot manually from the app for steps to be registered.”
6	“Kanskje mulighet til å skrive fritekst og bruke emojis. Ha også en utfordring og belønning etter å ha fullført utfordringen. Fordelene med fysisk aktivtet var veldig fine å ha.”	“Maybe the ability to write free text and use emojis. Also, have a challenge and reward after completing the challenge. The benefits of physical activity were very nice to have.”
7	“Mulighet for å åpne AktiMot fra meldinga som kommer fra varslet. (enten via Telegram eller at AktiMot sender varselet)”	“Possibility to open AktiMot from the message in the notification (either via telegram or that AktiMot sends the notification.”
8	“Tungvint når chatbotten ikke snakket med Samsung Health el lign., ikke alltid det er praktisk å bære telefon med seg i handa for å registrere skritt, ofte klær uten lomme. Har en jobb der jeg går mye men ikke har anledning å bære telefon med meg i handa/lomma. Så mye av skrittene ble ikke registrert av den”	“Difficult when the chatbot is not communicating with Samsung Health etc., it is not always practical to carry a phone in your hand to register steps, often clothes without a pocket. Have a job where I walk a lot but do not have the opportunity to carry a phone with me in my hand/pocket. So many of the steps were not registered by it.”
9	“Smileyene så ut som latteremoji på min telefon, så det så ut som det var gøy at det gikk dårlig. Føltes som: «Du nådde ikke målet ditt :D HAHAHA»”	“The smiley emojis looked like laughter emojis on my phone, so it looked like it was fun that it went badly. It felt like: "You did not reach your goal: D HAHAHA.”

8 Discussion

8.1 Results summary

The results from the usability study showed that the chatbot was able to increase the motivation of half of the participants. Further, over half of the participants were more aware of their step count while using the chatbot than before using it. In addition, the usability of the chatbot was scored to be average. This chapter will discuss the questionnaire findings, research problems, and design remarks.

8.2 Questionnaire findings and design remarks

Throughout the usability study, potential users used the system in their daily lives and reported their experience, possible improvements, and desired functionality.

8.2.1 Chatbot Usability Questionnaire

The AktiMotBot’s mean CUQ score was 68.4, almost equal to the SUS benchmark of 68 [48]. A score around the benchmark implies that the chatbot's usability is average. A CUQ score of 68 gives the chatbot the grade ‘C’. The average score shows that the chatbot's non-functional requirement “Usability” is achieved but should be further improved. The CUQ has not been used for as long as the SUS to assess the usability of a system. Most usability studies have used the SUS, but CUQ is comparable with SUS scores.

The AktiMotBot’s usability can be considered better than Ida [16], with a mean SUS score of 61.6. However, AktiMotBot scores less than *WeightMentor* [2], a self-help motivational tool for weight loss maintenance (mean CUQ 76.2) and a chatbot to prevent depression (mean SUS approx. 75.7) [79].

The technical problems with the AktiMot app could have had a negative impact on the results. To et al. [16] also mentioned that some technical issues with chatbot Ida could have reduced the usability. The technical issues were that the chatbot stopped sending daily notifications and technical problems with their source of activity data.

Although the SUS benchmark is 68, Lewis and Sauro [48] noted that companies aim to achieve a SUS score of 80 as evidence of an above-average user experience for industrial chatbots.

Positive and negative features

The aggregated results from the chatbot usability questionnaire (CUQ) show that the positive features had a higher rating than the negative features. However, the rating for the negative features was higher than expected.

In general, the results show that the participants perceived the chatbot’s personality as realistic and engaging. However, a lot of participants reported that the chatbot seemed too robotic. A possible explanation for this could be that the chatbot had repetitive behavior and a lack of conversation themes.

Larbi et al. [12] performed a usability study of MYA, a chatbot developed with the same purpose as AktiMotBot, and their survey also included the CUQ. The most valued features of their chatbot were that it was welcoming during the initial setup, easy to use, and had a realistic personality. Our results showed that the top two most valued features of AktiMotBot were the same: it was welcoming during the initial setup and had a realistic personality. This result also shows that the non-functional requirement “Chatbot Personality” was fulfilled.

The top three negative features of AktiMotBot were the same as MYA, although not in the same order [12]. The most highly rated negative features reported by Larbi et al. [12] were that the chatbot failed to recognize a lot of the user inputs, it would be easy to get confused when using the chatbot, and the chatbot seemed too robotic.

Conversation flows

The chatbot can handle some user-generated input, but it is minimal and only in the context of the implemented features. Further, the chatbot can not handle typos, dialects, or slang. The chatbot does not initiate conversations that expect user-generated input in response.

A lot of the participants rated many statements as 3 – neutrally. These statements required that the participant had spent some time communicating with the chatbot to form an opinion. Since many people answered neutral, one could assume that they did not spend a lot of time interacting with the chatbot and testing the features. For example, 8 participants chose neutral when asked if the chatbot coped well with errors or mistakes. In addition, 6 of the participants chose neutral in response to the statement that the chatbot seemed unable to handle any errors.

The lack of the chatbot initiating conversation could be the reason for the lack of participants' continuous interaction with the chatbot. In addition, the limited conversation potential could make it more challenging to establish a connection between the user and the chatbot. For example, the chatbot can not ask the user how their day was and respond according to the user's answer.

A design choice made was giving the user buttons to give input. Providing the user with buttons instead of the keyboard was done to ease the use of the chatbot. It is easier for the user to use buttons in the beginning to understand how the chatbot works. In addition, the button menu contains all features in the chatbot such that the user does not have to remember them. Ideally, the menu keyboard should have been set as the default keyboard, but this was not possible in Telegram.

Reducing the user-generated input by displaying buttons prevent situations where the chatbot does not understand or misinterpret the user input. As a result, the user may not detect the limited conversation flows and may not get as many apologetic messages from the chatbot. Incorrectly interpreting or misunderstanding the user's input decreases the system's usability [2].

One way to increase the chance of continuous use is to have the chatbot initiate conversations in the start phase. In the beginning, the user does not know how to use the chatbot and to which extent it can have a conversation. If the chatbot initiates conversations with the users, they will learn how to use it, increasing the probability of continuous use and incorporating it into their routines.

Since the development phase was short, the focus was on implementing the most critical features, the basis of "must-have" functionalities in the system. However, Holmes et al. [2] state that poorly designed conversation flows in chatbots reduce the system's usability. Therefore, to increase the usability of AktiMotBot, more time should be invested in implementing more conversation flows and allowing and understanding more user-generated input.

8.2.2 The chatbot's effect

Half of the participants reported increased motivation while using the chatbot. The reasons given by some of the participants who did not feel motivated can be addressed, like reduced motivation due to incorrect steps or automatically updated step count. The system is intended for people who could benefit from external support to become more physically active. Therefore, sufficiently active people might not need this support.

The chatbot was able to increase the motivation of half of the participants. Still, it could not influence the users to make additional effort to reach their step goal after receiving the afternoon message. The afternoon message is intended to remind the users about their progress and motivate them to achieve their goals in the evening. In the absence of updated step counts, the afternoon message was replaced by a message asking the user to update the server manually. The choice to replace the afternoon message with an update message and not send both was to reduce the number of messages the user got simultaneously. If the chatbot sends too many messages simultaneously, the user might not read them all, losing motivation.

If the system had the correct step count, sent complimenting messages, and reported the accurate step count to the users, they may have increased their effort to reach their step goal. On the other hand, if the user experienced the wrong step count from the beginning and never got the social reward, they may not get increased motivation. Furthermore, it could be frustrating not to receive recognition for reaching the step goal and that the chatbot reported the wrong step count.

Despite the problems with the incorrect activity data, the results show that the chatbot managed to increase the motivation of half of the participants. In addition, more than half of the participants said they were more aware of their step count when using the chatbot than before. Even though users may not have been motivated, the system raised awareness of their step count. One of the paths to behavior change includes raising awareness of one's behavior, which could lead to self-reflection and behavior change [15]. From this, we could argue that the system has the potential to at least raise awareness of the user's physical activity behavior.

The fact that the system was able to get the users to be more aware of their step count shows that these kinds of systems have the potential to motivate people or at least make them more aware of their behavior.

Most users said that they would maybe recommend the system to their friends or family, despite the additional user effort and incorrect step count. If the problem with extracting users' physical activity data were fixed, it could make it more likely for people to recommend the system.

Other chatbots have shown promising results in getting users to increase their physical activity levels. For example, a study with Healthy Lifestyle Coaching Chatbot (HLCC), a chatbot developed to motivate people to change their stair climbing habits by choosing to use the stairs more, showed that they effectively changed users' stair climbing behavior of the users [14]. In addition, the results from a study with Paola, a chatbot to increase physical activity and diet, showed that the participants increased their physical activity by one hour a week after six weeks [9].

8.2.3 Message count

The capstone project questionnaire results in autumn 2021[8] showed that the participants wanted less than one or one message per day from the chatbot. The implemented chatbot, AktiMotBot, was initially designed to send at most three messages a day. The developed system differed from the findings in the questionnaire because we realized that to test the system and its effects, the user needed to receive at least two messages a day; once in the morning and one if they reached their goal or in the afternoon.

Most participants that received complementing messages enjoyed or were motivated by them. Almost half of the participants reported that they thought the number of messages was appropriate, while half wanted to reduce the number of messages. Only one participant would increase it. Due to the irregular update, the chatbot had to send at least one additional message to the user. Each time the user manually updated the server, they would get another message. If the user expects only two messages, getting three or four messages could have been overwhelming. In addition, if two messages are received simultaneously with different themes, it may be challenging to understand the theme of both. The extra message they got to start the AktiMot app again could have been irritating.

The participants who tested WeightMentor [80] also emphasized the importance of a chatbot that is not pushy and has minimal interactions.

8.2.4 Choice of social media application

The motivation for integrating the chatbot into a social media application was to take advantage of its popularity. People spend a lot of time daily on these applications messaging friends, family, or others, and the applications are incorporated into people's daily routines. Therefore, the chatbot is easily accessible through a social media application, and users are not forced to download new applications. Moreover, since social media applications are continuously used and have many users, the chatbot can easier reach out to a big part of the population.

Although social media applications are beneficial, it is also vital that vi preserve the users' privacy and ensure that data processing is done securely. Therefore, as presented in Section 5.2, Telegram was chosen to maintain users' security and privacy.

When we preserved the user's privacy and security, the primary motivation for using a social media application, the popularity aspect, was sacrificed. To access the chatbot, the user must install yet another application that sends notifications and demands attention.

Both the chatbots Ida [16] and WeightMentor [80] used Facebook Messenger as an interface due to its popularity. However, neither the study with Ida [16] nor WeightMentor [80] discusses the privacy concerns with Facebook Messenger. Facebook Messenger was the ideal messaging application for this chatbot based on popularity but was eliminated as an option due to security and privacy.

One of the participants noted that the application seemed pushy and that they already had enough to keep up with their social media, email, and SMS (**Table 7** feedback nr. 2). This feedback shows that the user perceived AktiMotBot as an additional app that was quite pushy, especially with a lot of information on the phone, like other social media. If the chatbot had been integrated into one of the user's existing social media platforms, they could have felt less burden.

The Healthy Lifestyle Coaching Chatbot (HLCC) was integrated into KakaoTalk, Korea's most popular social media platform. This study highlighted the benefit of using a popular social media platform to minimize user effort and help provide motivation and continuous use [14].

8.2.5 Using a smartphone as an activity tracker

Using a smartphone as the activity tracker for a chatbot is beneficial because it is possible to develop a cross-platform application to work on both iOS and Android. In addition, most people own a smartphone with an integrated step counter.

On the other hand, a problem with using a smartphone as an activity tracker is that people cannot carry their phones at all times. If the user does not have any pockets or bags or cannot carry the phone in their hand, their steps will not be counted. One participant in the usability study reported experiencing this difficulty as their job makes it impossible to carry a phone.

Although users could register additional steps in the chatbot, this would require that they had another step counter that they could wear continuously. Furthermore, when users register their steps manually, they miss out on this spontaneous feedback they could get when they reach their step goal.

The Ally chatbot, which focuses on getting the participants to walk more, used GoogleFit or HealthKit to get the users' step count [11]. Similar to the implemented AktiMot app, GoogleFit and HealthKit are phone applications. The Ally chatbot also had missing step data since the participants did not interact with the chatbot, which was required to get the step count from GoogleFit or HealthKit [11]. Therefore, like AktiMotBot, Ally did not have the necessary data to utilize its full potential.

A study on the accuracy of the iPhone step counter showed that it underestimated the step count, leading to a lower step count than the actual steps taken. Further, how participants carried their phones influenced the step count. Finally, the authors also observed that people might not constantly carry their phones [81]. If people do not always carry their phones, it will not count the small everyday activities like walking to the washing machine. Therefore, using a smartphone as an activity tracker may not accurately represent total steps, and other options should be explored.

Alternative design options

Using an already existing step counting application was possible instead of starting and implementing one. For example, GoogleFit could have been used to retrieve step counts for Android and iOS phones. However, we did not want to ask the users to share their data with another company since we do not know how they process and use it.

