MASTER'S THESIS

User Study of a Prototype for Mobile Work Time registration

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2016

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3/30/2016

Abstract

Work time and task registration is done in some form at most workplaces. It might be everything from writing down the times in a physical logbook to having dedicated software for time registration. Tracking time and how it is spent can be beneficial for both the employer and the employee. The goal of this thesis is to find out if it is possible to make time reporting accurate and easy on a mobile unit, this by using methods from the user-centered design toolset to create a prototype. To facilitate seamless time registering scannable tags are introduced into the system.

During the thesis work 75 people answered a survey. Five of these people participated in a design workshop and evaluated the finished prototype. The survey examined general attitudes towards time registration, the current system used at their workplace and a proposal for a new system. The survey formed the basis for the requirements on the system. A design workshop was held where the participants had to realize these requirements in a paper prototype. The participants from the workshop tested the programmed prototype at their workplaces and evaluated it. They also evaluated the experience of participating in the design process.

The result of the prototype testing indicates that time reporting can be made easy and accurate and that the NFC-tags that were used were an aid. The testers were of the view that user-centered design is a good toolset that when used correctly can be used to capture requirements well.

Acknowledgements

I would like to thank Staffan Johansson, my supervisor at Neava, for giving me the opportunity to work on my thesis there. Thanks to Josef Hallberg, my supervisor at Luleå University of Technology for his continuous support, ideas and advice throughout the thesis work.

I also want to thank the people who took time and answered the questionnaire and a big thank you to the five persons that participated in the design workshop and tested the prototype.

Last but not least I would like to say thanks to all of my friends and my family that helped me during my work with the thesis.

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1 Introduction

1.1 Background

At most workplaces the employees are required to register and report their work hours and maybe what type of work that have been done during the day. One important question is what tasks, activities or projects that require the most amount of time. By looking at how the time is used in a company the employer can determine what activities that should be prioritized.

Some of the reasons to track time are:

- Data for time estimations in future projects.
- Data for billable time.
- Facilitates prioritization between different tasks.
- Raises accountability of the employees.
- Gives the employees data to point at during salary negotiations.
- Helps in finding bottlenecks.

Today many companies use obsolete or inadequate systems to register their work hours. Not all the systems aids in reporting what tasks that has been done. Systems used are often based on the employee's own memory. The registration of how the time has been spent during the day, or perhaps even week, is done at the end of the day/week with the aid of estimations. This leaves room for human error and is usually not accurate. To manually register the time it takes to perform a variety of tasks can itself be time consuming and get in the way of the task at hand.

1.2 Problem definition

The purpose of this thesis is to find out how a time reporting system should be designed to be as easy to use as possible, from a user's perspective and to evaluate the user-centered design toolset. It makes sense to design a system that is used on a smartphone since most people always have access to a smartphone. This increases the flexibility of the system.

The goals of the project are:

- To gain insight in how a user of a time reporting system thinks through user-centered design.
- To evaluate the user-centered design toolset.
- To find out if it is possible to make time reporting accurate and easy to use on a mobile unit.
- To find out if it is possible to enhance the experience of a time reporting system with the help of scannable tags.
- To have a working prototype at the end of this project that has been tested and evaluated by users.

1.3 Delimitations

The project is limited to only one round of survey, design workshop, prototyping, testing and evaluation, this due to the limited time of the project. Optimally the prototyping and testing stages are repeated a few times until a consensus is reached among the participants that the application is well designed. The project will at the design-phase be limited to focus on the requirements of one or two occupations or at least occupations with similar requirements. This is due to the fact that

different occupations may have widely different requirements. It would be too time consuming to look at more occupations and try to please everybody with a single prototype.

It is out of the scope of this project to create a complete application. The application created will only be a prototype and will therefore have its limitations. For example it will not be a secure application with a rigorous logon procedure, encrypted data, or well formed input validation. The prototype will not be using the most optimal procedure to handle connectivity and assumptions about the connection state might be made in the prototype. The reason to not focus on having a rigorous logon procedure is simple, the effort it takes to add one does not add much functionality for the users to evaluate that they are not already used to.

