

BACHELORTHESIS

IT in the therapy process

How can an IT solution help a mental health professional with following up on their clients within the therapy process?

Bachelor	Applied Computer Science
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Major	Software & Systems Engineer
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Academic year	2018 - 2019
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Student	Ruben Dewitte
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Internal supervisor	Stijn Van Hijfte
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Preface

After three years of Applied Computer Sciences, this bachelor thesis and my internship is the ideal way to close an important chapter in my life.

First of all I would like to thank my internal supervisor Stijn van Hijfte for the guidance he gave during the writing of my Bachelor thesis. Also I would like to thank my external promoter Enzo Egghermanne and the people of Studio Hyperdrive for the technical support. Every time they gave me good tips and interesting remarks, which helped greatly with finishing this bachelor thesis.

Furthermore I would like to thank my parents for their support.

Moreover I would like to thank everyone who proofread my bachelor thesis. This allowed me to improve my thesis where necessary.

Finally I would like to thank my partner for the support she gave me over the past year. She encouraged me to continue even when things weren't going so well.

Summary

The prevention of mental health disorders is a very topical issue. A commonly used method to treat mental health disorders is psychotherapy under the guidance of a mental health professional (Mental Health America, 2019).

A mental health professional can only base their decisions on the information obtained from the patient. Therefore a large part of the responsibility on how the therapy progresses, lies with the patient (Smith & Segal, 2018).

Clients often experience difficulties talking about their problems. The information that is verbally provided by the client during a consultation after a number of weeks is often inaccurate. Important information remains unmentioned or is forgotten (Grohol, 2018).

Due to a lack of (accurate) information, the mental health professional is unable to give effective counselling. Also as a result, wrong decisions could be taken regarding the diagnosis of the mental disorder or the treatment of the mental disorder.

In addition, clients often have difficulties actively partaking in the therapy process. The side-effects that many different mental disorders share, can make it more difficult for clients to actively participate. The most common problem that clients with, for example depression, experience is having low energy levels which causes them to not be able to execute simple tasks (TheInsideStory, 2008).

Following this thesis, a system consisting out of a mobile application and a web application was developed to help aid in the therapy process. This was done by giving mental health professionals a better oversight of a client's mental state using the web application.

Clients were encouraged to keep track of their mood, emotions, experiences and thoughts. In addition clients were also encouraged to partake in the therapy process by aiding them with performing tasks. This was done with the help of a mobile application.

Glossary

API	A set of routines and protocols that allows applications to communicate with one another.
Brute-force	A method used to crack passwords, where the attacker simply submits a large amount of passwords with the hopes that one of the submitted password is the correct one.
Mental health professional	A health care practitioner who offers services aimed at improving the mental health of an individual.
APK	The file format that is used for mobile applications on an Android device.

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1 Research Question

Currently there are a lot of applications available that are targeted towards helping people with mental health issues (Psycom, n.d.). These applications include tools that for example help people recognise patterns in their mood, they provide methods to cope with various mental issues and they provide activities that can reduce symptoms of these mental issues.

The effectiveness of these types of applications could be combined with, or used within the therapy process.

In addition, the effectiveness of therapy is based on how well a mental health professional can guide their clients, only the client can make the necessary changes to move forward (Smith & Segal, 2018). Therefore the most effective way to further improve the therapy itself, would be to help the mental health professional help their clients.

This thesis will mainly focus on the connection between the mental health professional and their clients and how this connection can be improved.

With this information, the following research question can be formed: “How can an IT solution help a mental health professional with following up on their clients within the therapy process?”.

2 Research

Before we can continue with the technical implementation and technical research of this thesis, I first need to elaborate shortly on the psychological aspect of this research.

2.1 A brief introduction to Psychology

A mental disorder or also called mental illness is characterized by deviant behaviour and experiences (Wikipedia, 2019).

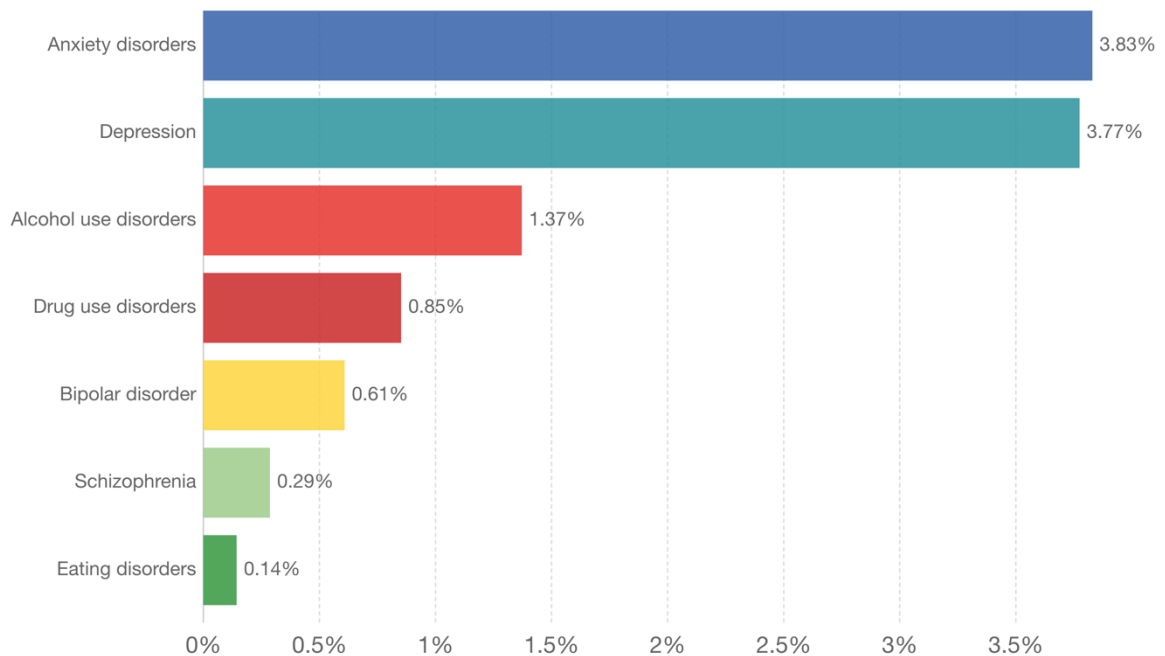
It is estimated by the Global Burden of Disease that over 1.1 billion people worldwide suffered from a mental or substance disorder in 2016. Roughly speaking this is 14.4% of the world population.

The most common mental disorders are anxiety disorders and depression. Approximately 4% of the world population suffers from either of them (Our world in data, 2018).

Prevalence by mental and substance use disorder, World, 2016



Share of the total population with a given mental health or substance use disorder. Figures attempt to provide a true estimate (going beyond reported diagnosis) of disorder prevalence based on medical, epidemiological data, surveys and meta-regression modelling.



Source: IHME, Global Burden of Disease

CC BY

Figure 1: Prevalence by mental and substance use disorder, World, 2016

2.1.1 Anxiety and depression

Anxiety disorders and depression are the most common mental health disorders as depicted above.

What are anxiety disorders?

According to the U.S. Department of Health & Human Services, anxiety disorders are a group of mental health disorders that are characterized by feelings of anxiety and fear (What are the five major types of anxiety disorders?, 2014).

The most common anxiety disorders are:

- Generalized Anxiety Disorder
- Obsessive-Compulsive Disorder (OCD)
- Panic Disorder
- Post-Traumatic Stress Disorder
- Social Anxiety Disorder

These anxiety disorders have many symptoms in common; lack of sleep, excessive worrying, anxiety and so forth.

What is depression?

Depression (major depressive disorder or clinical depression) is a common mood disorder. It negatively impacts many things such as your sleep, your appetite and the amount of energy you have. It generally makes everyday life a lot harder (Overview of depression, 2018).

Depression and anxiety disorders are two different types of disorders. However, many people who suffer from depression experience the same symptoms to those of an anxiety disorder. No study proves that there is a correlation between the two disorders, however many people who suffer from depression also suffer from anxiety disorders (Understanding depression, 2019).

2.1.2 Psychotherapy

There are many forms of psychotherapy, the most commonly practiced therapy method is cognitive-behavioural therapy also known as CBT (David, Cristea, & Hoffman, 2018).

What is CBT?

Cognitive Behavioural Therapy is a type of psycho-social intervention that aims to improve the mental health of a person. It focuses on challenging negative thoughts or feelings a person has about him or herself and the world, in order to change unwanted behaviour patterns. It also helps people to develop personal coping strategies that are aimed at solving existing problems (Cognitive Behavioural Therapy, 2019).

CBT is an evidence based psychological treatment that is used to help deal with many different behavioural disorders. It is proven to be an effective treatment method for anxiety disorders and depression (Hoffman, Asnaani, Vonk, Sawyer, & Fang, 2012).

Problems with cognitive therapy

In general CBT is a great way to deal with a wide range of mental disorders. However it also has its disadvantages.

The main issue with CBT is that the person has to commit to the process. A mental health professional can only advise what the client should do in order to improve their behaviour, or how to deal with certain situations. A problem that clients face is that they have a hard time committing to this process due to their depressive symptoms (Grohol, 2018).

CBT can only be effective when the client is truthful to their mental health professional about how they feel. Clients sometimes struggle telling their mental health professional vital information that can help them improve their mental problems (Grohol, 2018).

Clients are afraid that their mental health professional will judge the way they think. They are often in denial or they don't know what information is relevant for the therapy process. In addition clients sometimes have learned to skilfully lie about their problems to avoid having to confront them (Grohol, 2018).

These issues can reduce the effectivity of CBT; they can cause mental health professionals to misdiagnose their clients or they can drastically slow down the process (Grohol, 2018).

2.1.3 Effective ways to deal with symptoms of anxiety and depression

Besides therapy there are other effective ways to deal with a majority of the symptoms caused by depression and anxiety. The two most effective and most recommended methods are consistently exercising and having a stable sleeping schedule (Tips, 2019).

Exercise

There is strong evidence that exercise and regular activity positively impact the pathophysiological processes of anxiety (De Moor, Beem, Stubbe, Boomsma, & De Geus, 2006; Anderson & Shivakumar, 2013).

Exercise is said to sometimes be as effective as medication and has the possibility to heavily reduce symptoms of depression (Stonerock, Bension, Smith, & Blumenthal, 2016; Exercise for Stress and Anxiety, 2019).