During the design phase, we discussed the possibility of choosing an activity tracker and implementing the solution for that specific brand and watch. However, we refrained from doing this as it would exclude many potential users of the chatbot. Therefore, we decided to use an application that used the phone’s step counter since most people own a smartphone. The application was initially implemented for Android phones, but in the end, it was restricted to only Samsung phones.

The system requires users to accept that their activity data is shared with the Health Platform. However, this does not mean that we asked users to share their data with another company. The Health Platform is owned and developed by Android and is a platform that is intended to make it easier for the user to decide which apps can access their activity data.

Updating activity data

Through the usability study, the AktiMot app did not behave as expected. The scheduled updates did not happen hourly but rather at longer intervals, and some did not send an update at all. The missing updates resulted in the chatbot reporting incorrect step counts to the users and no message complimenting them when they reached their goal. One of the participants said that the incorrect step count was the reason for the lack of motivation.

One participant reported that they stopped using the chatbot because it reported an inaccurate step count. In addition, two participants said that they stopped using the chatbot since it did not work where they most likely referred to the incorrect step count. When the chatbot engine discovered that it had not updated step counts, it asked the user to manually update through the AktiMot app. Having to ask the user to update every time put additional work on the user, and many participants reported that the extra work was burdensome.

Since the AktiMot app did not send updates hourly, the participants did not get to experience all the system's features. For example, most users did not get spontaneous complimenting messages if they had been out walking or shortly after they reached their step goal. The complimenting messages were designed for the *Social Reward* BCT. However, since the chatbot was not updated on the step count, the *Social Reward* BCT could not be used to influence the user’s behavior.

The morning messages, afternoon messages, and the messages the user received when asking about their step count were also incorrect due to the erroneous step count. The morning messages were intended to motivate the user and inform them about their performance the previous day. However, when the previous day's step count is wrong, the chatbot may tell the user that they did not achieve their goal when they did. Telling the user that they did not reach their goal when they did may irritate the user instead of motivating them.

If the chatbot engine notices that it has not been updated for three hours, the afternoon message is replaced by a message asking the user to update the server. The afternoon message event was implemented to realize the *Discrepancy between current behavior and goal* BCT. Therefore, in the absence of afternoon messages, the effect of the BCT was reduced because the users would only be influenced by it if they asked for their steps themselves.

Possible reasons for irregular updates

A possible reason why the AktiMot app stopped sending updates could have been if the users had completely closed the application. If the application is not running in the background, it will not be able to do background tasks, hence not sending the hourly update. In addition, if the user's phone enters battery saving mode, the system will stop the background task, leading to a lack of updates. However, the users were informed that they must not close the app entirely in the information sheet they received at the beginning of the study. So, although this could be a reason for the lack of updates, it is not likely the main reason.

One problem with the periodic work request was discovered during the alpha testing phase. The mobile application stopped sending update requests at night when the phone entered doze mode. The doze mode is a power-saving feature to extend the battery life of a device, and it manages how apps behave [82]. In addition, the phone enters doze mode when the device is unused for long periods, which defers the background central processing unit and network activity for apps [82].

During doze mode, the phone enters maintenance windows. The applications are allowed to run scheduled tasks and access the network in maintenance windows. The longer the phone stays in doze mode, the fewer maintenance windows are scheduled.

With regards to the AktiMot app, it did not start the work during the maintenance windows, and it did not resume the work when the system exited doze mode. The AktiMot app uses "Work Manager", the primary recommended API for background processing [74]. The documentation states that the Work Manager adheres to the power-saving features and best practices like doze mode, so the developer does not have to think about it [74]. The documentation also states that work scheduled by the Work Manager is guaranteed to be run. But it did not work as expected in the AktiMot app.

A change that was made before the beta testers got the application was that the app would get a notification when the phone changed to and from doze mode. When a message about mode change appeared, the application would send an update if it had not done it in the last 50 minutes. In addition, the chatbot engine would send an additional message in the morning and afternoon if it saw that it had not been updated, as described in Section 5.3.2.

Work scheduled with the Work Manager is only guaranteed to be run, but it is not guaranteed to run at an exact time. The start time of scheduled periodic work can be influenced by many variables, like battery percentage, device health, and other simultaneous jobs that have higher priority. For example, work scheduled to start in 15 minutes may not be run until 8 hours later, depending on the device's health. Therefore, although the phone was not in doze mode, the scheduled work may not be run due to other variables influencing the start time.

A possible solution would have been to set an alarm that would go off every hour to ensure the update is sent, but this is not recommended. Using an alarm would have ensured that the update happened precisely every 50 minutes. The alarm wakes the device from doze mode and runs the job, but this would drastically drain the battery. Users are more likely to uninstall apps that drain their phone’s battery.

8.2.6 Choice of activity measure

The chatbot’s goal is to influence the user to increase their daily step count. The choice to use step count as the measure was due to its high availability. Step count is highly available since almost all devices can calculate steps. In addition, step count is an understandable measure for the users. A change in user behavior through increasing their step count is easily detected. Further, converting historical step count data into graphs makes it easy to display to the user how they have improved.

Getting the users to increase their step count is not dependent on access to other equipment or a gym. Walking is an accessible and safe activity that anyone can perform, and it can be performed almost anywhere. Although walking is not categorized as either a vigorous- or moderate activity (due to the limited increase in heart rate), getting people with a sedentary lifestyle to walk more would still be a significant improvement.

The chatbot suggests goals for the user based on their historic step goal. If the user does not have any step goal, the chatbot will suggest 4000 steps by default, and if the user has a step goal, the chatbot will add or subtract 2000 from the old step count and suggest it depending on whether the user wants to increase or decrease the current step goal. The suggestions are implemented in this manner for simplicity and to test the system.

The chatbot does not try to get the user to reach any "standards" like 10.000 steps. Instead, it focuses on increasing users' step count, if only by 2000. The chatbot aims to get people to increase the number of steps per day by motivating them to reach a manageable goal based on their current activity level. Even the smallest increase in walking done by people with a sedentary lifestyle is beneficial to their health, and findings from Diehr, P. and Hirsch, C [83] support this.

The goals should be individually fitted and manageable for each user, and the chatbot should be able to recommend a new goal to the user based on whether or not the user has completed their goal. For example, if the user has reached their goal every day of the week, the chatbot could suggest increasing the goal. On the other hand, if the user has not reached their goal, the chatbot could recommend reducing it to a more manageable goal. If the user never completes their goal, they will never feel satisfaction and get a confidence boost. Therefore, the chatbot could temporarily decrease the step goal to get the user to reach it, increasing their motivation and boosting self-confidence.

Reporting activity functionality

Since the AktiMot app did not detect other activities, a feature that allows users to report other activities was implemented. The users could register steps the smartphone did not count and report other activity that is converted into steps.

The implemented feature that allows users to report other activities or add steps works as a demonstration and should be improved to increase the acceptance of the chatbot. For example, the possible activities the user can report are limited to those defined in the chatbot engine, and it is not possible to dynamically add other activities. Furthermore, when users report an activity, they have to write the activity word identical to how it is defined in the chatbot engine. If the user writes it differently, the chatbot engine will not recognize it as an activity and not trigger the proper action.

Since the chatbot engine only matches words defined, the question to the user is not always grammatically correct. For example, if the user writes *“Running 20 min”,* the chatbot would reply with *“Is it correct that you running in 20 minutes?”* while it ideally should be *“Is it correct that you ran 20 minutes?”*.

Based on user feedback, a workaround was implemented, which rephrased the sentence: *“Is it correct that your activity is ‘running’ in 20 minutes?”*. In addition to rephrasing the sentence, the activity and duration reported by the user are put in quotation marks. Rephrasing the sentence and adding quotation marks were done to make it more acceptable to have grammatical errors. The users were also asked to write the activity in the past tense as this would give more grammatically correct sentences.

The step conversion table which was used differed the activities based on intensity. For example, running was divided into different categories based on pace. Each category would give different amounts of steps per minute. Further implementation should take the intensity of the activity into account to make a more accurate conversion.

The activity feature had some limitations, but it was a good way to allow users to register additional activities or steps. In addition, although the smartphone did not record activities and not steps when the user was not carrying their phone, the user could report these situations and be given credit for all activities.

8.3 Security

A lot of time has been spent investigating the security of the social media applications to ensure that the third-party application used does not pose any security issues for the users. However, the security of the implemented system should be further reviewed before being deployed on a larger scale. The development phase was short to ensure that potential users could test it. Therefore, security has not been the main focus during the development and testing phase because the implemented system was made as a prototype.

One security issue is that the chatbot engine randomly generates a five-digit password that the user gets in the chat. The password is not encrypted in the database, not encrypted when sent in the chat to the user, and not encrypted in the request from the AktiMot app. As a result, anyone with access to the conversation can use the password to log in to the mobile application, posing as the user if they used the password before the intended user.

Further, the server accepts incoming requests from anyone and does not have any authentication to ensure that the incoming request is from a trusted user. Although the requests are type-sensitive, it would accept any requests with the correct format. The server does not provide API endpoints to get information about the user. Still, it would be possible for an attacker to put simulated step data for a user by having their user identification. It would also be possible for an intruder to delete the user activity data by having their user identification and knowing the delete endpoint.

If the system is to be used further, the password must be encrypted, and the server must be access restricted. In addition, the API endpoints must be secured to make sure that only users that are authenticated can access them.

8.4 Research problems

Research problem 1 was to find out how we could integrate the chatbot into a social media application and preserve users' privacy and security. Through a thorough investigation of privacy and security aspects in different social media applications, we found that we could integrate the chatbot into Telegram and still preserve the user's privacy and security. Integrating the chatbot into a social media application and maintaining the user's privacy and security was possible because Telegram uses sophisticated data encryption in transit and at rest [59]. In addition, Telegram was developed to preserve users' privacy, and they have spent much time ensuring that the data is private and secured. Finally, Telegram does not collect a lot of data and does not share or sell it [61].

When research problem 1 was investigated and answered, and the development phase was done, the usability study was conducted to answer research problem 2: *"How do users perceive the system, and how can it be improved?"*.

We found that the users perceived the system to be average usable. The users found the chatbot to have a realistic and engaging personality and welcoming during the initial setup. The system could be improved by finding another way to integrate activity data into the chatbot and implement more conversation flows.

Research problems 1 and 2 were subproblems that originated from the main research problem. The main research problem was: *"How can a chatbot integrated into a social media application that is connected to activity trackers be developed and used to help motivate users to increase their physical activity levels?"*.

This thesis shows that a chatbot could be integrated into a social media application, answered through question 1. The chatbot can integrate step data from a smartphone application that extracts the user's step count from the smartphone's health application. Various BCTs were implemented through functionality and defined messages to influence users' behavior. Finally, through the usability study, we saw that the implemented system successfully increased motivation in half of the participants and raised awareness of their step count in more than half of the participants.

8.5 Strengths and limitations

One of the strengths of this research is that the system has been through extensive testing by experts and peers throughout the iterative development process. As a result, the feedback from the continuous testing helped improve the functionality and find and fix bugs.

The group of supervisors consists of two from the computer science field, one from the psychology field, and one from the health field. Having supervisors within each specialization is beneficial and has given valuable feedback, and helped implement the system to best influence people's physical activity behavior.

After extensive testing by both experts and peers, the system was tested by 12 potential users. It is recommended to have at least 26 participants in a usability study with the CUQ to identify all usability issues [2]. Since this study did not have 26 participants, it may not have been extensive enough to find all the usability issues. Therefore, comparing the results from this usability study with studies with a lot more participants may not be completely accurate. However, all the 12 participants enrolled in the usability study gave detailed and valuable feedback.

The CUQ [2], which was used as a part of the questionnaire in this usability study, is a validated questionnaire in the English language but is not available in the Norwegian language [2]. Due to this thesis's time limitation, a direct translation of the CUQ into Norwegian has been used in the usability study. If the translation of the questionnaire was not accurate, this could have led to the participants of the usability study misunderstanding the questions, thereby negatively influencing the results.

The direct translation into Norwegian was necessary to investigate the system's usability. The participants in the usability study were Norwegian, and a validated chatbot usability questionnaire in Norwegian does not exist. Future research in Norwegian on chatbots should consider validating and adapting the Chatbot Usability Questionnaire (CUQ) to the Norwegian context.

Ensuring the user's privacy and security were prioritized. First, five different social media applications were investigated to ensure that the proper application was chosen regarding security and privacy. Secondly, the data protection manager at the university was contacted to ensure that the data were processed securely. Finally, a thorough anonymity assessment of the data collected was done to ensure that we could process data anonymously.

One limitation in the usability study was the complex setup of the system on the user's phone. Due to the complex setup of the application and connecting the AktiMot app and the AktiMotBot, some participants forgot some permissions or gave the wrong permissions, resulting in the app's inability to read the step count from Samsung Health. Finally, the irregular update from the AktiMot app may have influenced the results.

8.6 Future work

For further implementation, the most important feature is to find another way to send the user's activity data to the chatbot. For example, it could be possible for the chatbot engine to retrieve the data from the user's phone when needed. Another solution would be to choose an existing app, like GoogleFit, where the data are periodically synced to the cloud, and the chatbot engine could then retrieve the data from the cloud on-demand. Finally, it could also be possible to choose one or more activity tracker brands, like Fitbit or Garmin, and implement data retrieving from the brand's cloud storage. Selecting one brand would initially exclude people who do not have the exact brand, but it is possible to integrate several different brands so that users can choose their preferred brand.