This project will not consider or evaluate similar already existing applications that handle seamless check-ins or time reporting. This due to the fact that user-centered design is used in this project to design and evaluate a system. An integral part of this project is to design a system according to the wishes of the users, not redesigning an existing system

This thesis work does not go into depth regarding ethics. The data collected is handled anonymously and presented in the thesis on a group level to avoid that an individual easily can be singled out.

1.4 Method

The user-centered design toolset is utilized in this project with the purpose of connecting with the intended users. The approach used in this thesis is based on the suggested ways to involve users in the design and development process by Abras et al. [1]. This includes:

1. A questionnaire collecting quantitative data regarding the users' expectations on the system.
2. Analysis of the answers from the quantitative study to form requirements.
3. A design workshop where the requirements are discussed and realized.
4. Chauffeured prototype testing to gain additional information on the needs and expectations on the system.
5. Usability testing to evaluate the prototype.
6. A questionnaire and interview to collect data on the usability test.

1.5 Thesis structure

Section 2 briefly mention work related to this thesis. The focus of section 3 is on the methods that have been used during this thesis work for gathering data. Section 4 motivates the choices made regarding what tools and technologies that has been used during this thesis work. In section 5 the results from the questionnaire are presented. The results from the design workshop and its participants are discussed in section 6. Section 7 gives an insight into how the prototype and the server were implemented. Section 8 presents the results from the prototype tests and the evaluations made by the five testers. Section 9 contains a discussion about the methods used and the results from this project. Section 10 touches on conclusions that can be drawn from this project and Section 11 on possible future work if one would want to expand upon this thesis work. The Appendix has been placed in section 13-15 here one can find the questions from the questionnaires, images of all the screens produced during the workshop and also images of all the screens reachable in the prototype application.

2 Related work

2.1 User-centered design

User-centered design is a practice that is widely used in engineering [2]. User-centered design is not a method in itself, rather it is a collection of methods and ideas that in some way involves the intended end users at different stages in the development process [1]. The techniques are many and how they are applied varies among practitioners of user-centered design. There are plenty of examples of where user-centered design has been successfully applied.

Baecker et al. [3] developed software for collaborative writing through using user-centered design techniques such as interviews, surveys, prototyping and laboratory studies, based on the interviews and laboratory studies they built prototypes for users to test. As a part of the evaluation of the system they had their testers answer both a questionnaire and an interview. This is a good method since they get structured data but also lets the testers express themselves freely and give information that does not fit into the predefined questionnaire.

Koskela et al. [4] constructed a mobile phone UI for a smart home using user-centered design techniques such as contextual inquiries, theme interviews, focus groups, usability tests etc. The prototype was evaluated for three months by a couple living in a smart home. The long testing period is a nice touch and gives real qualitative data. However, the system has only been evaluated by one couple that may have a specific opinion that might differ from the mainstream opinions. A mean between qualitative and quantitative might have been more rewarding. For example they could have had three couples live in the house for one month each instead. This is the way the testing is handled in this thesis work, but on a smaller scale.

Drugge et al. [5] tried out techniques such as ethnographic studies, paper prototyping and Wizard of Oz testing this in the process of constructing a wearable prototype suitable for healthcare workers. The benefits of paper prototyping are made clear in this article and are what led me to use it in this thesis. Drugge et al. also uses a Wizard of Oz approach to demonstrate the prototype to the intended users. This is a good approach if you have a semi-functional system. The work presented in this thesis utilizes the chauffeured prototyping method; see section 3.2 Chauffeured prototype testing, as it can be used together with paper prototypes.

2.2 Mobile communication media

Modern smartphones have many options to communicate with the world. For example it can communicate via WiFi or Bluetooth. If the smartphone has a camera it can read codes such as barcodes and QR-codes. One of the more recent additions to the communication protocols of smartphones is the Near Field Communication (NFC) port, the first NFC enabled mobile was released in 2006[1]. The addition of NFC to commercially available phones led to the development of new systems and applications that utilize this technology. Two common usages of this technology are to integrate it into some sort of ticketing or payment application [6] [7] [8]. The focus in these applications is the fast and secure transfer of data between a mobile phone and a tag as a mean to make some mundane task simpler and less intrusive. The usage of a mobile communication media in this thesis work is used for the same reason.