Sleep

Sleep disturbance is also a common factor for depressive symptoms. A successful management of sleep disturbance is needed in order to improve the quality of life of people who struggle with depression (Nutt, Wilson, & Paterson, 2008).

2.2 Technical research and elaboration

The main focus of this thesis is to develop a practical solution to the communication issues that occur between mental health professionals and clients. This will be done by tackling the most common issues that occur in behavioural therapy as described above.

The following issues will be evaluated:

- Inability to convey information that is vital to the therapy process
 - o Forgetting certain information
 - o Being too afraid to convey said information
 - o Not knowing what information is relevant to the therapy process
- Inability to commit to the therapy process
- Inability to perform certain tasks imposed by the mental health professional
 - o Not having the right mindset or energy to commit due to the symptoms of their mental disorder

2.3 Tackling the issues

As listed above several issues will need to be addressed. This chapter will talk more in depth about these issues and how they can be properly dealt with.

2.3.1 The inability to convey information that is vital to the therapy process

Many clients have issues with conveying information correctly to the medical health professional, either because of insecurities or by for example forgetting the essence of problem.

Mood charting

A solution to this problem could be tracking data of the client daily (such as their mood) so the mental health professional can better keep track of the client's mental state. According to the research of Bauer, et al. (2006) daily mood charting complements the monitoring process of the mental health professional and provides both the mental health professional and client with many benefits.

In Bauer's study many patients were asked to self-report data such as their mood and sleep using an automated computer-based reporting system.

Using the collected information the mental health professional would be able to more properly guide, diagnose the client, and for example see which medication works best for their client.

The study showed that the possible bias self-reporting has, is significantly higher with paper-based mood charting compared to computer-based mood charting. Automated mood charting with the use of computers is also said to have a positive effect on the data quality.

The information collected can be used to help mental health professionals aid clients with identifying triggers and develop coping strategies (Mayo Clinic, 2019).

According to another study by Matthews, Doherty, Sharry, & Fitzpatrick (2018), evidence was provided that the mobile phone could be an effective platform for adolescents to record their moods.

Which data should be collected?

As such to help support the conveyance of information to the mental health professional, tracking several points of interest with the use of an IT application could be a possible approach.

To know which data should be kept track of we can use the study of Bauer, et al. (2006) as a starting point. In said study the following data items were collected as well as the frequency of the data which was collected.

Data Collected	Description	Frequency of Collection
Mood	Overall mood for the prior 24 hours, in relation to extreme anchor points set for patient	Daily
Sleep	Awake, asleep, or in-bed and awake for each hour of the day	Daily
Medications	Name and dosage of all psychiatric medications taken in the prior 24 hours	Daily
Life Events	Patient description of significant life events in the prior 24 hours	Daily
Menstrual Cycle*	Menstrual bleeding over the prior 24 hours (Y/N)	Daily
Weight	Body weight	Weekly

* Only collected from pre-menopausal women.

Figure 2: Data collected with ChronoRecord (Bauer, et al., 2006)

Points of interests

Starting from the study of Bauer, et al. (2006) only the data items that are seen as most relevant will be described in depth. Since the data items “medication” and “menstrual cycle” are only for specific use cases, these will be omitted.

Mood and emotion

In the study of Bauer, et al. (2006) clients were asked to enter a single rating (a single number) that represented their mood over 24 hours.

Several psychological frameworks have been developed as a method to identify how someone feels or in other words the current emotions they experience (Carmichael, 2012).

A simple classification method used to identify emotions is the Circumplex Model of Affect developed by James Russel in 1980.

This model splits emotions into two different dimensions, where the x-axis represents how pleasant an emotion is and where the y-axis describes whether the emotion is of high or low arousal.

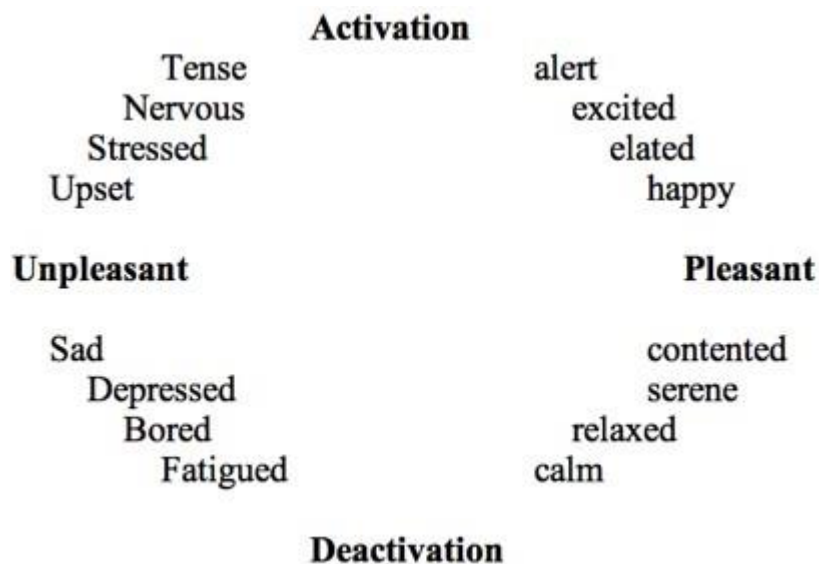


Figure 3: The Circumplex Model of Affect (Russell, 1980)

For example, feeling anxious is seen as an unpleasant emotion of high arousal (energy).

Next to the Circumplex model there are many other frameworks such as the ‘Lövhelm cube of emotion’, all of which are not practical for the use of determining someone’s emotions and are more used as a classification tool.

As previously mentioned the frequency of the determination of a person’s mood is more important than the detail of the determination (Bauer, et al., 2006). As long as the information is accurate it will have value. Since the determination has to be done by the clients themselves it would be better to use a more simplified method.

Thereafter, the self-reporting mood tracking mobile application “Daylio” targeted towards the general population, uses a more simplistic approach. It uses a smiley based system to determine a person’s mood.



Figure 4: Smileys: screenshot taken from the Daylio mobile app

The IT solution to our problem would require a more precise and accurate tracking of one’s mental state. A purely based smiley system does not describe what emotions a person is feeling.

A more accurate description of the client’s mood and emotions would be beneficial for both the client and the mental health professional. When both parties can better understand how the client feels, they can both work on developing ways to deal with these feelings.

In the study conducted by Matthews, Doherty, Sharry, and Fitzpatrick (2018) smileys were used to determine how a person felt on a specific day. Participants were also asked to note down how much energy they had and what thoughts they had each day.

A combination between a basic smiley system to determine a client’s mood and a more research based emotion classification method to determine how a person feels, would be a good middle ground.

Sleep

The determination of sleep is rather simple, the client has to be able to keep track of when they were asleep or awake. This can be done by simply asking the client how many hours he or she slept on that day.

Life Events

Life events in general, can have a significant influence on a person's mental state (Cleland, Kearns, Tannahill, & Ellaway, 2016). Therefore it is important that the mental health professional knows about said events.

Weight

People that struggle with anxiety and depression are more prone to neglecting their own health, due to for example, their lack of self-esteem and having low energy levels. Symptoms of depression can cause people to lose track of their food intake (Mental health and weight, 2019).

Since in our society, where a healthy weight is valued, there are also people who constantly pressure themselves about their weight, causing them to feel depressed or anxious (Mental health and weight, 2019).

If a mental health professional can oversee the changes in a client's weight, they can prevent them from developing eating disorders. They can properly guide and advise the client about the importance of maintaining their food intake.

2.3.2 The inability to commit to the therapy process

A problem that clients experience with CBT is that they lack the ability to commit to the process. This is mostly due to the symptoms of their mental illness, such as lack of energy or self-confidence (Cognitive behavioural therapy, 2016).

It is a common practice in CBT for mental health professionals to assign tasks to their clients. However, since the completion of these tasks completely depends on the client, it is possible that these tasks are neglected due to, for example lack of energy (Shpancer, 2018).

Since the effectiveness of the therapy process is based on how well the client is willing to cooperate with the mental health professional, it is important that the clients are stimulated to execute the given tasks (Shpancer, 2018; Smith & Segal, 2018).

An approach that could be used to stimulate clients to perform the assigned tasks is by helping them to form a habit.

According to the study of Stawarz, Cox, and Blandford (2014) time-based cues (reminders) in smartphone apps keep people engaged and help them to repeat the behaviour. This could for example be achieved with the help of some sort of notification on mobile device.

2.4 A solution proposal

The focus of this thesis is mainly directed towards the development, the architecture and the design of an IT solution that can help provide a solution to the problems listed in previous chapters.

Concept

The main idea is to tackle the common issues with CBT as described above. While doing so it will also strengthen the relationship between mental health professionals and their clients.

Clients will need a way to convey information, that is vital to the therapy process, to the mental health professional. This could be automated or electricized in the form of an application.

On the other hand, mental health professionals will need a system where they can view, keep track and analyse the data provided by the clients.

To help stimulate clients with the conveyance of the information, the client could be stimulated to log this information on a daily basis. Any information that can help a mental health professional in their practice is seen as vital and of use. This stimulation will in turn also encourage clients to be more engaged within the therapy process.

The data collected in the study of Bauer, et al. (2006) and In the study of Matthews, Doherty, Sharry & Fitzpatrick (2018), will be used as a reference to which information is seen as crucial in the therapy process. This data consists of a client's daily mood, emotions, experiences, thoughts, sleep pattern and their weight.

Additionally, to help clients aid with their commitment in therapy, clients could be assigned tasks. The status of these tasks could then be provided to the mental health professional, so he or she can then adapt the therapy process accordingly.

A reminder system, could also stimulate the client to continuously log their mood entries or could help them execute the assigned tasks.

The mental health professional will need to be able to 'subscribe' to their client. They will need to be able to view, review and analyse the information that has been logged by the client. In order to make the analysis of the data more practical, mental health professionals could be provided with a statistical representation of the data. Besides that they will also need to be able to assign cognitive therapy-related tasks to a specific client.

A clear overview of the clients data and his or her progress could help the mental health professional adapt their therapy accordingly. It will at least give the mental health professional more room to work with.

Design

According to the National Institute of Mental Health (Mental Illness, 2019), the majority of people that suffer from a mental illness (22.2%) are young adults (ages 18-25). Thereafter the majority of people that own a smartphone (94%) are of the same age category.

Considering that, people seeking help will most likely be young adults, developing a mobile application as a tracking device would be the best choice in that case.

The application used by the mental health professional will have to represent a lot of data. This data will have to be represented in a way that is easy to understand and interpret. Mental health professionals usually use computers to aid them in their practice. Therefore it would be logical to develop an application that can be used on a computer.