If the chatbot engine retrieves cloud data, almost all security vulnerabilities are solved. The server can then remove its API endpoints such that it does not accept input from others. It would not be necessary for the system to have any login type. The chatbot engine would ask the user to log into their account on the brand, allowing the chatbot engine to retrieve the user's data.

When the chatbot engine can access updated data, the next thing that should be implemented is different and more complex conversational flows in the chatbot. For example, the chatbot should ask the user if they have had a good day. In addition, the chatbot could ask the user how they plan to reach their goal and how to overcome obstacles.

The chatbot's step goal suggestions should be reviewed, and scientific evidence should be used to calculate a new step goal based on the user’s last goal. In addition, the chatbot should suggest a new step goal based on the user's historical activity data. Finally, it would also be prudent to have a check system; if the user chooses an unrealistic goal, the chatbot should try to convince the user to rethink the decision.

A motivational feature that should be added is to show the user their historical data, either in graphs or another way. Finally, the last six functional requirements in **Table 3**, not implemented in this system, could be implemented to improve the chatbot.

Furthermore, the message events should be more dynamic. For example, if the user’s step count is noticeably lower than the previous day, the chatbot can send a message comparing the step counts. The users should also be able to choose any time of the day for the current morning and afternoon message and not restrict the options to the four or time options currently implemented.

9 Conclusion

This thesis aimed to implement and test a chatbot developed to help people increase their physical activity levels by getting them to increase their daily steps. First, the design and implementation of AktiMotBot and the AktiMot app have been presented and discussed. Further, the problems with the AktiMot app have been enlightened, and other design alternatives have been discussed that could help improve the system. Finally, the system has been tested extensively by people with different expertise through the iterative development process. The system was further tested through a usability study where 12 potential users used the system in their daily lives for a week.

The usability study results showed that some participants had increased motivation to walk more. Furthermore, more than half of the participants were more aware of their daily number of steps while using the chatbot than prior to its use. The findings showed that chatbots could motivate people to increase their physical activity behavior and make people more aware of their step count.

This thesis emphasizes the importance of users' privacy and security. We found that it was possible to integrate the chatbot into a social media application and still preserve the privacy and security of the users by using Telegram. Further, we investigated how users perceived the system and how it could be improved through the usability study with potential users. As a result, we found it possible to develop a chatbot integrated into a social media application and integrate an activity tracker. Furthermore, the proposed system successfully motivated half of the participants while raising awareness of daily steps for over half. Finally, improvement and future work were shortly presented as possible methods of improvement.

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Appendices

Appendix I Physical Activity Social Media Chatbot Messages

Appendix figure 1*: Physical Activity Social Media Chatbot Messages*

Phase	**Message(s)**	**Behaviour Change Techniques**
Reaching goal	Congratulations (emoji). You reached your goal today. Keep up the good work (emoji)	"Review behaviour goal" * "Social reward"
	You have reached your goal! Great job (username). Keep it up (emoji)	"Review behaviour goal" * "Social reward"
	You have reached your goal! Congratulations on your hard work (emoji). Continue to work hard (emoji)	"Review behaviour goal" * "Social reward"
	Happy to see you accomplished your step goal (emoji). You are amazing (emoji)	"Review behaviour goal" * "Social reward"
	You have reached your goal! Well done (username) (emoji).	"Review behaviour goal" * "Social reward"
	You have reached your goal! You did it (emoji). So proud of you (emoji).	"Review behaviour goal" * "Social reward"
	Hooray! Step goal achieved (emoji) Keep up the hard work (emoji)	"Review behaviour goal" * "Social reward"
	Congrats (username)! You've worked so hard to reach your step goal (emoji)	"Review behaviour goal" * "Social reward"
	You are awesome (emoji) You reached your step goal. Way to go (emoji)	"Review behaviour goal" * "Social reward"
	You have reached your goal! Congratulations (emoji). This is only the beginning of even more great things to come (emoji)	"Review behaviour goal" * "Social reward"
Nearly reaching goal *(messages should come if the user checks steps and step goal not reached)*	You have (number of steps). Only a few more steps to reach your goal. You can do this (emoji)	"Discrepancy between current behaviour and goal"
	You have just (number of steps remaining) steps left. Persevere! (emoji)	"Discrepancy between current behaviour and goal"
	Just a few more steps to your goal. Don't give up (emoji)	"Discrepancy between current behaviour and goal"
	Only a few more steps to reach your goal. You are doing a great job trying to reach your goal (emoji).	"Discrepancy between current behaviour and goal"
	Only a few more steps to reach your goal. You are amazing for trying to reach your goal (emoji)	"Discrepancy between current behaviour and goal"

	Only a few more steps to reach your goal. Hang in there (emoji). You've got the willpower and resilience to do this (emoji)	"Discrepancy between current behaviour and goal"
	Only a few more steps to reach your goal. Hang in there (emoji). I know you'll succeed in reaching your goal (emoji)	"Discrepancy between current behaviour and goal"
	Only a few more steps to reach your goal. It takes serious courage to come this far. Stay on it (emoji)	"Discrepancy between current behaviour and goal"
	Only a few more steps to reach your goal. It takes serious determination to come this far. Stay on it (emoji)	"Discrepancy between current behaviour and goal"
	Only a few more steps to reach your goal. You've got what it takes to reach the goal. Hang in there(emoji)	"Discrepancy between current behaviour and goal"
	Only a few more steps to reach your goal. You can do this. I believe in you (emoji)	"Discrepancy between current behaviour and goal"
	Only a few more steps to reach your goal. Don't give up and remember you are a survivor (emoji)	"Discrepancy between current behaviour and goal"
Increase step goal	Wonderful! You increased your step goal from (current step goal) to (new step goal) (emoji)	"Review behaviour goal" * "Social reward"
	You increased your step goal from (current step goal) to (new step goal). That's the spirit (emoji)	"Review behaviour goal" * "Social reward"
	You went beyond your current goal! Alright! Let's get on with this new achievable step goal (emoji)	"Review behaviour goal" * "Social reward"
Decrease step goal *(user sets a new goal, lower that earlier)*	The new step goal is lower than earlier. That is okay. The most important thing is that you keep moving during the day (emoji)	"Goal setting"
	The new step goal is lower than earlier. It is good to know your limits. Keep working hard towards your new step goal (emoji)	"Goal setting"
	The new step goal is lower than earlier. That is alright. You can increase your step goal whenever you are ready (emoji)	"Goal setting"

* As part of this BCT, in addition to the dialogs included in the table, the chatbot could also ask the user if he/she wants to re-set his/her goals.

Physical Activity facts/benefits

- **Physical activity** refers to **all movement**. Popular ways to be active include walking, cycling, wheeling, sports, active recreation, and play.
- Physical activity has significant health benefits for hearts, bodies, and minds. *BCT "Information about health consequences"*
- Regular physical activity helps to prevent and manage noncommunicable diseases (NCDs) such as heart disease, stroke, diabetes, and several cancers. *BCT "Information about health consequences"*
- Regular physical activity helps prevent hypertension. *BCT "Information about health consequences"*
- Regular physical activity helps to maintain healthy body weight and can improve mental health. *BCT "Information about health consequences"*
- Physical activity reduces symptoms of depression and anxiety. *BCT "Information about health consequences"*
- Physical activity enhances thinking, learning, and judgment skills. *BCT "Information about health consequences"*
- Regular physical activity improves quality of life and overall well-being. *BCT "Information about health consequences"*
- Regular physical activity can improve muscular and cardiorespiratory fitness. *BCT "Information about health consequences"*
- Regular physical activity can improve bone and functional health. *BCT "Information about health consequences"*
- Regular physical activity can reduce the risk of falls as well as hip or vertebral fractures. *BCT "Information about health consequences"*
- Meeting physical activity goals or challenges, even small ones, can boost your self-confidence. *BCT "Information about emotional consequences"*
- Fulfilling physical activity goals or challenges, even small ones, can give you a sense of satisfaction. *BCT "Information about emotional consequences"*
- Regular physical activity can help improve your mood. *BCT "Information about emotional consequences"*
- Regular physical activity can help relieve stress. *BCT "Information about emotional consequences"*
- **Physical inactivity** is one of the leading risk factors for noncommunicable diseases (NCDs) and death worldwide. *BCT "Information about health consequences"*
- Increased levels of **physical inactivity** have **negative impacts** on health systems, the environment, economic development, community well-being and quality of life. *BCT "Information about social and environmental consequences"*
- **Four to five million deaths** per year could be **averted** if the global population was **more active**. *BCT "Information about social and environmental consequences"*
- According to the World Health Organization, every move counts towards better health. *BCT "Information about health consequences"*
- Physical activity can be done as part of work, sport and leisure or transport (walking, wheeling, and cycling).
- Physical activity can be done through dance, play and everyday household tasks, like gardening and cleaning.

Physical activity recommendations

- All adults (including those with chronic conditions and those living with disabilities) should undertake regular physical activity. *BCT "Information about health consequences"*
- Adults should limit the amount of time spent being sedentary. *BCT "Information about health consequences"*
- Replacing sedentary time with physical activity of any intensity (including light intensity) provides health benefits. *BCT "Information about health consequences"*

Physical activity good practice statements

- Doing some physical activity is better than doing none. *BCT "Information about health consequences"*
- Start by doing small amounts of physical activity, and gradually increase the frequency, intensity, and duration over time.
- Taking more steps per day is associated with lower risk of all-cause mortality, and lower risk of cardiovascular disease morbidity or mortality. *BCT "Information about health consequences"*
- Even at low levels of activity, taking an additional 1000 steps per day is associated with lower risk of all-cause mortality, and lower risk of cardiovascular disease morbidity or mortality. *BCT "Information about health consequences"*
- Small increase in walking is associated with meaningful health benefits. BCT "Information about health consequences"
- Sedentary healthy older adults could benefit from even modest increases in the amount they walk. *BCT "Information about health consequences"*

Appendix II Information sheet to the user in the usability test

Informasjon og veiledning til brukertesting av chatbot ifm. Masteroppgave ved UiT

Hei. Du har fått dette skrivet siden du har sagt deg villig til å delta på testing av en implementasjon av en chatbot på et sosialt medium som er integrert med en fysisk aktivitetssensor. Målet med prosjektet er å se om brukere kan bli motivert til å øke deres fysiske aktivitet ved å bruke en chatbot på et sosialt medium som har tilgang på deres aktivitetsdata igjennom en fysisk aktivitetssensor. En chatbot er et dataprogram som skal etterligne et menneskes måte å samtale på, i form av skriftlige meldinger.

Som en del av masteroppgaven min har jeg utviklet en chatbot på Telegram som skal prøve å motivere deg til å bli mer fysisk aktiv ved å se på antall skritt daglig. Telegram er en applikasjon som er veldig nøye med sikkerhet og krypterer all data de lagrer. Telegram bruker heller ikke dataen til noe og selger den ikke videre.

I denne brukertesten **samles det ikke inn noen form for personlig informasjon**. Telegram vil ha tilgang på telefonnummeret ditt, men det vil ikke være lagret i chatbotten. Det eneste som lagres i chatbotten er skrittdataen din og **brukernavn som ikke skal være ditt virkelige navn**. Det deles heller ikke noe informasjon med Samsung ettersom det eneste telefon applikasjonen gjør er å hente skrittdataen ut fra Samsung Health og lagrer ingen personlig informasjon.

Testen starter lørdag 23.04.2022 til fredag 29.04.2022. På siste dag vil dere få tilsendt en lenke til et anonymt spørreskjema på e-post som dere svarer på. Spørreskjema handler om bruken av chatbotten og hvordan det opplevdes.

For å kunne være med i undersøkelsen må du:

1. Ha en Samsung-telefon som er nyere enn 2017.
2. Ha logget inn på Samsung Health eller logge inn.
3. Ha en Telegram bruker eller være villig til å opprette en Telegram bruker.

Oppsettet består av 4 steg, listet under, og er forklart på neste side.

- Laste ned Telegram
- Tillate Samsung Health å sende aktivitetsdata
- Installere Mobil applikasjonen

- Starte chat med Chatbot

Oppsett

Dersom noe er uklart i oppsettet ligger det bilder med forklaring til flere steg nederst i dokumentet.

Steg 1: Laste ned Telegram

Dette steget er nedlastning av Telegram appen hvor du kommuniserer med chatbotten.

1. Last ned Telegram applikasjonen ved å gå på «Play Store» og søk på Telegram (Figur 1)
2. Lag deg en bruker ved å trykke «Start Messaging» skriv inn telefonnummeret ditt og du vil få en bekreftelseskode på SMS. (Figur 2)

Steg 2: Tillate Samsung Health å sende aktivitetsdata til Health Platform

1. Gå til Innstillinger -> Apper -> Samsung Health -> Samsung Health-innstillinger (Figur 3) -> Tilknyttede tjenester (Figur 4)
2. Trykk på Health Platform (Figur 5) og trykk enten "Fortsett" eller "Installer" (figur 6).
    a. Dersom du må installere appen kommer du inn i Play Store og må installere den derifra og gå tilbake til steg 1.
3. Godkjenn koblingen mellom Health Platform og Samsung Health og fortsett til du kommer til «Data tillatelser»
4. Når det kommer opp «Data tillatelser» bla ned til «Tillat å sende» å huk av «Aktivitet» (Figur 7) (Se NOTE på neste side.)