[1] http://www.nearfieldcommunication.org/smartphone-development.html Accessed: 2016-02-22

Köstinger et al. [9] developed an NFC based patient identification and ward round system for mobile Android units. They integrated an NFC-tag in a wristband that the patient got to wear; on the tag they stored an ID for use with the related application. The hospital staff scanned this tag to get information about the patient. This approach is a secure one. If you as an outsider have an NFC reader you do not get any information about the patient if you scan the tag. You have to have the right application installed on your smartphone that takes the ID and connects you to the backend where the information is. This is the preferred way to do it, from a security aspect. For the sake of the prototype this approach will not be used, since it increases the need for a reliable network connection. In this thesis work the data itself will be stored on the tags.

3 Theory

The methods presented in this section are all part of the user-centered design toolset. These are the techniques/tools that were used to gather and evaluate data.

3.1 Prototyping

The method of prototyping has been found to be useful in software projects where the main issue is human computer interaction [10]. Prototyping is a user-centered design method that involves the intended users of the product in the development of the product [1]. This by letting the users be a part of the development, testing and evaluation of a product, or otherwise exposing them to the product. The main advantages of prototyping are that it can reduce the time it takes to develop a complete system and reduce the cost of developing it [11]. By having a prototype available that the users can see and feel while talking about it reduces the number of misunderstandings. The users' input from testing a prototype may create new requirements for the developers to consider.

There are two main types of prototyping, throwaway prototyping also known as rapid prototyping and evolutionary prototyping [11]. They have different approaches but the same end goal, a better product for the user.

3.1.1 Evolutionary prototyping

In the evolutionary approach you build a prototype that in the end of the development will be the finished product. Throughout the development the prototype is tested by the users and improved upon. New features are added when the users discovers the need for them. This leaves room for the developers to only add the features that are well understood. When you only implement well understood features that the users want and need you do not waste time and money on features that will not be used.

3.1.2 Throwaway prototyping

In throwaway prototyping, you quickly create a simple prototype of the system that can be tested by the users. The users can form new requirements while they are testing the prototype, when the prototype has been evaluated by the users you “throw it away” and take the new requirements and build a new improved prototype [12].

One way of doing throwaway prototyping is called paper prototyping [13]. In paper prototyping you can design a prototype with pen and paper that you later let the user interact with. The benefit of this is that the user can see how the product will look like without the developer having to do any coding. A tester can give valuable information about perceived flaws in the system and changes can be made right away due to the simplicity of the tools used. The results give the developers valuable data that will be taken into consideration when decisions are made in the implementation phase of the project.

3.2 Chauffeured prototype testing

Chauffeured prototype testing [14] is a technique similar to the Wizard of Oz technique. Hannington & Martin [12] describes Wizard of Oz in the following way

“*In the Wizard of Oz technique, a researcher (the “wizard”) simulates system responses from behind the scenes, while a participant engages with a system that appears to be real.*”

The purpose of this is to find out how people feel about a system and how they interact with it. This without having to spend valuable resources on developing a fully functional system before the intended users can test and evaluate it. An important aspect of this approach is that the user who is testing the system is not aware of the "wizard" since the interaction might change if the user knows that the communication is between two humans and not between a human and a computer [15].

The main difference between Wizard of Oz and chauffeured prototype testing is that in the latter the user knows that the system is not a real one, i.e. they are aware of the "wizard". When the users are aware of the "wizard" the definition of what can be called a system changes as well. In chauffeured prototype testing, a pen and paper prototype is feasible since the user don't have to be under the impression that this is a complete system. As the user interacts with the system the chauffeur changes what information is presented to the user. If the user does something unexpected the functionality that the user tried to use can quickly be added by drawing new pieces to add to the prototype.