The development of the solution will be split into two applications, a mobile application targeted towards the clients and a desktop application targeted towards the mental health professionals.

Architecture

Both the mobile and web application need to be able to access the data collected by the client and added by the mental health professional.

Considering this it would be a logical choice to setup a single API that is shared between both applications as depicted in the schema.

The API will in turn read and write data from a database.

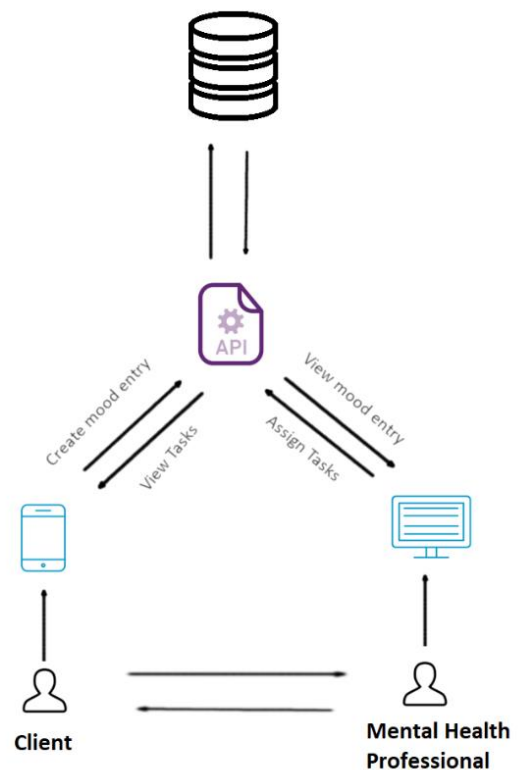


Figure 5: Depiction of the architecture

2.5 Backend

2.5.1 RESTful API

A RESTful API, also known as a REST web service, is an application program interface that is based on the REST architecture. It allows users to use HTTP requests to, for example, GET data from a database (Redka, 2016).

The API in our architecture will only serve one purpose and that is database access, considering this, using a REST web service is a considerable choice.

2.5.2 Technologies

Both the web application and the mobile application will be developed using JavaScript as the main programming language. Being able to write one scripting language across the development stack, makes maintaining applications a lot easier. NodeJS would be the preferable choice of technology for the backend API.

NodeJS' single-threaded event driven system is good at handling many requests at once from many different clients and at handling I/O-bound applications. This makes NodeJS well suited for our architecture. Last but not least, there are many 3rd party libraries available through the npm system for both client and server (Neagoie, 2018).

Express

Express is a light-weight web application framework that is used to build web applications and web APIs. It is the most popular NodeJS framework and it is used mainly for efficiency and ease of development. NodeJS together with the Express framework will be used in the development of the API (Express, 2019).

2.6 Database

2.6.1 Technologies

Before the technologies can be decided the requirements of the database must first be listed.

Requirements

- Highly scalable

The database needs to be able to handle large amounts of data. Each client will be able to store a large amount of mood entries. Over time this will stack up relatively fast.

- Flexibility

The data that needs to be collected could change over time, it would be beneficial if data models could easily be modified.

- Speed

Handling large amounts of data can cause issues with speed as the database scales up. Ensuring that the user experience is not affected by this, high performance is necessary.

Relational databases and NoSQL Databases

Currently the most popular types of databases are relational (SQL) databases and non-relational (NoSQL) databases (DB-Engines Ranking, 2019).

Relational databases store data in tables and rows. While non-relational databases store data in collections of, for example JSON objects.

The top widely used SQL databases according to the DB-Engines Ranking (2019) are currently:

- Oracle
- MySQL
- Microsoft SQL Server

The top widely used NoSQL databases according to the DB-Engines Ranking (2019) are currently:

- MongoDB
- Redis
- Cassandra

SQL databases are used when the data stored is very structured and when there is need for ACID compliance. ACID stands for atomicity, consistency, isolation and durability (Chan, 2019).

ACID protects the integrity of your database by describing exactly what interactions do in the database (Chan, 2019).

While in NoSQL databases the data that is stored is mostly unstructured. SQL databases put their focus more on the ACID compliance while the focus of NoSQL database is put on flexibility (Chan, 2019).

NoSQL databases offer a lot of flexibility due to removing the object-relational mapping (ORM) layer, which allows for data models to be easily changed without having to redesign the entire database structure (Homan, 2014; MongoDB, 2019).

Another difference between SQL and NoSQL databases is how their scalability works. NoSQL databases are mostly horizontally scalable. This means that the capability of the database can simply be increased by adding more servers, these servers will in turn work as a single unit. While SQL databases are mostly vertically scalable, they can increase the capacity of the existing hardware by adding more resources (Shiff & Rowe, 2018).

For this use case, that data that will be stored, will need to be flexible since what information will be stored could change over time. The data will also be stored in large amounts. Since the majority of the data that will be stored, are standalone pieces of data (such as a single mood entry), meaning that they are not related to one and other, there is little to no need to have a relational database structure.

MongoDB

MongoDB is a non-relational database that stores data as documents. These documents represent a JSON-like structure called BSON (MongoDB, 2019).

MongoDB meets all the requirements for the database system listed above. It is also the most popular non-relational database system at this time (DB-Engines Ranking, 2019). It also has a large community behind it. Next to this MongoDB is also very easy to use and setup. The data that will be stored in the database for this use case will exclusively be JSON objects.

A downside to MongoDB is that its query language can be rather complex and hard to manage. Whenever related data has to be retrieved complex handlers have to be written. Next to this, due to its high flexibility, you have little to no control over how the data model looks like in MongoDB (Headly, 2017).

Mongoose

In order to decrease development time, several libraries were developed to resolve the issues concerning MongoDB.

For NodeJS the library Mongoose was developed. Mongoose is an easy to use schema-based solution to model your application data (Mongoose, 2019).

Mongoose includes features such as, a more simplified way of query building, type validation and Object Oriented data modelling of MongoDB documents. The main advantage of using Mongoose over MongoDB is abstraction. In general Mongoose makes the development of applications a lot easier and faster (Mongoose, 2019).

Mongoose is governed by the MIT license, which makes it free to use and to be commercialized.

2.7 Mobile application

As mentioned in chapter 2.4 the mobile application is the mood logging system used in this system.

2.7.1 Main features

Before the actual development and technical research, the essential features that need to be implemented should be described firstly.

The main features the mobile application will roughly consist out of:

- Clients need to be able to keep log the aforementioned data
 - Mood
 - Emotions
 - Experiences
 - Thoughts
 - Sleep
 - Weight
- Clients need to be able to complete tasks
- Clients need to be stimulated to perform tasks and log mood entries
- The logged data needs to be shared with corresponding mental health professional

2.7.2 Technologies

Before the technologies for the development of the application can be determined we must first determine the requirements of the application.

- The mobile application needs to work offline

In case the client doesn't have access to the internet, he or she still needs to be able to add a new log entry.

- The mobile application needs to support push notifications

An important part of the application is that the client needs to be stimulated to log their data daily. This can be done with the use of push notifications.

- The mobile application needs to be easy and fast in use

If the application is not performant or easy to use it could hinder the clients experience and could prevent them from committing to the process.

- The mobile application needs to work on most systems

The biggest mobile phone market consists of mostly Android (75.27%) and iOS devices (22.74%) (GlobalStats, 2019).

Determining the most fitting type of mobile application

Native Apps

A native mobile app is an application built specifically for use on a specified platform or system. For example Android applications are natively written in Java while iOS applications are natively written using Objective-C or swift (Monus, 2019).

React Native

React Native is an open-source mobile application framework developed by Facebook. It lets you build native apps using the React framework and pure JavaScript. React Native runs a background process on a native device that interprets JavaScript directly onto the device which allows it to generate UI elements (Facebook: React Native, 2019; Wikipedia, 2019).

React Native is very popular and has a big community behind it, especially since it's built on top of the React Framework (Facebook: React Native, 2019).

Hybrid Apps

A hybrid mobile app combines elements of both web apps and native apps. They can make use of several operating system features. Alongside this they can also be distributed to app stores (Gist, 2019).

Web Apps

A web app is a mobile version of a web application run in an internet browser. They are written using JavaScript HTML, JavaScript and CSS (Gist, 2019).

The biggest advantage hybrid and web apps have over native apps is mostly the development effort. The only notable downside to Native apps is that the same application has to be developed for iOS and Android (Gist, 2019).

With the addition of progressive web apps, web apps can also be used offline and can make use of push notifications. However the performance of a web application is still drastically lower than that of a native application. Furthermore web apps have restricted access to device hardware and have less support for native features (Dua, 2019).

React Native can build an application for Android and iOS. This covers the initial downside that Native Apps have, while still giving the advantage of performance that native apps have (Dua, 2019).

Developing a native application with the use of React Native seems to be the most logical choice as it meets all requirements.

2.7.3 Authenticating the client

In order for the client to be able to start creating mood entries, the client has to be connected to a mental health professional. To be able to do this some form of authentication is necessary.

Every client needs to be able to authenticate with the API. The client needs to be able to POST new mood entries to the API, and receive tasks assigned by the mental health professional.

The API needs to be secured so only authorized clients and mental health professionals can access or manipulate said data.

There are several ways to handle authentication:

Token-Based authentication

Token-based authentication is a security technique that authenticates the users who attempt to log in to a server, or some other secure system, using a security token provided by the server. The most popular token format is JSON Web token (JWT) (Killoran, 2017).

OpenId

OpenID is an open standard and decentralized authentication mechanism that allows the possibility of Single Sign-on. Single sign-on allows users to be logged in on multiple devices after a single sign-on. OpenId is mainly used in enterprise applications (Lightfoot, 2016).

SAML

SAML is a widely used federation protocol for web browser single sign-on (Lightfoot, 2016).

Token-based authentication is most commonly used for API authorization whereas SAML and OpenId are used mainly for applications that require features such as single sign-on.

The API only needs to be able to authenticate via the web application and the mobile application. Token-based authentication is also easy to implement, and is in this case sufficient.

2.7.4 Token-based authentication

To able to implement token-based authentication, some sort of unique identification is necessary. Generally a username and password is sent to the API to authorize the user.

Since clients will not be able to login or register an account themselves they will still need some sort of way to identify themselves as a means of authentication.

Besides using a username and password, another way to safely authenticate a user is by using passwordless authentication (Auth0, 2017).