Steg 3: Installere mobilapplikasjon

Dette steget laster ned mobil applikasjon AktiMot som fungerer som er som en passiv aktivtetssensor og oppdaterer chatbotten automatisk med skrittene dine.

1. Inne på telefonen trykker du på filen «AktiMot.apk» du har fått tilsendt og installer. Dersom du ikke får lastet ned følg instruksene på neste side.
2. Se at du har fått en applikasjon som heter "AktiMot"
3. Når du åpnet AktiMot appen godkjenne at "AktiMot" kan få data fra Health Platform og at den har tilgang til fysisk aktivitetsdata (Figur 8)
4. Forsett til steg 4 Start– Her vil du bli veiledet av AktiMotBot og logger inn i appen underveis i oppsettet.

    Du kan helt fint gå ut av appen og den vil fortsette å oppdatere. Det er viktig at du ikke avslutter/lukker appen helt ved å sveipe opp fra bunnen og lukke for da vil den ikke lenger automatisk oppdatere skrittene dine til serveren.

Steg 4: Start i Telegram appen

1. For å starte å bruke chatbotten går du inn på Telegram appen og trykker på forstørrelsesglasset øverst i høyre hjørne.
2. Søk på «AktiMotBot» og det vil komme opp en bot med navn «AktiMotBot»
3. Trykk på AktiMotBot og trykk på start

Fullfør oppsettet med AktiMotBot chatbotten – du vil i dette oppsettet samtidig sette opp mobil applikasjonen AktiMot

Dersom du får feil når du prøver å laste ned eller ikke får installert den på grunn av at det er en APK fil. Gjør som følger:

- Prøv å last den ned til mine filer og prøv å installer den fra «Mine Filer»
- Det kan hende du må tillate «Mine filer» å installere «apper fra ukjente utgivere» da går du til «Instillinger -> Biometri og Sikkerhet -> Installer ukjente apper», slå på «Mine filer» her.

NOTE:

AkitMot appen vil ikke få skrittene for hele dagen, kun skrittene du har gått etter du har godkjent koblingen mellom Health Platform og Samsung Health. Dersom appen enda har 0 skritt etter en stund og du har beveget deg sjekk at Health Platform har tillatelser til Fysisk aktivitet. Dette sjekker du ved:

- Gå inn på «Instillinger -> Apper -> Health Platform -> Trykk på Tillatelser». Sjekk at Health Platform har «Fysisk Aktivitet» under tillatelser. Se bilde 9 på siste side.

Slutt

Testen varer i 7 dager og på siste dag svarer du på et spørreskjema som du får tilsendt på mail.Dette er et helt anonymt spørreskjema hvor du gir tilbakemelding på hvordan du oppfattet chatbotten og hvordan det var å bruke den.

Avslutt test og avinstaller

1. Avinstallere AktiMot appen
2. Gå inn på innstillinger -> Apper -> Samsung Health -> Samsung Health-innstillinger -> Tilknyttede tjenester -> Health Platform å slå av tillatelsen
3. Du kan slette Telegram brukeren din ved å gå på https://my.telegram.org/auth?to=deactivate logg inn og slett brukeren.

Tusen takk for at du deltar på brukertesting.

Vennlig hilsen

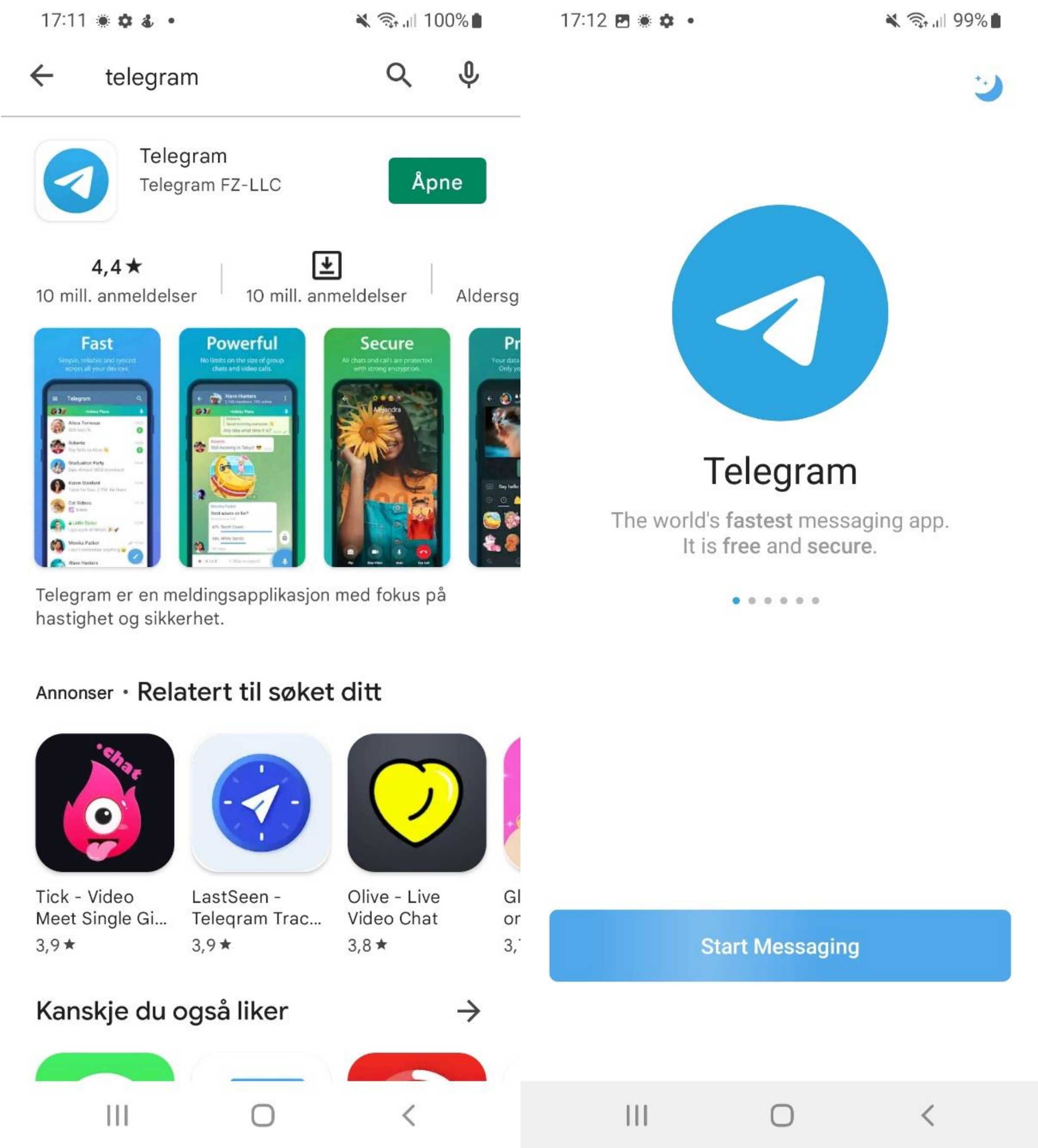
Helle Sandsdalen

EKSTRA: HVIS DU ØNSKER Å SLÅ AV SYNLIGHET FOR ANDRE

Hvis du ønsker å slå av synlighet for at andre kan finne det på Telegram kan du gjøre det slik:

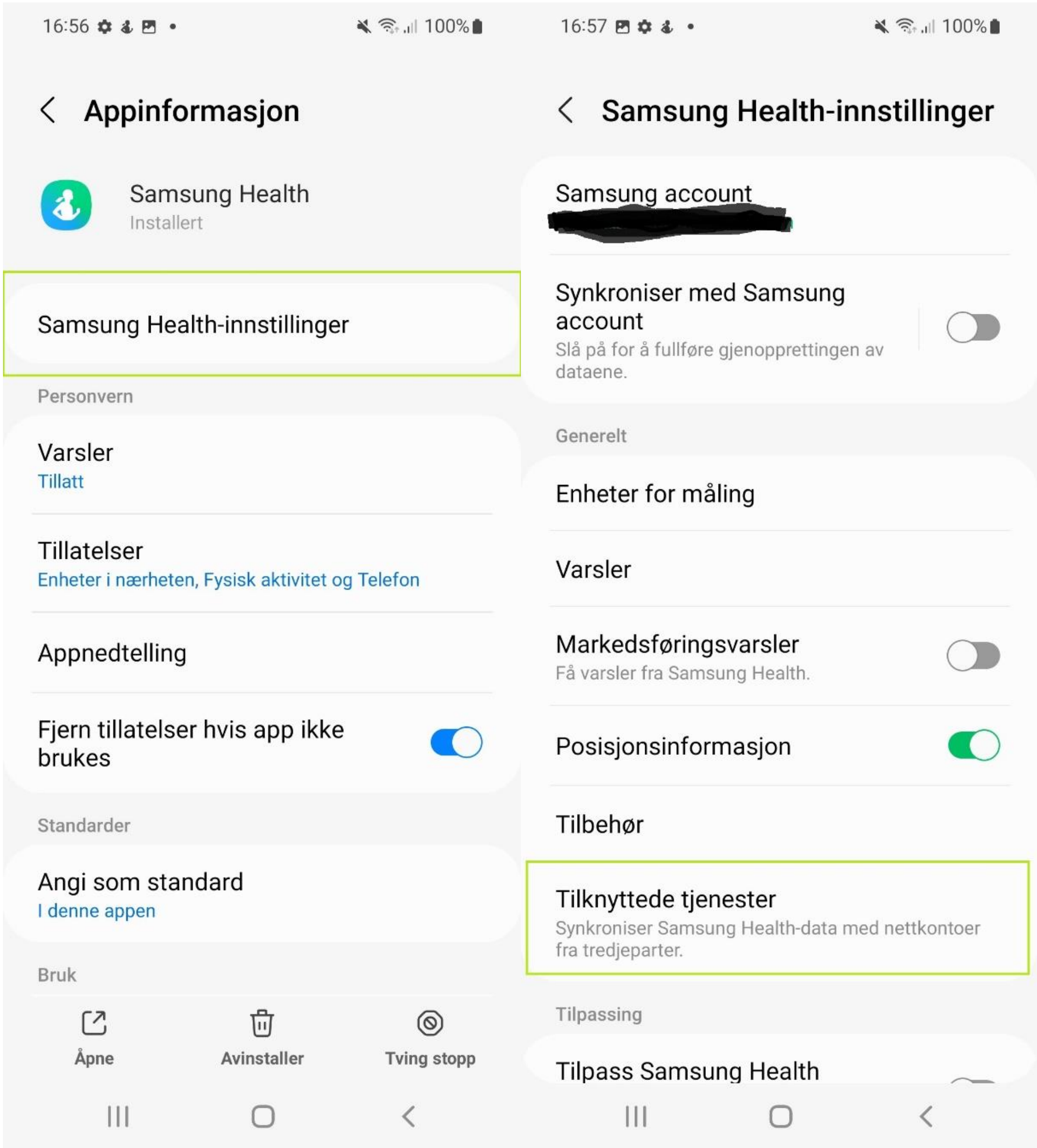
1. Gå til Settings i Telegram appen
2. Privacy and Security
3. Trykk på telefonnummer (Phone number)
4. Velg **Ingen** på «Hvem kan se mitt telefonnummer».
5. Velg **kontakter** på «Hvem kan finne meg ved telefonnummeret mitt»