Following examples:

- Passcode
- Passphrases
- Login codes and magic links
- SMS codes
- Guardian / Authenticators

According to the people of Auth0 (2017), a passphrase can be a perfectly adequate form of security as long as it is complex and unique enough. A valid way to identify a client would be by the use of a unique long and complex string identifier. This identifier could then be passed onto the client by the mental health professional. Afterwards this identifier can then be used to access the API.

UUID

A universally unique identifier or UUID is a 128-bit randomly generated number. The main purpose of a UUID is to be universally unique, without depending on a central registration authority. The probability of a duplicate UUID being generated is as good as zero (Wikipedia, 2019).

The UUID could serve as the unique passphrase that is required for the identification and authentication of a client.

What is a JWT?

A JSON Web Token is a JSON object that is used as a way to represent a set of information between two parties. The token is composed of a header, a payload, and a signature (JWT, 2019).

To generate a JWT, a payload such as login credentials or a passphrase, needs to be signed by an encryption algorithm together with a predetermined secret. The more complex this secret is the longer it takes to brute-force a JWT.

This JWT is then used in the authentication header of a network request to verify the identity of the user making the request.

Authentication with JWT

Since we now have a way to identify a client using a passphrase, authentication is now possible.

The mental health professional will be able to register a new client, which will in turn generate a new UUID or passphrase in this case.

The passphrase, generated by the mental health professional, will need to be shared locally with the client.

The authentication of the client only needs to be done once, once the client is logged in, he or she will stay logged in until the mental health professional removes the client.

This passphrase will be sent to the API, the API will make a database request to verify whether or not the client exists. If the client exists, a signed JWT token will be sent back to the client. This token can in turn be used to access protected endpoints on the API.

To access protected routes on the server, the JWT should be sent in the Authorization header using the Bearer schema. The JWT will in turn be verified, if the JWT is valid, the user will be granted access to the endpoint.

Sharing the passphrase

Since a UUID is 36 characters long, it would be tedious to have to type it into a mobile application. To speed up this process something like a QR code scanner can be implemented into the mobile application. The mental health professional will, when registering a new client, be prompted with a QR code containing this passphrase which the client will then be able to scan.

Using the react-native-qr-code-scanner library, the camera of the device can be accessed in order to scan a QR Code.

```

<QRCodeScanner
  onRead={this.authClient}
  topContent={
    <Text>
      Scan the QR code given by the mental health professional!
    </Text>
  }
/>

```

Upon scanning a QR code the this.authClient() function will be executed, the data read from the QRCodeScanner is passed into this function.

Firstly the data is first checked to see if a QRCode code containing a valid UUID has been scanned. This is done using a regular expression.

```

const UUID4Regex = /^[0-9A-F]{8}-[0-9A-F]{4}-[4][0-9A-F]{3}-[89AB][0-9A-F]{3}-[0-9A-F]{12}$/i;
if (UUID4Regex.test(userId)) { ← Regex test
  try {
    const res = await authClient(userId); ← Request JWT token
    if (res.code === 200 && res.token) {
      setJWTToken(res.token);
      setUserId(res.userId);
      this.props.navigation.navigate("Main");
    }
  } catch (error) {
    Alert.alert("Register user", "Failed to authenticate the client.");
    this.props.navigation.navigate("Entry");
  }
} else {
  Alert.alert("Register user", "Invalid QR Code!");
}
}

```

Whenever a valid UUID has been scanned, a request is sent to the server, with the UUID as payload, to check whether or not a client exists with the given UUID. If this is the case a generated JWT token together with the original UUID is sent back and stored in the storage of the application. Both the JWT token and the UUID will be used to authorize the client for future requests to the server.

Whenever the application is removed or whenever the data stored in the application is cleared, the stored JWT token and UUID will be lost. Clients will be allowed to re-enter the passphrase manually or they can request the mental health professional to provide them with the QR code.

Implementation of authentication

Using the jsonwebtoken library, JWT signing and verification can be easily done in NodeJS.

```
router.post("/auth/client", async (req, res) => {
  const body = req.body;
  if (body.userId) {
    try {
      // Verify if user exists
      const response = await controller.authClient(body.userId);

      if (response) {
        // Sign the client UUID using the private key
        jwt.sign(body.userId, privateKey, {}, (err, token) => {
          if (err) {
            throw new Error(err);
          }
          // Send the corresponding JWT token
          res.json({ token, status: "ok", code: 200, userId: body.userId });
        });
      }
    }
  }
});
```

The signing of the passphrase is done with a generated 2048 bit RSA key to ensure brute-forcing is not possible.

Middleware can in turn, be used to protect certain endpoints. In this case, the checkToken() function will check whether or not an Authorization header exists that uses the Bearer schema. If this is the case the token will be passed with the request into the endpoint.

```
const checkToken = (req, res, next) => {
  const header = req.headers.authorization;
  if (typeof header !== "undefined") {
    const bearer = header.split(" ");
    const token = bearer[1];
    req.token = token;
    next();
  } else {
    //If header is undefined return Forbidden (403)
    res.sendStatus(403);
  }
};
```

The JWT token will then be verified, together with the private key. Whether or not this verification fails will determine if the user has access to the endpoint or not.

For example it can determine whether or not a client is authorized to post a new mood entry.

```
const { mood, date, thoughts, entryId, emotions, experiences } =
req.body;
if (mood && date && thoughts && entryId && emotions && experiences) {
  try {
    const userId = jwt.verify(req.token, privateKey);
    const moodEntry = {
      entryId,
      userId,
      mood,
      date,
      thoughts,
      emotions,
      experiences
    };
    const result = await controller.addMoodEntry(moodEntry);
    res.json(result);
  } catch (err) {
    errorLogger.error("mood endpoint failed to post new moodentry",
err);
    res
      .status(500)
      .json({
        code: 500,
        status: "error",
        msg: "Failed to register the mood entry",
        body
      });
  }
}
```

2.7.5 Logging mood entries

Referring back to the research on mood charting, the items to take note of were:

- Mood
- Emotions
- Life events
- Thoughts
- Sleep
- Weight

The implementation surrounding each of these items will be described in detail in this chapter.

Mood

Based on research, a client’s mood will be determined using a smiley system consisting out of five moods.

Which smiley fits your mood the most?

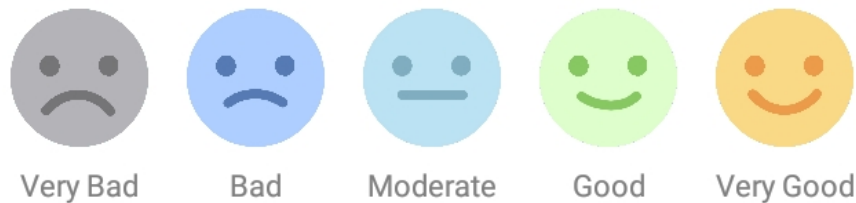


Figure 6: Mood smileys credits to Sandra Baumann for the design

Each smiley representing a certain mood, from left to right: very bad, bad, moderate, good, very good.

Emotions

A client’s emotions will be determined using the Circumplex Model of Affect. In the study of Russell (1980), people were asked to place a dot onto a circle based on how activated, inactivated and pleasant, unpleasant their emotion felt.

Since this method of determination is impractical, the client will simply be asked to describe their energy levels and emotional state. Based on this information a list of possible emotions (according to the circumplex model) will be displayed that the client can choose from.

Describe your current energy levels.

🔋
HIGH ENERGY

🔌
LOW ENERGY

Describe your current emotional state.

😊
PLEASANT

😞
UNPLEASANT

Select at least one option that fits best:

CONTENT

SERENE

AT EASE

CALM

RELAXED

TIRED

SLEEPY

+ ADD EMOTION

Figure 7: Mood entry creation screen, mood and emotions section, screenshot taken from the mobile application

Considering the fact that there are many words to describe a single emotion, clients will also have the ability to add a word to describe their own emotions.

Sleep and weight

The client will simply be prompted to enter the necessary information. Sleep will be prompted to enter every day while weight will be asked to enter every week.

Experiences (life events)

As done in the study of Bauer, et al. (2006) clients will have the ability to note down significant life experience or life events.

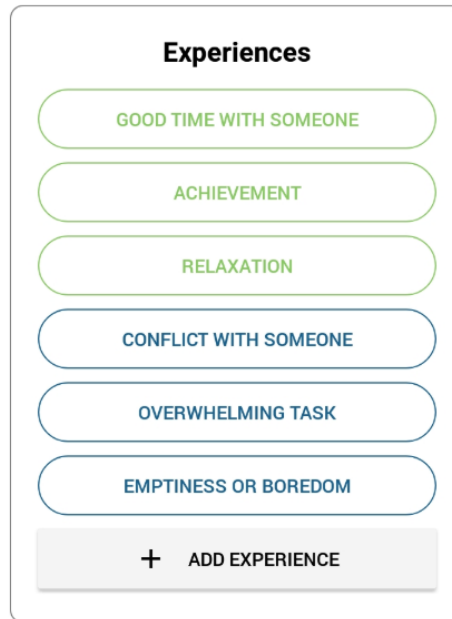


Figure 8: Mood entry creation screen, experience section

Clients will be able to choose from an array of already existing and common experiences, this is done to speed up the logging process and to help simplify the process for the client.

Add a custom experience:

Name of experience

Is the experience positive?

Figure 9: Adding a custom experience

In addition they will also be able to add their own custom experience and decide whether or not said experience was positive or negative.

Thoughts

As done in the study of Matthews, Doherty, Sharry, & Fitzpatrick (2018) clients will have the ability to describe their thoughts and give a more detailed explanation about how they feel. This in turn will make it easier for the mental health professional to aid the client in the upcoming session.

Figure 10: Mood entry creation screen, thoughts section

Data structure of a mood entry

This section will recap, summarize all the data items that need to be collected and represent how it will look like as a database entry.

The mood entries created will firstly be stored as JSON objects in the async storage of the mobile application. These JSON objects will later be uploaded to a MongoDB server using the API.

Mongoose lets users create object oriented schemas for MongoDB. The code below shows the MongoDB schema that is used for a mood entry.

```
const MoodEntrySchema = new Schema({
  date: Date, ← Date when the entry was created
  emotions: Array,
  entryId: { type: String, required: true }, ← Unique UUID of the mood
entry
  experiences: Array,
  hoursOfSleep: Number,
  mood: String, ← "very good, bad..."
  thoughts: String,
  userId: { type: String, required: true }, ← Unique UUID of the client,
used to determine who created the mood entry
  weight: String,
});
```

Using Mongoose data can easily be stored into the database.

```
const addMoodEntry = moodEntry => {
  return new Promise((resolve, reject) => {
    const newMoodEntry = new models.MoodEntry(moodEntry);
    newMoodEntry.save((err, data) => {
      if (err) {
        reject(err);
      }
      resolve(data);
    });
  });
};
```

2.7.6 Tracking mood entries

Clients need to be able to view the mood entries they have just added. In case a mistake is made the client will also need to be able to remove or edit a certain entry.

The list of mood entries added by the client, can be displayed in a compact view on the homepage of the mobile application.

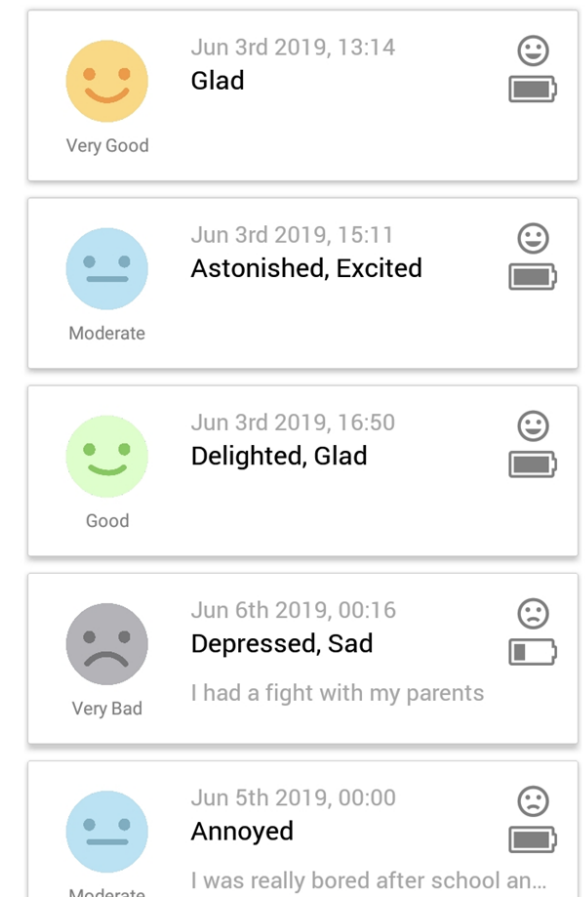


Figure 11: Mood entry overview screen

2.7.7 Storing mood entries

The mobile application needs to be able to be used offline, considering this the mobile application will be developed with offline first in mind.

The idea behind offline first is to develop your application as if the internet doesn't exist and then later add the necessary internet functionality (Google, 2019). Therefore it would be logical if new mood entries are first stored locally.

AsyncStorage in React Native allows us to store data locally onto the device. It is in a sense a replacement for LocalStorage in web browsers (Facebook: React Native, 2019).

Now that the data is successfully stored offline it will need to be synced with the server once an internet connection is available.

Database synchronization

There are two methods to synchronize data to a database. We either make use of a self-synchronizing database such as: CouchDB, Realm, Firebase Realtime Database, et cetera or a self-made synchronization procedure. (Codete, 2018)

Since our existing architecture doesn't make use of a self-synchronizing database, a synchronizing procedure will need to be created.

Before designing the procedure several aspects should be taken into account (Codete, 2018):

- How to initiate the procedure and how many times should it execute?
 - Periodically
 - Event-based
 - Fixed time
- How to avoid potential conflicts between local entries and remote?
- How can a local database entry be compared with a remote entry? What makes them unique?

Synchronization algorithm

In React Native, it is possible to check whether or not a connection is available using the Net-Info API. However the API cannot guarantee whether or not there is an actual connection with the internet. It is possible to for example be connected to Wi-Fi, and not have a working internet connection (Facebook: React Native, 2019).

Considering the fact that, there is no proper way to check when a valid internet connection is available, the process will need to be executed periodically. This will ensure that the syncing process will take place whenever internet is available. Whenever no internet connection is available the request to the server will fail and the process will restart.

Since the offline and online mood entries will need to be compared, each mood entry will need a unique identifier. For this a UUID will be used.

Since a client cannot add two mood entries at the same time, the state of the mood entries will be based on their index. Both the mood entries locally and remotely are added in the same order, meaning their indexes are the same. The process will be run in the background on the start of the application.

The sync manager will request the server what the last added entry is. It will then determine the index of this last entry in the local mood entries. If the index of this entry is the same as the amount of entries then all local mood entries are currently in sync. If the index is smaller, then all entries beyond this index will be pushed to the server.

IT in the therapy process

This flow chart depicts the syncing process that the sync manager will execute.

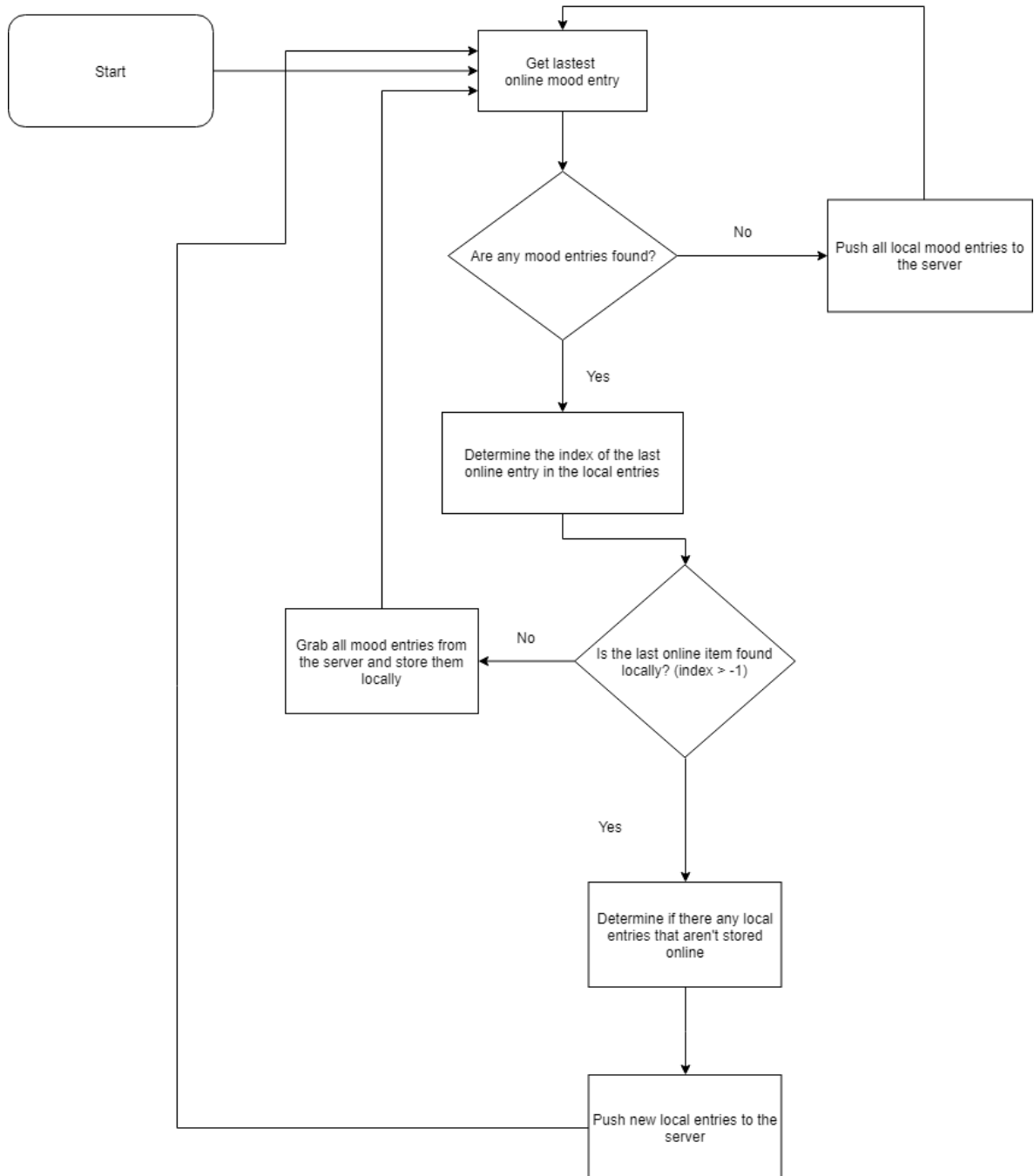


Figure 12: Syncing process flowchart

Finally the actual implementation of the syncing process:

```
try {
  const userId = await getUserId();
  const onlineId = await getLastKnownOnlineId(userId);

  // receive local data
  const localMoodEntries = await getLocalMoodEntries();

  // if there are no online entries
  if (!onlineId) {
    // add all local entries to the online database
    localMoodEntries.forEach((e: MoodEntry) => {
      store.dispatch(fetchAddMoodEntry(e));
    });
    return;
  }

  // index of the last online entry found in the local entries
  const indexLastOnlineInLocal = localMoodEntries
    .map((e: MoodEntry) => e.entryId)
    .indexOf(onlineId);

  // if the last online item is found locally
  if (indexLastOnlineInLocal > -1) {
    // get all new local changes that aren't found online
    const newLocalNotOnlineEntries = localMoodEntries.slice(
      indexLastOnlineInLocal + 1
    );

    // push all new local changes
    newLocalNotOnlineEntries.forEach((e: MoodEntry) => {
      store.dispatch(fetchAddMoodEntry(e));
    });
  } else {
    store.dispatch(fetchMoodEntries());
  }
} catch (error) {
  // internet not available, do nothing and repeat the process
}
```

2.7.8 Tasks and activities

Another issue that needed to be tackled was the client’s inability to commit to the therapy process or the inability to perform certain tasks imposed by the mental health professional.

To tackle this issue the mobile application will allow clients to view and actively complete activities that have been appointed to them by the mental health professional.

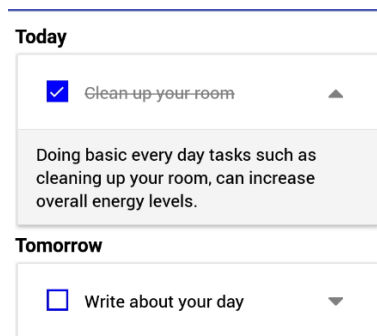


Figure 13: Task overview screen

As shown above a task consists of a title, a date for when it was assigned and additional information about the task. Whenever the client marks the task as completed, the task is updated in the database.