Steg 1: Installer Telegram

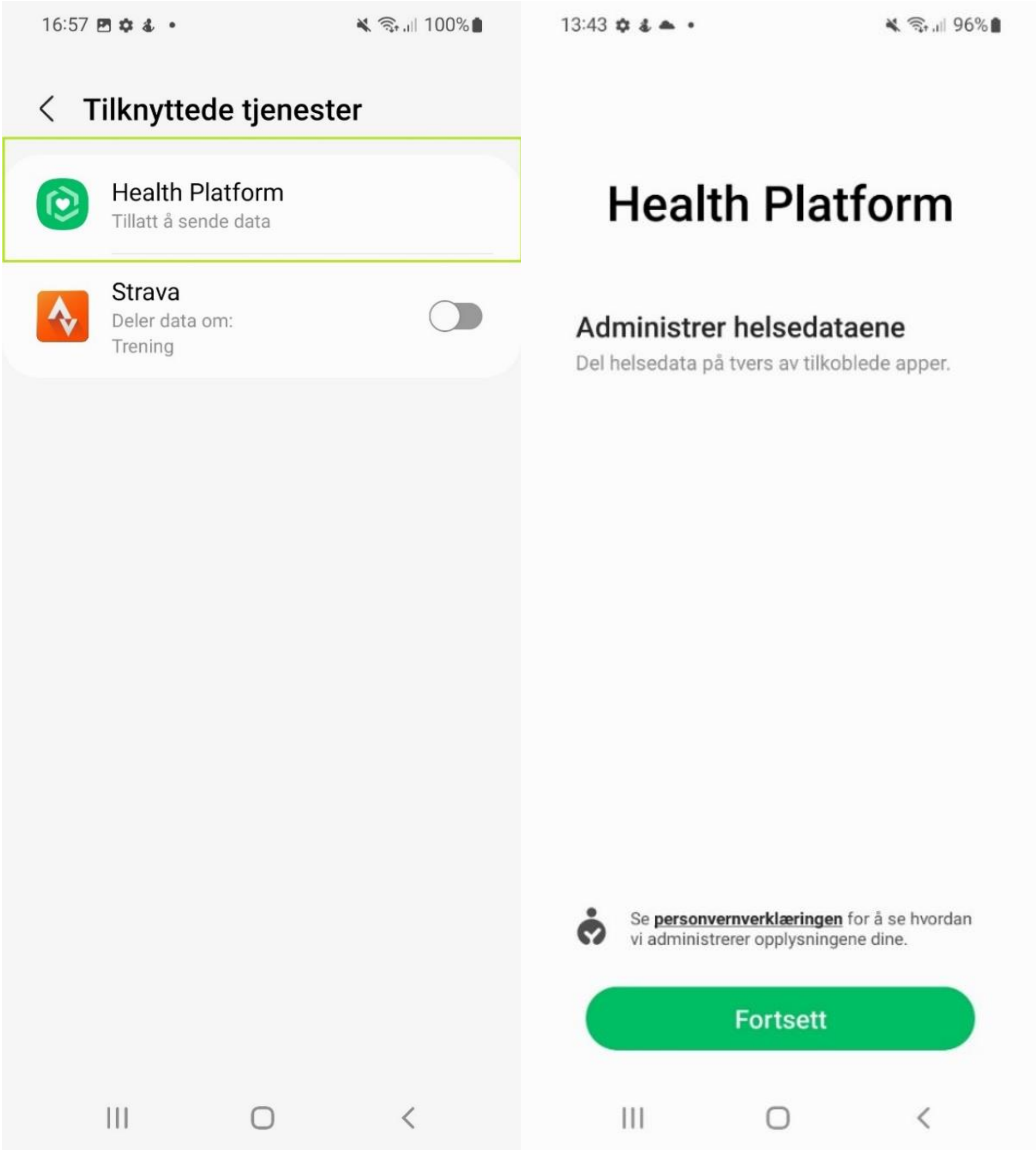


*Appendix figure 2: Telegram in Play Store **(Figure 1 left).** Telegram start screen **(Figure 2 right)***

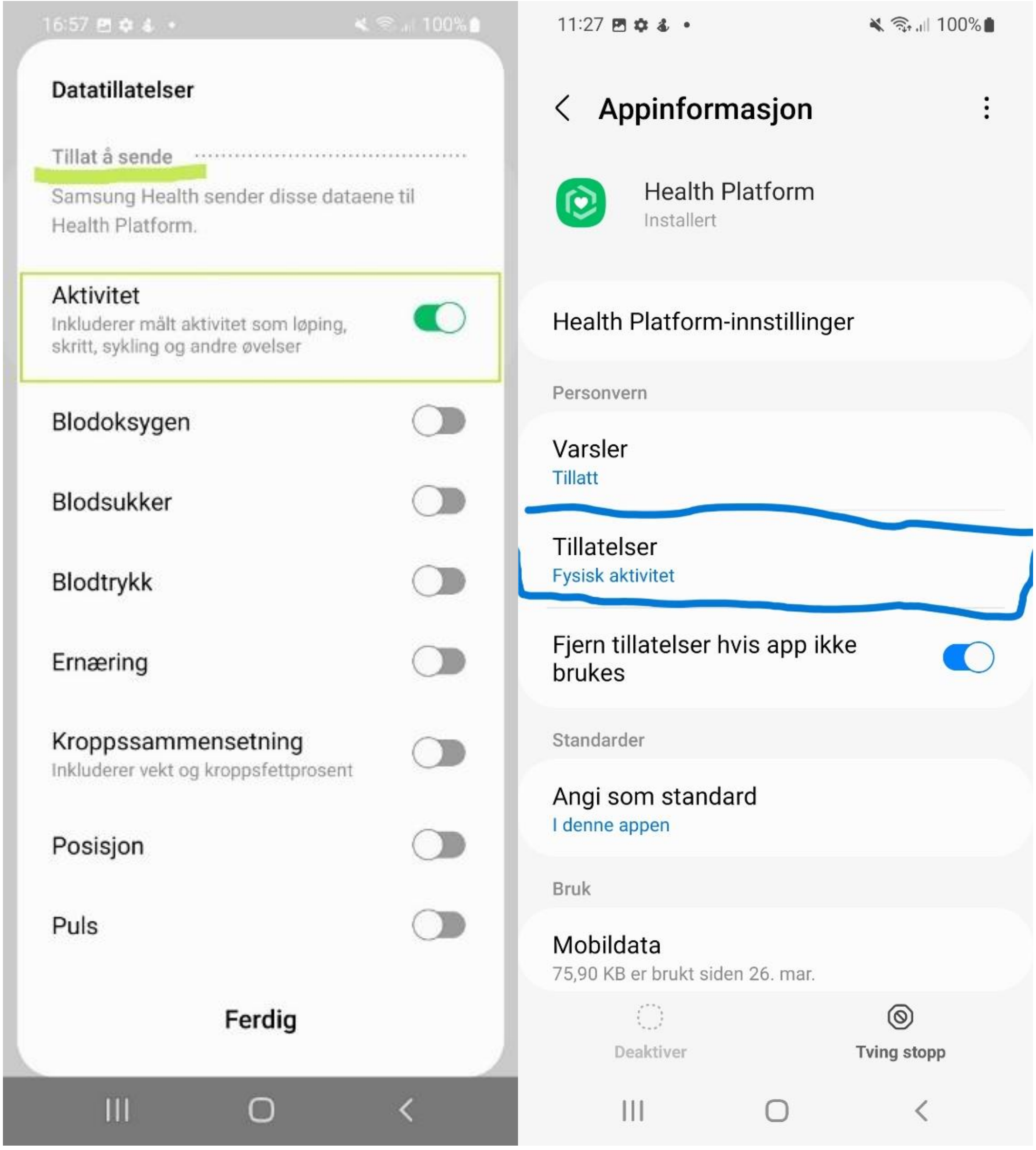
Steg 3: Tillate Samsung Health å sende aktivitetsdata til Health Platform



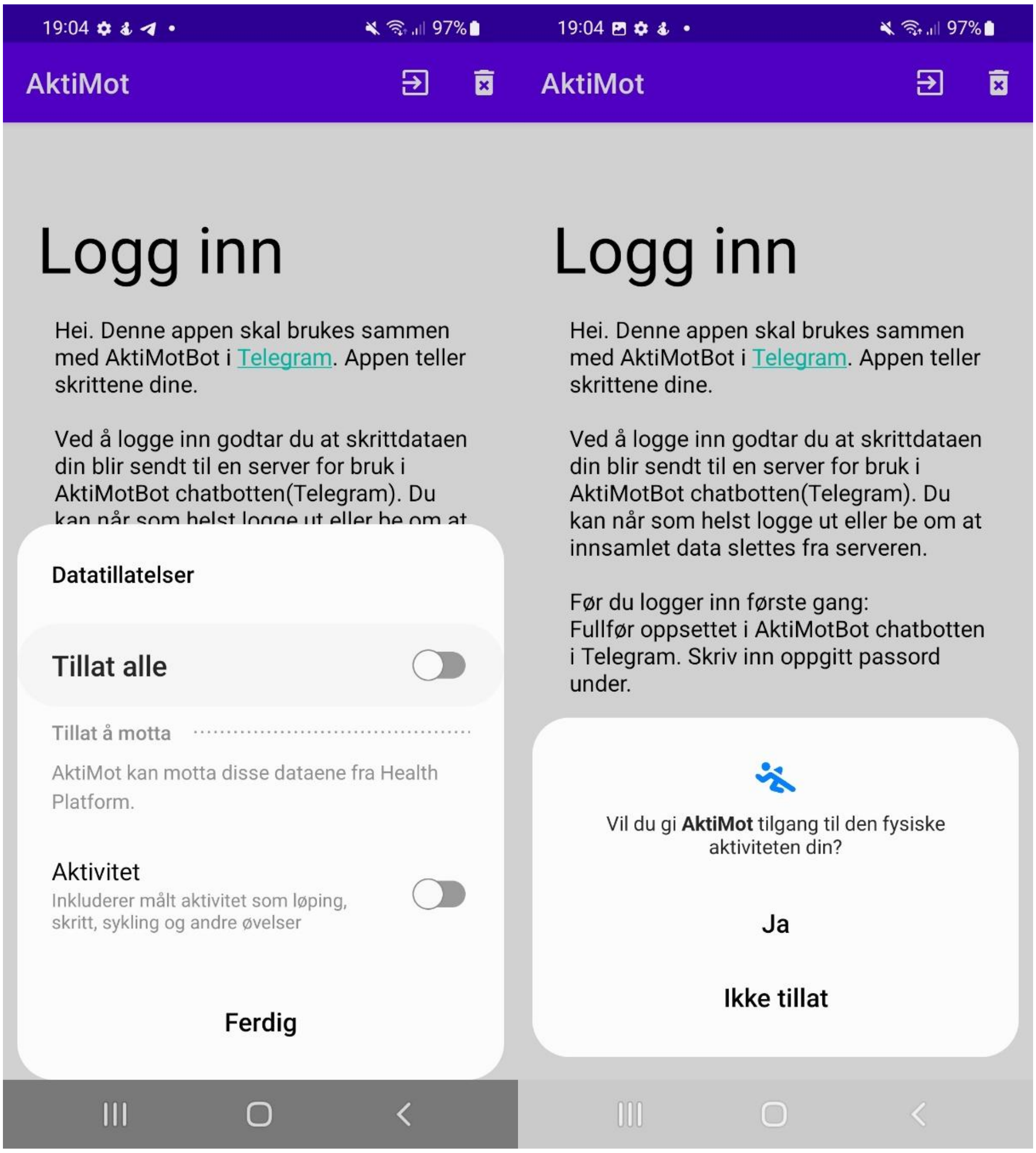
Appendix figure 3: Samsung Health settings (Figure 3 left). Connected services (Figur 4 right)



Appendix figure 4: Figure 5 - press Health Platform (left). Figure 6 - Continue/Install (right)



Appendix figure 5: Figure 7 - Ensure you choose "Allow to send" and choose Activity (left). Figure 9 – Check permissions



Appendix figure 6: Figure 8 - Accept the connection between Health Platform and AktiMot (left). Allow AktiMot to access activity data (right)

Appendix III E-mail to the data protection officer

Hei.

Jeg skriver en masteroppgave ved institutt for informatikk og skal i den sammenheng utvikle en chatbot som har som formål å motivere brukeren til å bli mer fysisk aktiv. Chatbotten bruker et sosialt medium som kontaktpunkt mellom brukeren og chatbotten og det er i tillegg en mobil applikasjon som teller antall skritt brukeren går og sender dette til en server som lagrer dette.

Dataen som samles inn igjennom mobil applikasjonen er kun antall skritt og det er ingen annen personlig informasjon som sendes fra mobilen til serveren. Det som lagres på serveren er heller ikke personlig eller sensitiv informasjon. Dataen som er lagret på serveren er:

- Brukernavn som vil være annet enn deres egentlige navn.
- Daglig skritt data fra brukeren (hvis de laster ned mobil applikasjonen)
- Historikk basert på de daglige skrittdataene
- Skritt mål
- Kanskje samtalehistorikk mellom chatbot og brukeren. Det vil ikke være sensitiv eller personlig informasjon, kun tekstmeldingene sendt mellom bruker og chatbot.

Serveren vil kjøre på en pc på UiT og serveren vil slåes av etter testen. Dataen vil også lagres på et trygt sted og slettes fra pc-en når testen er gjennomført.

Telegram er applikasjonen som skal brukes i sammenheng med chatbotten. Det er en applikasjon som har blitt utviklet med tanke på sikkerhet og dataen er sendt og lagret kryptert. Ingen sensitiv informasjon blir innhentet eller lagret via chatbotten.

Jeg er en del av Helseinformatikk og -teknologi forskningsgruppen ved IFI og sammen med veilederne mine skal jeg gjennomføre brukertester. Veilederne mine er Eirik Årsand, André Henriksen, Dillys Larbi og Elia Gabarron. Testpersonene i brukertesten vil være venner/kollegaer/familie.

Det vil være to tester. Først vil brukerne bruke systemet i en dag også svare på en spørreundersøkelse. Etter dette vil nødvendige endringer bli gjort basert på tilbakemeldinger før brukerne tester systemet på nytt og gir tilbakemeldinger gjennom en spørreundersøkelse. Spørreundersøkelsene vil ikke samle inn noen for form personlig eller sensitiv data. Det vil kun stilles spørsmål om hvordan deltakerne oppfattet løsningen og deres opplevelse med systemet. Informasjonen om deres brukeropplevelse blir innhentet via spørreskjema laget på nettskjema.no.

Det vi lurer på er om vi trenger å sende en søknad til NSD eller REK for å gjennomføre brukertestene, eller om vi kan gå i gang med testene basert på din anbefaling?