The offline first approach is also used here. To obtain the tasks for the first time an internet connection is needed, the tasks are then stored offline in the async storage. Changes made to the task such as the completion state, are kept locally. The sync manager will, as with the mood entries, attempt to sync the data periodically.

Whenever a task is marked as completed, the date of completion is also stored within the task. This way the mental health professional can oversee if the client could successfully complete the task and also if the task was completed at the assigned date.

If the tasks aren’t being completed by the client or when the tasks are completed at later dates, the mental health professional could adjust his or her approach in consultation with the client.

2.7.9 Keeping clients committed

A commonly used method to keep users committed to a mobile application is by using push notifications.

It is important that clients form the habit of logging their mood entries daily and completing their assignments. Push notifications can help with forming this habit (Stawarz, Cox, & Blandford, 2014).

What are push notifications?

Push notifications are small messages that can be sent by an application to the user when the application is not running. They are commonly used to keep users interested in using a mobile application.

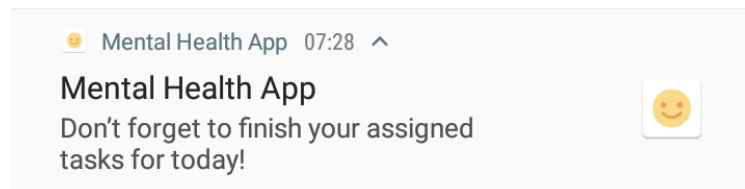


Figure 14: Example of push notification in Android app

There are two types of push notifications, remote push notifications and local push notifications.

Local push notifications are created locally in the application and are then displayed in the notification centre.

Remote push notifications are sent from a remote service such as the Apple Push Notification Service (APNS), the Google Cloud Messaging service (GCM) and the Firebase Cloud Messaging service (FCM).

Since clients need to be reminded on a fixed interval (on a daily basis) to note down their data, using local push notifications would be sufficient. Additionally using remote push notifications would require the additional setup of a remote service as mentioned above.

Implementation

Using the react-native-push-notification library the implementation of local push notifications is relatively straightforward.

Firstly, the PushNotification instance has to be configured. This is done by passing an object to this instance. The only requirement for the configuration is defining the onNotification() function, this function is called whenever the user first opens the notification.

By default, the application is opened whenever the notification is pressed.

```
PushNotification.configure({
  // Called when a notification is opened or received
  onNotification: function(notification: any) {
    console.log("NOTIFICATION:", notification);
  }
});
```

Afterwards, push notifications can be scheduled by simply calling the localNotificationSchedule() function with an object.

```
PushNotification.localNotificationSchedule({
  date: new Date(Date.now()), // time to display notification after scheduling
  color: "blue", // colour of notification title
  vibrate: true,
  vibration: 300, // strength of vibration
  title: "Mental health app",
  message: "Don't forget to complete your assigned tasks!",
  repeatType: 'day',
});
}
```

Clients will need to be reminded at least daily to put in their details. The PushNotification API allows us to easily schedule repeated push notifications using the repeatType parameter.

2.8 Desktop application

As mentioned in chapter 2.4 the desktop application will be the entry point for the mental health professionals where they can view and analyse data provided by the clients.

2.8.1 Main features

Before the actual development and technical research, the essential features that need to be implemented should be described first.

The main features the desktop application will roughly consist out of:

- Mental health professionals will need to be able to register clients
- Mental health professionals will need to be able to view, review and analyse the mood entries provided by the client
- Mental health professionals will need to be able to assign tasks to their clients and keep track of the status of each individual task

2.8.2 Technologies

Before the technologies for the development of the application can be determined we must first determine the requirements of the application.

- The application needs to be able to be used on a desktop computer
- The application needs to work on most operating systems
- The application needs to be able to represent data in a visually appealing way
- The application needs to be easy and fast in use

The requirements for the desktop application are rather slim, so the choice of technologies will be aimed towards having a good user experience and a fast development time.

To provide support for every operating system, a web application would be a good choice.

Considering the requirements, the choice of web application type won't directly impact the user experience. The focus can be aimed towards the ease of development.

Since both the mobile and web application will request data from the same API, it would be beneficial if all endpoints used for the mobile application can be reused for the web application. Therefore it would be a logical choice develop a Single Page Application.

The framework used to develop the SPA is also not very relevant, every popular framework, such as React Vue.js or Angular could be used for the development.

Since the mobile application is written in React Native it would be easy to make the switch to ReactJS for the development of the web application.

2.8.3 Registration of mental health professionals

The web application will be hosted publicly and will be open for anyone to use, not just mental health professionals. For example a user could technically keep track of their own data by registering himself as a client. The data pushed to the database from the mobile application does not contain any personal information.

Users can simply register an account with a username and password. These credentials will in turn be saved onto the MongoDB database. The username will be used as the unique identifier of the account for authentication.

Security

To avoid the leakage of passwords during a database breach, the passwords will need to be encrypted.

There are currently three types of algorithms that are commonly used for password hashing (Auth0, 2018):

- Bcrypt
- Scrypt
- PKDF2

All three algorithms would suffice for this particular use case. The standard used for password hashing is Bcrypt. Bcrypt is a password hashing function that incorporates a salt. Bcrypt is sufficient and robust enough to protect against any form of brute-force attacks.

Bcrypt can easily be implemented in NodeJS using the bcrypt library. The code example below shows the implementation of bcrypt hashing of the password of a newly created user. Before the entry is saved into the database the clear text password is replaced with the hashed version of the password.

```
ProfessionalSchema.pre("save", function(next) {
  let professional = this;
  bcrypt.hash(professional.password, 10, function(err, hash) {
    if (err) {
      return next(err);
    }
    professional.password = hash;
    next();
  });
});
```

Whenever a login attempt is made, the bcrypt library can be used to compare the hashed password with the password sent during login.

```

Professional.findOne({ email }).exec(function(err, professional) {
  if (err) {
    f(err);
  }
  if (professional == null) {
    f("professional not found");
  } else {
    bcrypt.compare(password, professional.password, function(err,
success) {
      if (success) {
        s(professional);
      }
      f("Email or password incorrect");
    });
  }
});

```

If the passwords match, the user is granted access to the system.

2.8.4 The registration of clients

When registering a client the mental health professional needs to enter a client’s first name, last name and birthdate.

This purely to help the mental health professional identify the client. For each client, as mentioned before, a UUID is created. Using only this UUID as a means of identifying which client is which, would be impractical.

Figure 15: Registering a client, screenshot taken from the web application

2.8.5 Connecting with clients

Every single mood entry is coupled to a client. Multiple mental health professionals can make use of the system. Considering this, it is important that the mental health professional can only view and access the data of its own clients.

In the database system all clients and mood entries are in the same collection (equivalent to a table in MySQL) in MongoDB.

To know which client belongs to which health professional, each client needs to be given an identifier. In this case a UUID is used. Every mental health professional is granted this unique id on creation.

Whenever the mental health professional successfully logs in, a JWT token is generated using the login credentials.

This JWT token can then be used to send requests to all protected endpoints that only allow authenticated mental health professionals to access them.

For example only an authorized mental health professional should be able to access the data of all his or her clients.

The following code abstract for the /client/:profId endpoint, shows the steps that are taken to ensure authenticity.

```
try {
  const payload = jwt.verify(req.token, privateKey);
  const professional = await controller.authProfessional(payload.email, payload.password);
  if (payload.profId === profId) {
    const clients = await controller.getClientsByProf(profId);
    res.json({ status: "ok", code: 200, clients });
  } else {
    res.status(500).json({
      code: 500,
      status: "error",
      msg: "Id does not match id in bearer"
    });
  }
} catch {
```

Firstly the JWT token is verified using the previously generated privateKey. If the JWT token is invalid an error is thrown and a status 500 response is returned.

A valid JWT token will contain the valid login credentials and profId of the mental health professional.

The login credentials are checked in the database to verify whether or not a user with these credentials exists and if they are valid.

Thereafter the profId found in the decoded payload of the JWT token is compared to the profId provided in the request parameters. If these ID's match we can ensure that only the rightful mental health professional is trying to access his or her client's data. If this is not the case a 500 response is returned.

2.8.6 Representation of client data

A mental health professional will need to be able to view their client’s data in a visually appealing manner.

There are three parts of client data that need to be represented:

- The clients personal information and unique Id
- The mood entries logged by the client
- The tasks that have been assigned

Personal information and unique identifier

After the creation of a client the user will be prompted with a QR code which will in turn be scanned by the client.

Since the unique ID of the client is stored in the async storage of the application, removing the mobile application or clearing the data of the mobile application will cause the client to be logged out.

To ensure clients can easily reconnect, the mental health professional needs to be able to provide their clients with the necessary credentials. Therefore the mental health professional will need to be able to view the generated QR code or the ID after registration.


General information	
<p>Client Details</p> <p>Id: eb4caefe-3da0-4b46-85de-d9248cf4f829</p> <p>First name: Ruben</p> <p>Last name: Dewitte</p> <p>Birth date: 23-1-1998</p>	<p>Client QR Code</p> 

Figure 16: General information of the client

Mood entries

The main reason for this system is that mental health professionals can have a better understanding of their clients. Mental health professionals need to be able to easily and correctly interpret the data (mood entries) provided by the client.

One way to represent a large array of data is by using graphs. There are a large amount of JavaScript graphing libraries out there, such as amCharts, AnyChart, Chart.js, Chartist.js, et cetera.

The only requirements for the charting library would be:

- Simple in use
- Flexible
- Free to use (MIT license)

What library we use is not of much importance as most charting libraries will offer same features and flexibility.

Chart.js is the most, free, popular open source and MIT licensed charting library out there. It has a vast and detailed documentation and a large community backing the project.

Chart.js is a simple to use library and it is also really flexible. It allows for a lot of customisation in terms of design and the representation of data.

The tracking of a person’s mood is a long term process. The data needs to be represented in a way that peaks and low points in a person’s mood can be easily identified.

For example the study of Bauer, et al. (2006) represents daily mood entries using a line chart where the x-axis describes the date of logging and the y-axis describes the overall mood of a person. In this study someone’s mood is represented by a number between 0 and 100.

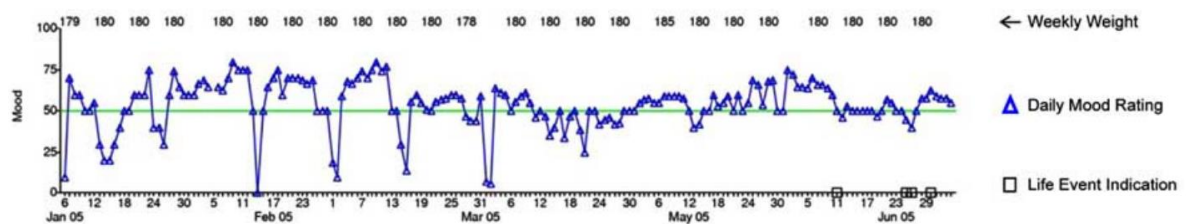


Figure 17: Visual representation of mood entries, image taken from the study of (Bauer, et al., 2006)

Consequently it would be most logical to visualize the data using a line graph.

In order for the mood entry data to be represented, the data will need to be mapped to their x and y coordinates. The x-axis representing when the mood entry was created and the y-axis representing the general mood of the user.

The general mood of the user needs to be mapped to a y-coordinate, in this case: 0 represents "Very Bad", 5 represents "Bad", 10 represents "Moderate", 15 represents "Good" and "Very Good" is represented by 20.

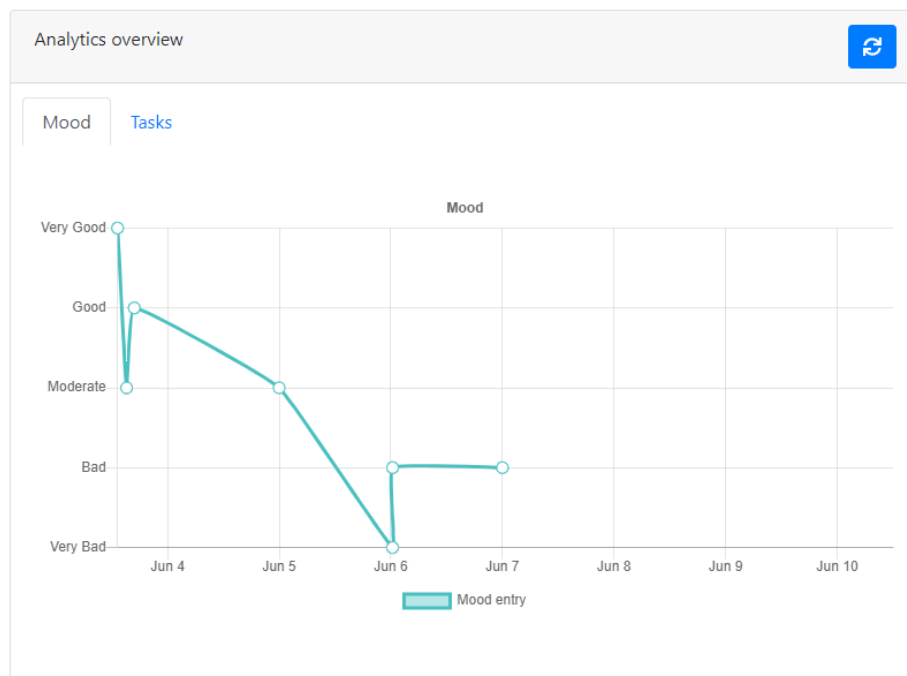


Figure 18: Visual representation of mood entries in the web application

Using chart.js it is possible to also determine the time unit and step size of this time unit on the x-axis. In the graph depicted above, the step size is one day and the start and stopping point spans across one week.

This JSON object represents the time configuration that was passed into the Chart.js object.


```
time: {
    unit: "day",
    unitStepSize: 1,
    min: minDate.getTime(),
    max: maxDate.getTime() + 302400000
},
```

Whenever a user interacts with a graph in Chart.js an event is emitted. This event can be coupled to any action. In this particular case the action is used to display every detail of a single mood entry. This action is called whenever a user clicks on a point on the graph that depicts a mood entry.

Selected Mood Entry

Entry date: 6-6-2019 00:22:38

Mood:



Very Bad

Emotions:

Sad
Miserable

Experiences:

Conflict with someone

Thoughts:

I had a fight with my parents.

Figure 19: Detailed representation of a mood entry

Tasks

A Task consist out of following items:

```
const TaskSchema = new Schema({
  userId: { type: String, required: true },
  entryId: { type: String, required: true },
  assignmentDate: { type: Date, default: new Date() },
  isDone: { type: Boolean, default: false },
  title: String,
  description: String,
  completionDate: Date
});
```

Whenever a task is assigned the task is added to the database. To be able to determine who the task is assigned to and which task is which, every task entry will have a `userId` and an `entryId`. Both, for the sake of consistency and simplicity are UUIDs.

Mental health professionals will be able to assign tasks as mentioned before.

Assign a new task

Assignment Date

Task title

Task description

Assign task

Figure 20: Assigning a task

While assigned tasks will simply be represented in a table format. Completed tasks or incorrectly entered tasks can also be deleted by the mental health professional.

#	Assignment date	Task title	Task description	Has been completed	Completion Date	Actions
1	5-6-2019 00:43:42	Clean up your room	Doing basic every day tasks such as cleaning up your room, can increase overall energy levels.	Yes	5-6-2019 14:42:03	Delete
2	6-6-2019 02:00:00	Write about your day	Writing about your day can help you process thoughts and help you better understand how you feel.	No	Not completed yet	Delete

Figure 21: Overview of assigned tasks

3 User testing

Both the web application and the mobile application now meet all the requirements and have the tools needed to tackle the existing issues that are prevalent in CBT.

To be able to determine how usable and effective the system created is it has to be tested.

Since the system is meant to be used in a professional setting (used by a mental health professional and a client), the testing environment should match or should be as close as possible to the real setting.

In this case the system should preferably be tested by people who are in therapy, and struggle with mood related issues.

To find people who were willing to take part in this testing process a survey was made to see what people could partake. The actual survey that was used can be found in the appendix.

In addition, several mental health professionals were contacted about their willingness to partake. The only mental health professionals that could be convinced where the practitioners whose clients I knew personally.

The only requirement to partake in this process is that the client possess an android phone. The distribution of an iOS app can only be done by creating a developer account, which has a cost of €99 a year. Android applications can easily be distributed by simply uploading the APK file to a file sharing service.

The users were asked to use the system for at least two therapy sessions (the period between each session can differ depending on the mental health professional). Afterwards an additional survey was given to them. This survey mostly questioned people about how effective the system was and if there is any room for improvement. The actual survey, and the surveys that were filled can be found in the appendix.

4 Results and feedback

4.1.1 Results

Only a small sample size of people were willing to participate in the testing process. This due to the high amount of requirements and the mental health professional needing to be willing to participate.

Four test subjects reported their feedback using the survey that was given to them after the testing period.

All four clients reported that the use of the mobile app had a positive effect for them during the therapy process. Three out of four mental health professionals said they would want to continue using the system in their practice.

The IT solution had the most significant impact on the client's commitment to the therapy process. All four clients claimed that the notifications stimulated them to note down the mood entries and complete the tasks that were assigned to them by the mental health professional.

The clients also said that they could better identify the cause of why their mood changed and that the mental health professional could lead conversations better during the therapy session.

4.1.2 Feedback

Three mental health professionals claimed that they liked the idea of the system and would be willing to use it in their practice. One of them stating that this would be a good tool to help aid in the therapy process with younger people but that older mental health professionals and older clients would most likely not want to adapt this system.

One other mental health professional claimed that he or she liked the idea and would want to see it further developed before wanting to adapt it in his or her practice. The professional wanted to see more features such as more ways to analyse the data and the ability to track custom data items predefined by the mental health professional.

Finally there was one mental health professions that wouldn't immediately want to adopt such a system in their practice. One of the professionals claimed that it could be an effective way to help people with mental issues but that the clients should be the ones focused on keeping track of their statistics.

5 Conclusion

How effective the therapy is depends on how well the mental health professional can process the information that is provided to them by the client. Based on this information the mental health professional is required to make decisions that ultimately need to benefit the client. Such decisions can be, for example, a proper diagnosis, providing proper methods to cope and deal with certain symptoms of their mental health issues and so forth.

The quality and accuracy of the information depends solely on the client. If the client fails to provide proper information to the mental health professional, he or she cannot properly guide the client or help them cure their mental issues.

In order for an IT system to effectively help in the therapy process, the system needs to help clients provide more accurate and qualitative information while also representing this information in a way so mental health professionals can make use of the information in their decision making.

This can be achieved by creating applications that can accurately request data from a client while still maintaining a good user experience for the client. Therefore the system needs to provide the mental health professional with the necessary data that can help them in their practice. This thesis demonstrates how this could be achieved.

The requirements of the information and what information is relevant will depend on the mental disorder and the client. Since this thesis focuses mostly on mood disorders, proper research would be required to develop tools that could be used to aid people with other mental disorders.

Another possible approach would be to let the mental health professional decide what information is relevant to them. This could be done by letting them customize what clients are required to report to their mental health professional, for example by letting them add their own custom input field in an application.

6 Critical reflection

I started working on my thesis with a lot of ideas and implementations in mind. Prior to this thesis I already had a lot of knowledge about psychology and mental issues in general. This made the research surrounding these topics relatively straightforward and enjoyable.

After the general research I could start with the technical research. I sometimes was a bit too eager to start developing before putting in the required research. I had to take a step back and make sure every choice that I made had an actual reasoning behind it.

Both the mobile application and the web application were built from scratch, I had some prior knowledge with the technologies used but a lot of research was still required. Sometimes I found myself spending too much time on the development.

The development of the applications is what took the majority of the time. Since the system had to ultimately be tested, some features could not be implemented in time.

I wanted to for example implement a system that could stimulate people to exercise daily. Furthermore I also wanted to implement a system that could keep track of a person's sleep automatically. These features could not be implemented in this thesis as they would require a lot more research and time.

After my graduation I want to continue the development of this project and ultimately I want to implement every feature mentioned above.

It was also really difficult to find people with mental issues, who went to therapy and were willing to partake in the testing process.

Mental health professionals were not willing to partake without me approaching their client first. Whenever clients were asked to present the system to their mental health professional they were willing to partake. Luckily I was able to find some fitting candidates that could test my system for a relatively long time.

In general I'm relatively happy with the result, and I'm also happy that my applications could also be tested in a real environment.

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9 Appendix

Attachment 1: Survey 1

To respond: or

This survey is targetted towards people who are clients of a mental health professional. I am in search for clients that are willing to partake in the testing process of a system that is meant to aid both client and professional in the therapy process.