Vennlig hilsen,
Helle Sandsdalen

Appendix IV E-mail response from the data protection officer

Hei Helle,

Takk for spørsmål og orienteringen om ditt mastergradsprosjekt. Det som er avgjørende for veien videre er om du skal behandle anonyme data, dersom det er gjennomførbart, i prosjektet. Det skal lite til for at data ikke er anonyme. Det er tilstrekkelig at det er mulig å indirekte identifisere deltakerne på et eller annet steg i prosjektet. En vurdering av anonymiteten vil bero på god kjennskap til dataene som skal behandles, tjenestene som skal benyttes og fagområdet. Dersom intensjonen her er å behandle anonyme data, så fordrer det at du og dine veiledere gjør en konkret vurdering av anonymiteten og fastsetter tekniske og organisatoriske tiltak for å sikre at behandlingen er anonym. Denne vurderingen skal ikke godkjennes av noen, men dere bør ta vare på den som dokumentasjon. Dersom dere mener etter en nærmere vurdering at behandlingen er anonym, så vil ikke personvernregelverket komme til anvendelse. Prosjektet skal da ikke meldes til NSD for nærmere vurdering.

Men dersom dere kommer til at behandlingen ikke er anonym, så må prosjektet meldes til NSD. Dersom dere er i tvil om anonymiteten vil jeg anbefale at dere legger til grunn at behandlingen ikke er anonym, men at det for eksempel ikke skal behandles direkte identifiserbare opplysninger, og følge universitetets retningslinjer for behandling av personopplysninger i forsknings- og studentprosjekter, se Retningslinjer+for+behandling+av+personopplysningar+i+forskings-+og+studentprosjekt+ved+UiT+(oppdatert+300921).pdf Punkt 8 har en sjekkliste for studenter.

Videre så skal alle forskningsprosjekter som omfattes av helseforskningsloven forhåndsgodkjennes av REK. REK-sekretariatene veileder forskere om søknadsplikten.

Med vennlig hilsen

Joakim Bakkevold
personvernombud

UiT Norges arktiske universitet

Tlf. 77 64 63 22

Appendix V Questionnaire in the usability study

Spørsmål 1: Brukervennlighet

Spørsmål (S)	1 - Helt uenig	2 - Uenig	3 - Nøytral	4 - Enig	5 - Helt enig
S1 Personligheten til chatbotten var realistisk og engasjerende	☐	☐	☐	☐	☐
S2 Chatbotten virket veldig som en robot	☐	☐	☐	☐	☐
S3 Under oppsetting ved start var chatbotten veldig imøtekommende	☐	☐	☐	☐	☐
S4 Chatbotten virket veldig uvennlig	☐	☐	☐	☐	☐
S5 Chatbotten forklarte dens omfang og formål meget godt	☐	☐	☐	☐	☐
S6 Chatbotten ga ingen indikasjon på dens formål	☐	☐	☐	☐	☐
S7 Chatbotten var enkel å navigere	☐	☐	☐	☐	☐
S8 Det er enkelt å bli forvirret når man bruker chatbotten	☐	☐	☐	☐	☐
S9 Chatbotten forsto meg bra	☐	☐	☐	☐	☐
S10 Chatbotten klarte ikke å gjenkjenne mange av mine spørsmål/svar	☐	☐	☐	☐	☐

S11 Chatbotten sine svar var nyttig, passende og informativ	☐	☐	☐	☐	☐
S12 Chatbotten sine svar var irrelevant.	☐	☐	☐	☐	☐
S13 Chatbotten håndterte nesten alle mine feil bra	☐	☐	☐	☐	☐
S14 Chatbotten virket ikke i stand til å håndtere noen av mine feil	☐	☐	☐	☐	☐
S15 Chatbotten var veldig enkel å bruke	☐	☐	☐	☐	☐
S16 Chatbotten var veldig kompleks.	☐	☐	☐	☐	☐

Spørsmål 2: Angi bevegelse og kroppslig anstrengelse i din fritid det siste året.

Hvis aktiviteten varierer gjennom året, ta et gjennomsnitt. Sett kryss i den ruta som passer best.

1. Lese, se på TV, eller annen stillesittende aktivitet
2. Spaserer, sykler eller beveger deg på annen måte minst 4 timer i uka (inkludert gang eller sykling til arbeidsstedet, søndagsturer etc)
3. Drivermosjonsidrett, tyngre hagearbeid, snø måking etc, minst 4 timer i uka
4. Trener hardt eller driver konkurranseidrett regelmessig flere ganger i uka

Spørsmål 3: Ville du anbefalt chatbotten til venner og/eller familie?

1. Ja
2. Nei
3. Kanskje

Spørsmål 4: Sluttet du å bruke chatbotten før testperioden var over?

1. Ja
2. Nei

Hvis ja på spørsmål 4 – forklar hvorfor

Spørsmål 5: Syns du antall meldinger chatbotten sendte om dagen var passende?

1. Ja, det er passende

2. Nei, reduser antall meldinger
3. Øk antall meldinger
4. Mulig å dynamisk endre på deg

Spørsmål 6: Var du mer bevisst på ditt daglige skritt mål i tiden du brukte chatbotten sammenlignet med før du brukte chatbotten?

1. Ja, jeg ønsket å nå målet mitt
2. Nei, den hadde ingen innvirkning på meg.
3. Ja, men jeg gjorde ikke mer for å nå målet mitt

Spørsmål 7: Følte du på økt motivasjon når du brukte chatbotten?

1. Ja
2. Nei

Forklar hvordan motivasjonen din ble påvirket

Spørsmål 8: Ble du glad/motivert av å få skryt fra chatbotten dersom du klarte målet ditt?

1. Ja
2. Nei
3. Nådde ikke målet mitt

Spørsmål 9: La du inn ekstra innsats for å nå målet ditt basert på chatbotten sin melding på ettermiddagen (dersom du ikke allerede hadde nådd målet ditt)?

1. Ja
2. Nei

Spørsmål 10: Hvilket kjønn er du?

1. Mann
2. Kvinne
3. Annet

Spørsmål 11: Hvilken aldersgruppe tilhører du?

1. 18 – 25 år
2. 26 – 35 år
3. 36 – 45 år
4. 46 – 55 år
5. 56 – 65 år
6. Over 65 år

Spørsmål 12: Forslag til forbedring eller andre ting du ønsker å få frem

Appendix VI Validated chatbot usability questionnaire in English

CHATBOT USABILITY QUESTIONNAIRE

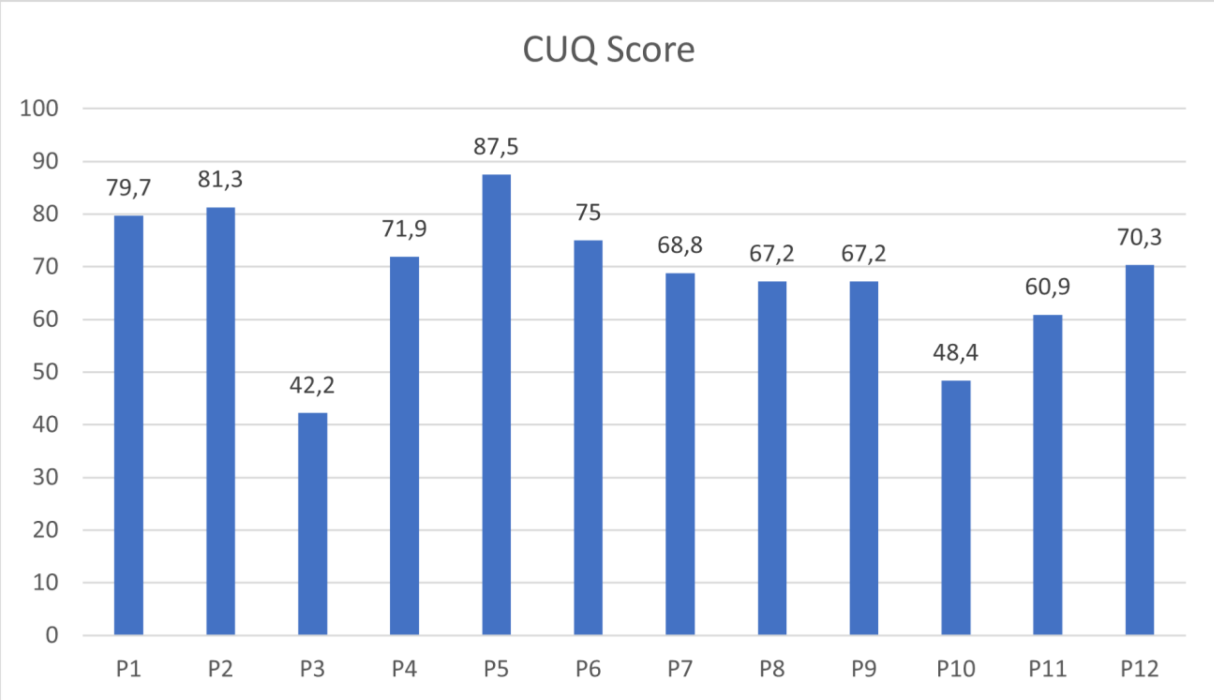
Please complete this questionnaire by reading each statement carefully and placing a tick (✓) or a cross (×) in the circle that best matches how you feel about the statement. Remember that there are no right or wrong answers!

	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
The chatbot's personality was realistic and engaging	○	○	○	○	○
The chatbot seemed too robotic	○	○	○	○	○
The chatbot was welcoming during initial setup	○	○	○	○	○
The chatbot seemed very unfriendly	○	○	○	○	○
The chatbot explained its scope and purpose well	○	○	○	○	○
The chatbot gave no indication as to its purpose	○	○	○	○	○
The chatbot was easy to navigate	○	○	○	○	○
It would be easy to get confused when using the chatbot	○	○	○	○	○
The chatbot understood me well	○	○	○	○	○
The chatbot failed to recognise a lot of my inputs	○	○	○	○	○
Chatbot responses were useful, appropriate and informative	○	○	○	○	○
Chatbot responses were irrelevant	○	○	○	○	○
The chatbot coped well with any errors or mistakes	○	○	○	○	○
The chatbot seemed unable to handle any errors	○	○	○	○	○
The chatbot was very easy to use	○	○	○	○	○
The chatbot was very complex	○	○	○	○	○

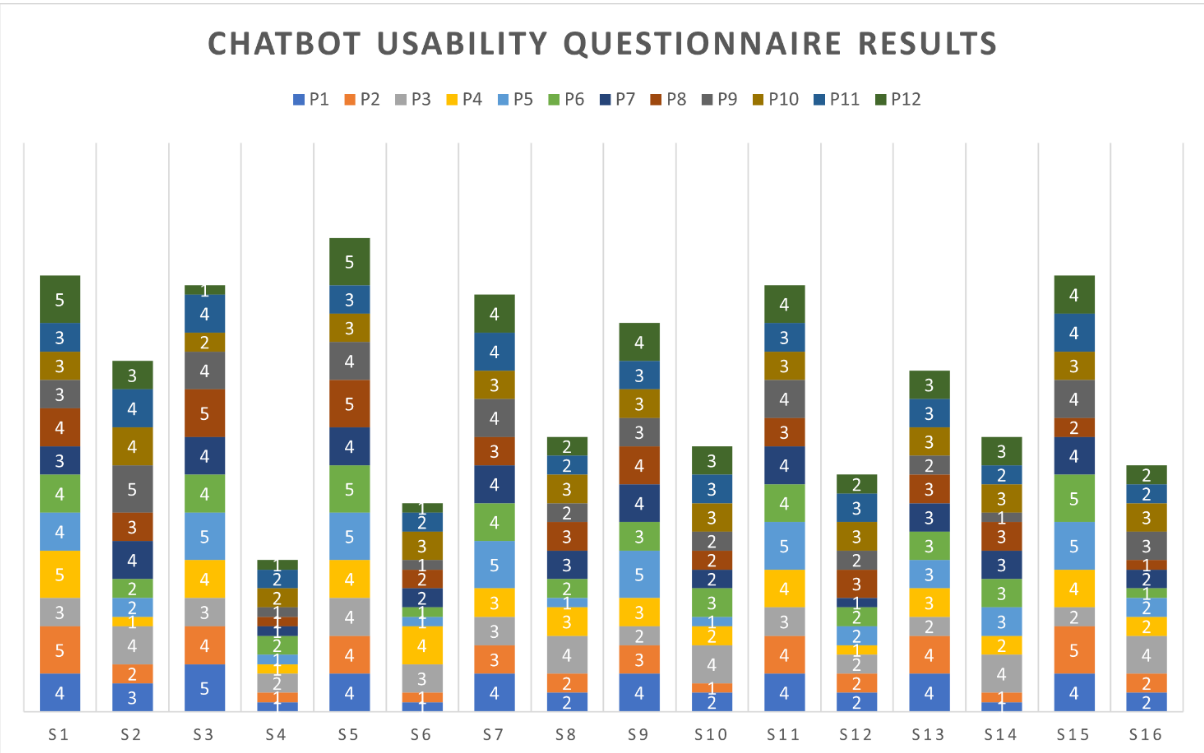
Appendix figure 7: Validated Chatbot usability questionnaire in English [2]