To be able to partake in this process, an android phone and the willingness to convince your mental health professional to partake in this process is required.

Both client and mental health professional will be required to make use of this system for a total of at least 2 therapy sessions.

Partaking would require you to actively keep track of information such as your mood, experiences, thoughts, amount of sleep, emotions and weight using a mobile application.

This information would in turn be required to be reviewed by your mental health professional using a web application. Next to this your mental health professional will also be able to digitally assign tasks to you.

Are you willing to partake in the testing process that would require you to actively make use of a mobile application?
(Please check all the boxes that apply)

Yes No

Please provide the name and or details of your mental health professional.

DAVID TEETAERT

Of what profession is your mental health professional? *(Please check all the boxes that apply)*

Psychiatrist Psychologist Psychotherapist

How old are you?

What is your gender? *(Please check all the boxes that apply)*

Male Female Other

How would you describe the type of mental problems you suffer from? (Name of diagnosed illness or general description of problems)

How many days are between each of your therapy sessions?



2

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1289 0001

To respond: or

This survey is a follow up survey to determine the successfulness and gather feedback of the IT solution for aiding the therapy process.

In how many sessions were the mobile application and web application used?

2

Did the reminders (notifications) stimulate you to complete the assigned tasks? (Please check all the boxes that apply)

Yes

No

Would your mental health professional be willing to continue using the system in their practice? (Please check all the boxes that apply)

Yes

No

Only if it was further developed

Did the reminders (notifications) stimulate you to log your daily mood entries? (Please check all the boxes that apply)

Yes

No

Would your mental health professional describe this system as beneficial to the therapy process? (Please check all the boxes that apply)

Yes

No

Would you describe this system as beneficial to the therapy process?

(Please check all the boxes that apply)

Yes

No

How would you describe the influence the use of the aiding system had on the therapy process?

*ik vind het zelf leuk om te gebruiken en vond dat het mij ook
hulp om me de mee bezig te houden. Door de smileys kon ik
ook beter brieven met mij blij of boos maken.*

Please provide any feedback or remarks you or your mental health professional have

*Mijn therapeut vond dat het positief was om de therapie naar dat
ik het zelf niet nu gebruiken en eerder nu sculter dan mij om lij
te houden. Hij wist dat de client zelf niet moet bezig houden met
het ondersteunen van patiënten.*



Attachment 2: Survey 2

To respond: or

This survey is targetted towards people who are clients of a mental health professional. I am in search for clients that are willing to partake in the testing process of a system that is meant to aid both client and professional in the therapy process.

To be able to partake in this process, an android phone and the willingness to convince your mental health professional to partake in this process is required.

Both client and mental health professional will be required to make use of this system for a total of at least 2 therapy sessions.

Partaking would require you to actively keep track of information such as your mood, experiences, thoughts, amount of sleep, emotions and weight using a mobile application.

This information would in turn be required to be reviewed by your mental health professional using a web application. Next to this your mental health professional will also be able to digitally assign tasks to you.

Are you willing to partake in the testing process that would require you to actively make use of a mobile application? *(Please check all the boxes that apply)*

Yes No

Please provide the name and or details of your mental health professional.

Dr. Geerts

Of what profession is your mental health professional? *(Please check all the boxes that apply)*

Psychiatrist Psychologist Psychotherapist

How old are you? 55 jaar

What is your gender? *(Please check all the boxes that apply)*

Male Female Other

How would you describe the type of mental problems you suffer from? (Name of diagnosed illness or general description of problems) angstaanvallen

How many days are between each of your therapy sessions? 14 dagen



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To respond: or

This survey is a follow up survey to determine the successfulness and gather feedback of the IT solution for aiding the therapy process.

In how many sessions were the mobile application and web application used?

1

Did the reminders (notifications) stimulate you to complete the assigned tasks? (Please check all the boxes that apply)

Yes

No

Would your mental health professional be willing to continue using the system in their practice? (Please check all the boxes that apply)

Yes

No

Only if it was further developed

Did the reminders (notifications) stimulate you to log your daily mood entries? (Please check all the boxes that apply)

Yes

No

Would your mental health professional describe this system as beneficial to the therapy process? (Please check all the boxes that apply)

Yes

No

Would you describe this system as beneficial to the therapy process?

(Please check all the boxes that apply)

Yes

No

How would you describe the influence the use of the aiding system had on the therapy process?

De app. had voor mij een positieve invloed tijdens de therapie. Door het systeem stelde ik me meer bezig met het proces, waardoor ik zelf ook beter inzicht kreeg op mijn problemen.

Please provide any feedback or remarks you or your mental health professional have

Mijn therapeut vindt dat het systeem nog meer verbeterd worden door bijvoorbeeld om data weer te geven in grafieken. Ook zou het top zijn als hij zelf kan kiezen wat ik zou moeten bijhouden. Viaar hij vond wel dat het hem hielp om een beter overzicht te vormen van mijn mentale toestand. Onze gesprekken kwamen ook beter op gang. Ik zou het persoonlijk leuk vinden om ook zelf bv. een muziekje of een foto te kunnen uploaden, een muziekje over wat ik me veel, een foto van mijn bezigheden.



Attachment 3: Survey 3

To respond: or

This survey is targeted towards people who are clients of a mental health professional. I am in search for clients that are willing to partake in the testing process of a system that is meant to aid both client and professional in the therapy process.

To be able to partake in this process, an android phone and the willingness to convince your mental health professional to partake in this process is required.

Both client and mental health professional will be required to make use of this system for a total of at least 2 therapy sessions.

Partaking would require you to actively keep track of information such as your mood, experiences, thoughts, amount of sleep, emotions and weight using a mobile application.

This information would in turn be required to be reviewed by your mental health professional using a web application. Next to this your mental health professional will also be able to digitally assign tasks to you.

Are you willing to partake in the testing process that would require you to actively make use of a mobile application? *(Please check all the boxes that apply)*

Yes No

Please provide the name and or details of your mental health professional.

Dipl.-Psych. Elke Marquardt

Of what profession is your mental health professional? *(Please check all the boxes that apply)*

Psychiatrist Psychologist Psychotherapist

How old are you? 23 years

What is your gender? *(Please check all the boxes that apply)*

Male Female Other

How would you describe the type of mental problems you suffer from? (Name of diagnosed illness or general description of problems) Anxiety, mood swings, sleep issues, trust issues

How many days are between each of your therapy sessions? 2-4 weeks



2

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1289 0001

To respond: or

This survey is a follow up survey to determine the successfulness and gather feedback of the IT solution for aiding the therapy process.

In how many sessions were the mobile application and web application used?

2 times

Did the reminders (notifications) stimulate you to complete the assigned tasks? *(Please check all the boxes that apply)*

Yes

No

Would your mental health professional be willing to continue using the system in their practice? *(Please check all the boxes that apply)*

Yes

No

Only if it was further developed

Did the reminders (notifications) stimulate you to log your daily mood entries? *(Please check all the boxes that apply)*

Yes

No

Would your mental health professional describe this system as beneficial to the therapy process? *(Please check all the boxes that apply)*

Yes

No

Would you describe this system as beneficial to the therapy process? *(Please check all the boxes that apply)*

Yes

No

How would you describe the influence the use of the aiding system had on the therapy process?

it was helpfull for me because it helped to remind me of events or situations that happened between my therapy sessions. Also it was really usefull for finishing my daily tasks. I think this system will be helpfull for my therapy because it connects myself more to the tasks. It is a nice and easy way to remind the past weeks since the last session and because of that it was easier to talk about it with more detail

Please provide any feedback or remarks you or your mental health professional have

I would like to have a chat feature because it would be easy to contact the therapist to cancel or make a new appointment if necessary. My therapist also mentioned that she would use this system with younger clients but not really with older clients. She thinks that other therapists would think /do the same



Attachment 4: Survey 4

To respond: or

This survey is targeted towards people who are clients of a mental health professional. I am in search for clients that are willing to partake in the testing process of a system that is meant to aid both client and professional in the therapy process.

To be able to partake in this process, an android phone and the willingness to convince your mental health professional to partake in this process is required.

Both client and mental health professional will be required to make use of this system for a total of at least 2 therapy sessions.

Partaking would require you to actively keep track of information such as your mood, experiences, thoughts, amount of sleep, emotions and weight using a mobile application.

This information would in turn be required to be reviewed by your mental health professional using a web application. Next to this your mental health professional will also be able to digitally assign tasks to you.

Are you willing to partake in the testing process that would require you to actively make use of a mobile application? *(Please check all the boxes that apply)*

Yes No

Please provide the name and or details of your mental health professional.

David Blomme

Of what profession is your mental health professional? *(Please check all the boxes that apply)*

Psychiatrist Psychologist Psychotherapist

How old are you?

20

What is your gender?

(Please check all the boxes that apply)

Male Female Other

How would you describe the type of mental problems you suffer from? (Name of diagnosed illness or general description of problems)

bipolar

How many days are between each of your therapy sessions?

7 days

Please provide your email address.

A download link for the mobile application and a link to the web application will be delivered via email address.



2

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To respond: or

This survey is a follow up survey to determine the successfulness and gather feedback of the IT solution for aiding the therapy process.

In how many sessions were the mobile application and web application used?

2

Did the reminders (notifications) stimulate you to complete the assigned tasks? (Please check all the boxes that apply)

Yes

No

Would your mental health professional be willing to continue using the system in their practice? (Please check all the boxes that apply)

Yes

No

Only if it was further developed

Did the reminders (notifications) stimulate you to log your daily mood entries? (Please check all the boxes that apply)

Yes

No

Would your mental health professional describe this system as beneficial to the therapy process? (Please check all the boxes that apply)

Yes

No

Would you describe this system as beneficial to the therapy process? (Please check all the boxes that apply)

Yes

No

How would you describe the influence the use of the aiding system had on the therapy process?

Ik zou het beschrijven als een aangename ervaring. Hoogstwaarschijnlijk heb ik van moodtracking en de mobiele app mij zeker op weg helpen. Soms heb ik last om te laten uitrekenen dat opgelijst zijn door mijn psycholoog deze app kan mij hierbij ook helpen.

Please provide any feedback or remarks you or your mental health professional have

Ik zou graag een aantal verbeteringen zien zoals de mogelijkheid om een afspraak te maken met mijn psycholoog was onder de indruk naar zou het graag willen verder gebruiken als het een officieel en uitgebreid product was. Zou het graag willen gebruiken bij zijn jonge cliënten.
psycholoog