Appendix VII Graphical representation of questionnaire findings

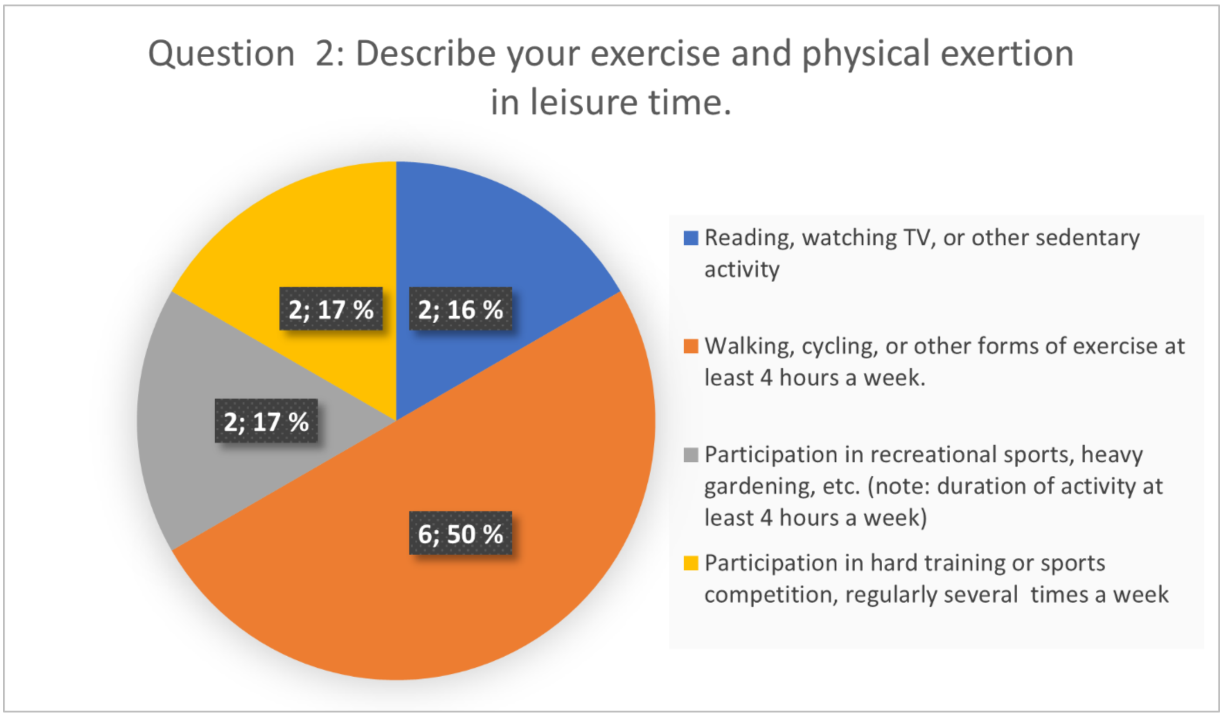
Appendix figure 8 – 19 depicts the results for each question from the usability study questionnaire.



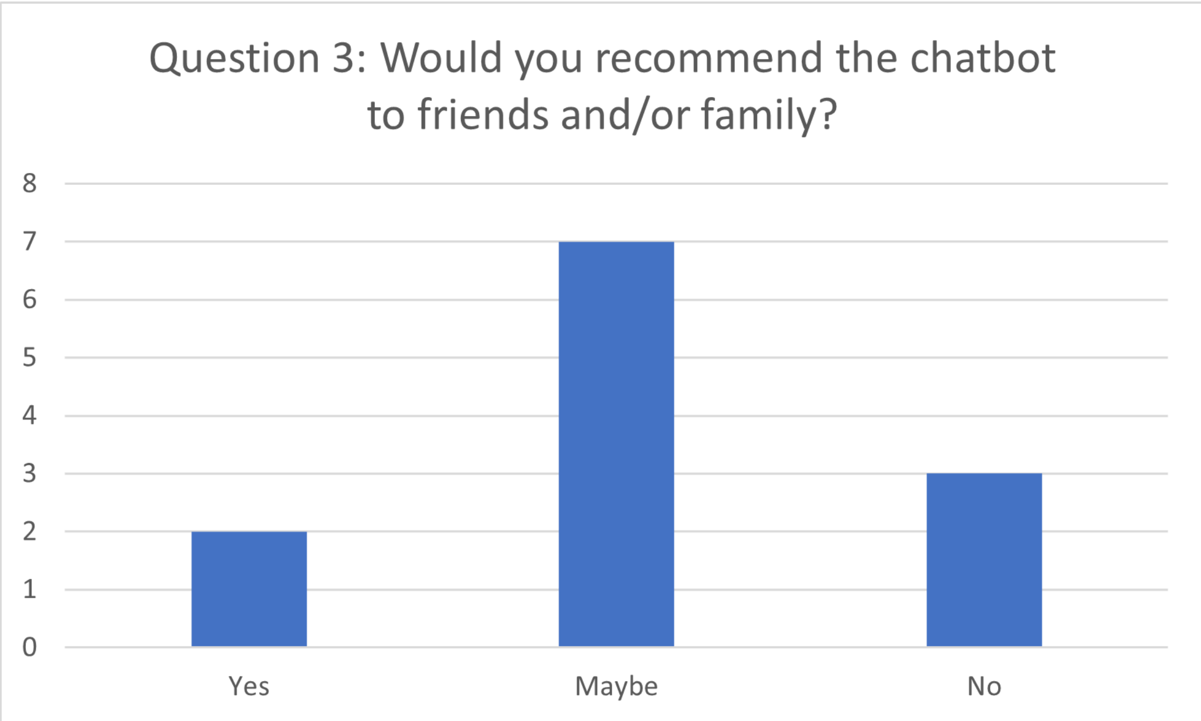
Appendix figure 8: Calculated CUQ scores per participant



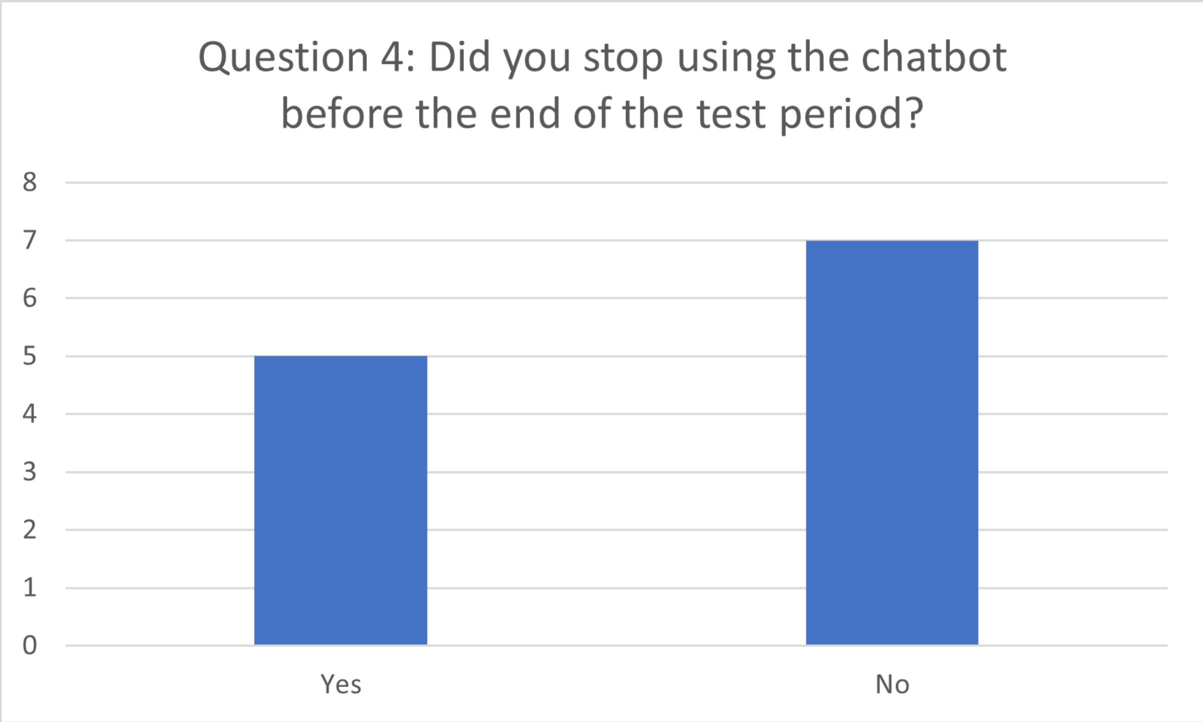
Appendix figure 9: Results from each statement of the CUQ. Odd statements are positive features, and even statements are negative features



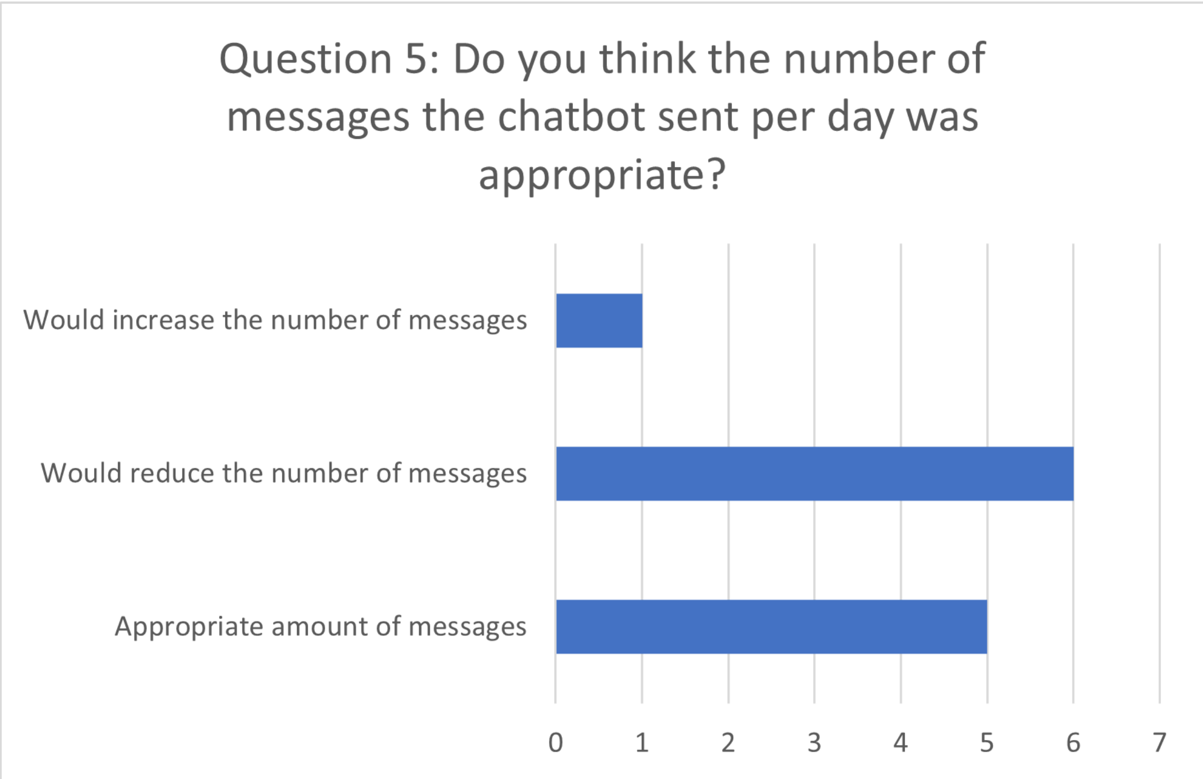
Appendix figure 10: The results from question 2 – showing the distribution of leisure time in participants



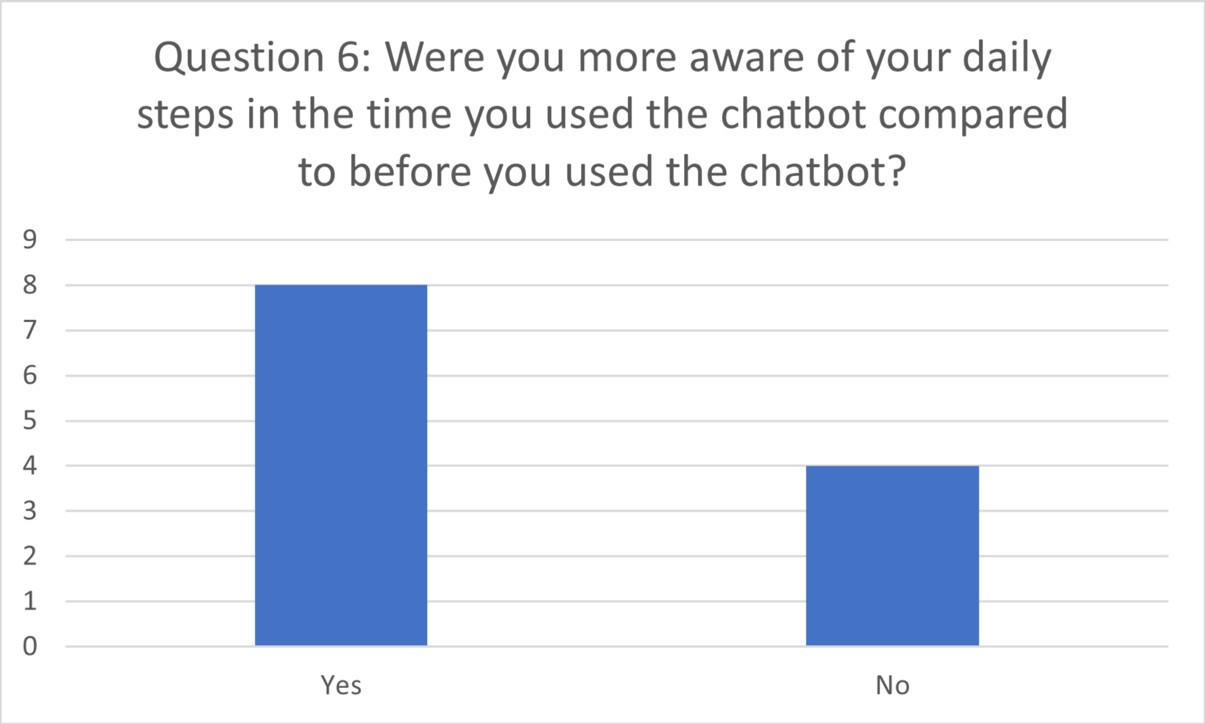
Appendix figure 11: Distribution of question 2 – if the participants would recommend the chatbot to family or friends



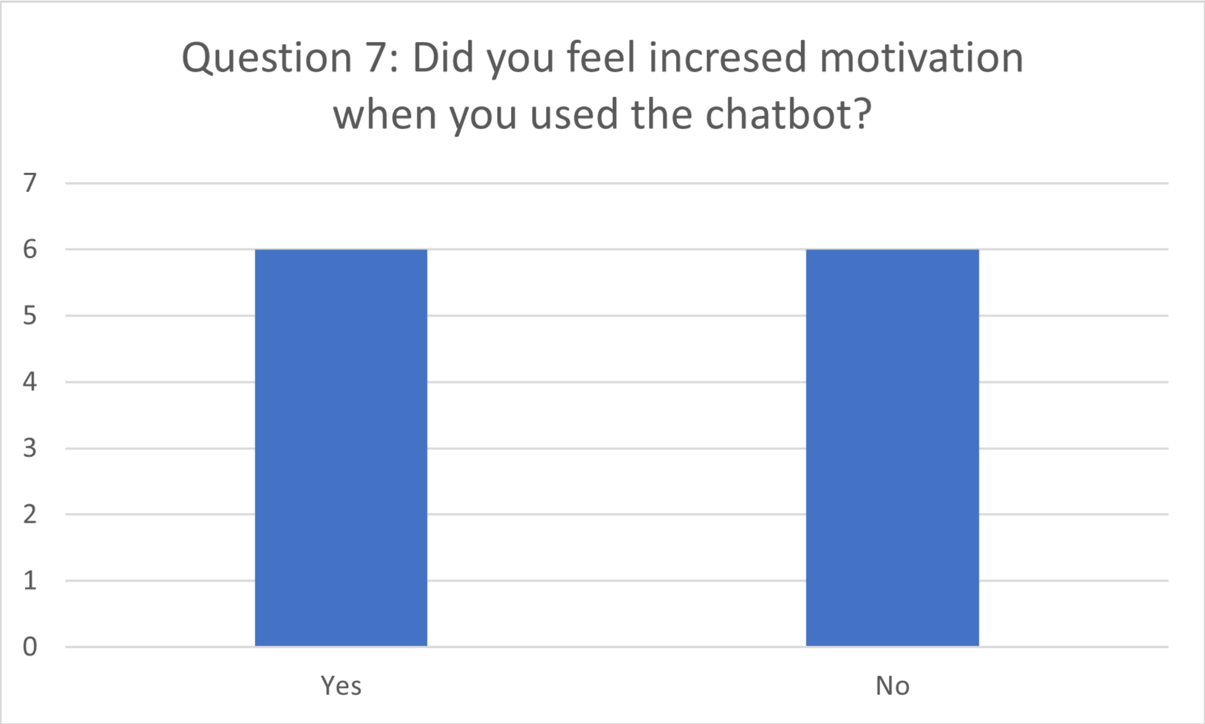
Appendix figure 12: Shows how many stopped using the chatbot during the test period and those finishing the whole test period.



Appendix figure 13: Depicts the feedback on what the users thought of the number of messages

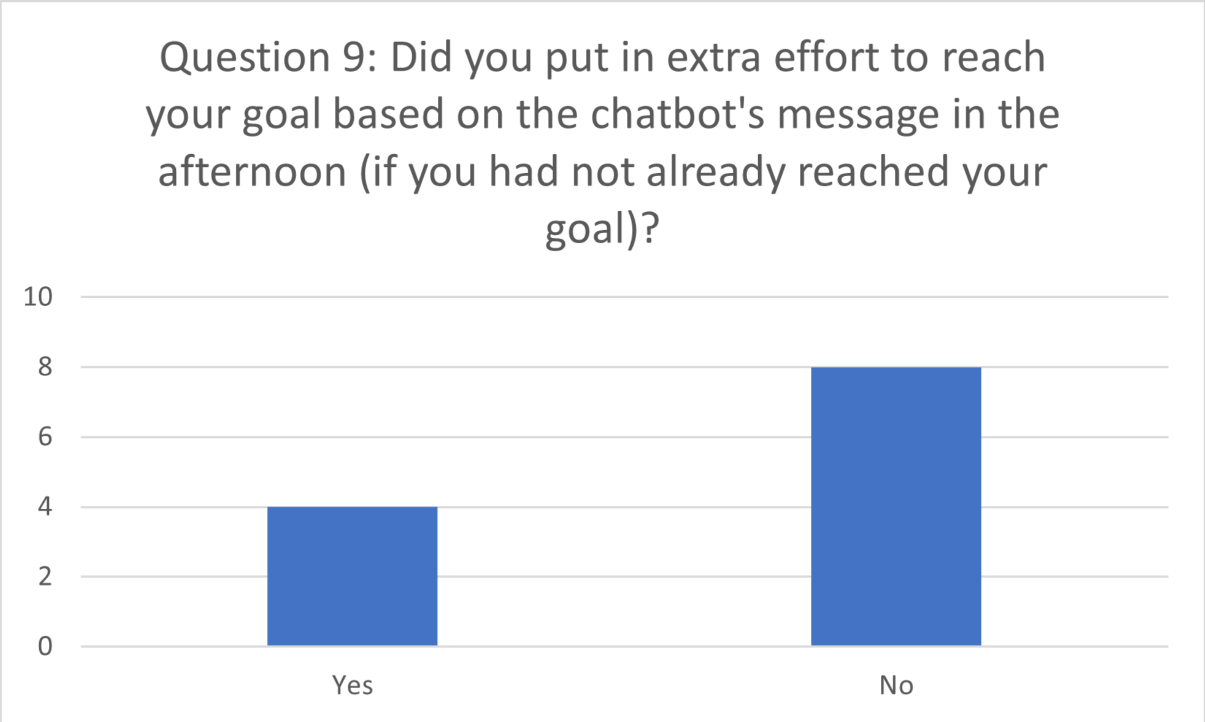


Appendix figure 14: Shows the distribution of how many were more aware of their step count after using the chatbot

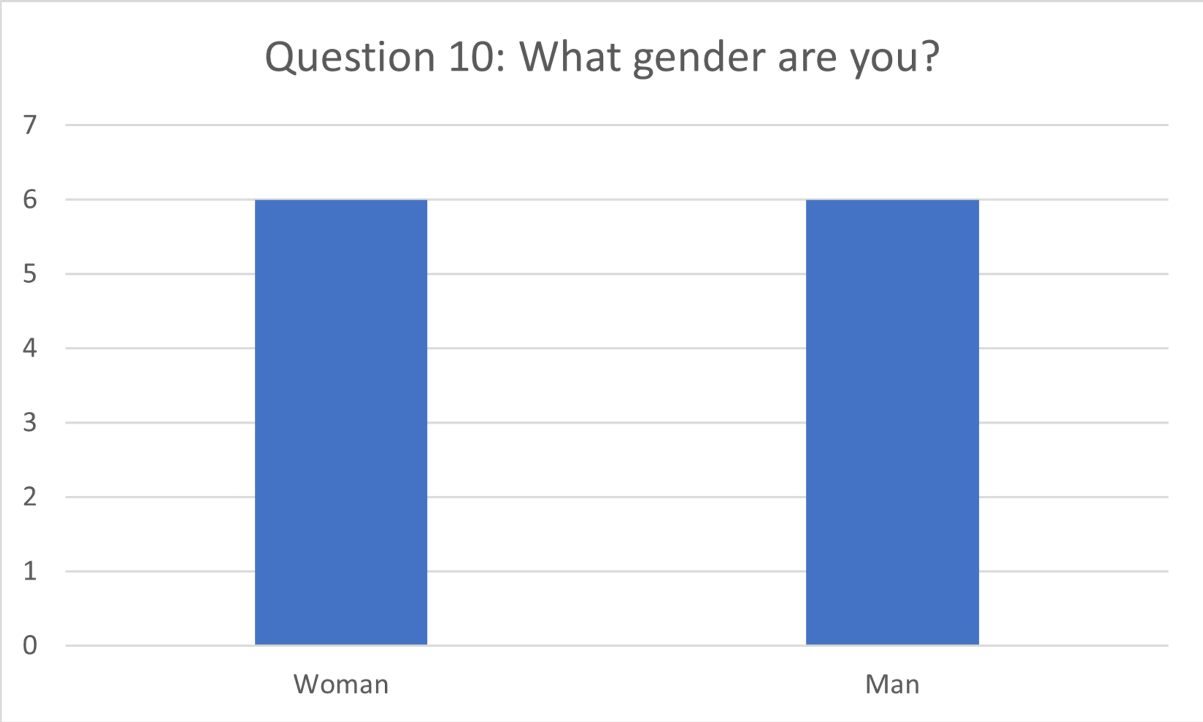


Appendix figure 15: Show distribution of increased motivation

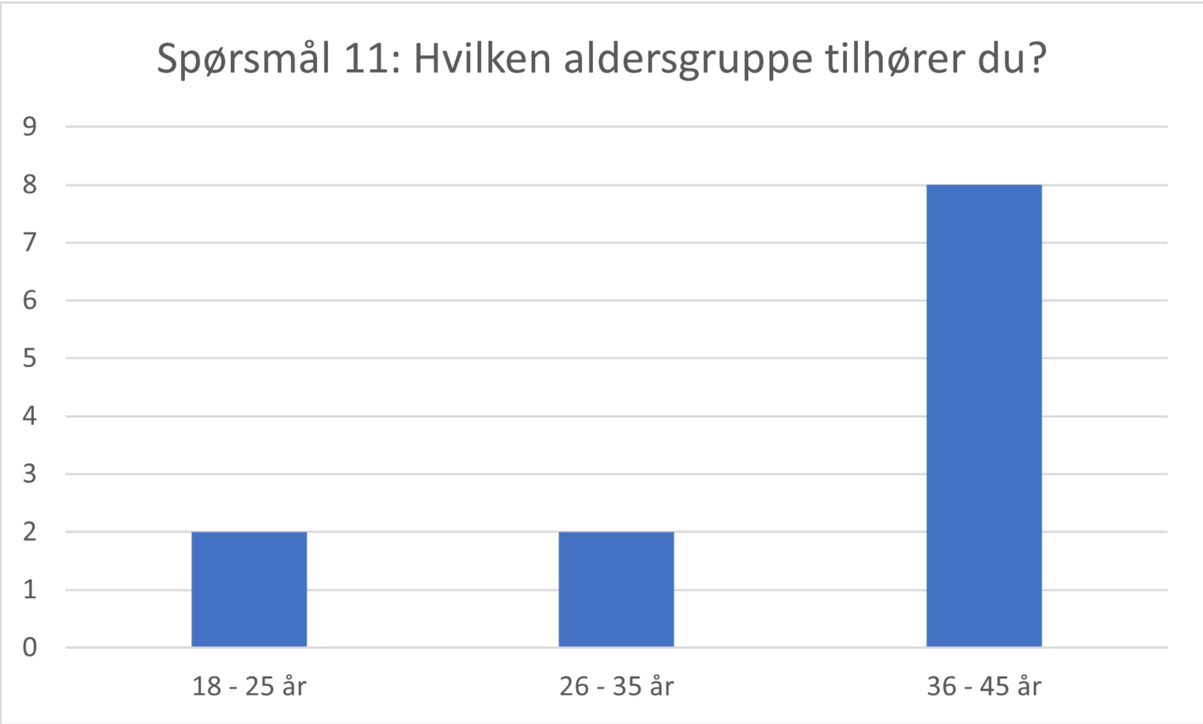
Appendix figure 16: Result from question 8 asking if the users were more motivated/happy from the chatbot messages



Appendix figure 17: Result from question 9 asking the user if they put in extra effort to reach their goal after receiving the afternoon message



Appendix figure 18: Shows gender distribution



Appendix figure 19: Age distribution