3.3 Surveys

There are two main areas of surveys, questionnaires and interviews, which can be divided into smaller subgroups. Which of these methods you should choose depends on a lot of different factors that has to be taken in consideration. Surveys might be the most known user-centered design tool due to its widespread use.

3.3.1 Questionnaires

Questionnaires are a quantitative research method. With a well formed questionnaire you have the possibility of targeting a big group of people with different experience levels in the field that your questions relate to. The participants get to answer the questions when it suits them, which increase the likelihood that they will actually take time to do so. There is however an inherent language barrier that can get in the way of getting good answers in the questionnaire [16]. If the respondent to a questionnaire misinterprets a question or if they do not understand a question they will not be able to give meaningful answers. This might lead to a skewed result. With a questionnaire you give the participants the opportunity and time to think and formulate well formed answers, which is good when asking open ended questions.

3.3.2 Interviews

Interviews are usually a qualitative research method. Compared to the questionnaire, the interview method is a lot more personal. You can conduct the interviews in groups or one-on-one. The interviews might be done over the phone or face to face. The fact that an interview requires someone to conduct the interview limits the number of answers that one person is able to collect due to the fact that the interviewer need to spend time on conducting the interview. Since the method is more intimate there are questions that the interviewees might feel more reluctant to answer [17]. For example personal questions regarding their religious beliefs, illnesses or questions that can make the interviewees feel incompetent. To perform a good interview requires skill, how a question is asked, when a question is asked, the mood of the interviewer/interviewee and the intonation are all things that might influence the answer. Still, an interview enables more in depth answers since the interviewer can ask the interviewees to explain their answer in more detail if an answer is unclear. The interviewer can also get additional information from an in person interview that would be lost in other settings. When asking a question the interviewer can see how the

interviewee reacts to the question, for example by evaluating the time it takes for the interviewee to form an answer, reading body language and listening carefully to intonation [12].

3.4 Design workshop

Design workshops are a user-centered design tool that can be used with different kind of goals in mind. A design workshop might have the purpose of creating a user interface or evaluating a proposed user interface. However, the main focus is always to get feedback and gain insight into the minds of the users. Different techniques can be used during a design workshop, depending on the goal of the workshop, like group discussions, collages, creating storyboards and mockups or role play interactions [12]. One important aspect of the design workshop is that the number of participants has to be limited to a number that the facilitators of the workshop can handle. If there are too few facilitators information might be lost if it is not properly documented by the participants. It is also important that the facilitators make sure that all participants feel comfortable and safe so that they all can participate with their knowledge and experience without being afraid of making mistakes.

4 Tools and technologies

In this project different tools and technologies were used. The ones used were advantageous in some aspects and this section motivates the choices made for the most integral parts of the project.

4.1 Mobile platform

Android was chosen to be the target platform for this thesis work since it is the most common operation system for smartphones. Android currently have over 80% of the mobile market[2]. This means that the majority of smartphone users are used to handle an Android smartphone. Android Studio was used to program the smartphone prototype application. This is the best choice since it is the primary IDE for developing native Android applications. Android Studio also has several version control systems integrated, for this project Git was used along with a repository on Github.

4.2 Communication media

The smartphones today have a multitude of different communication possibilities. For instance they can interact with Bluetooth, QR-codes, NFC, barcodes, WiFi and RFID. NFC-tags were selected for this project.

Reasons to use NFC-tags:

- easy to use (tap to use)
- short interaction time with tag
- short range (0-10cm), gives some sense of privacy
- easily immersed into environments
- can be used in places with bad/no lighting
- can be read and written to
- relatively cheap
- memory capacity
- durable

The biggest advantage of the NFC-tags is that they can be rewritten, compared to barcodes and QR-codes that has to be swapped out for another code if additional data needs to be added.

The biggest drawback of using NFC is that it is not available on all smartphones yet, as some of its competing technologies like QR-codes. However, NFC has been a part of Android since version 2.3.3 Gingerbread. Android added support in API level 10 for integrating NFC into your own applications. By having the API level 10 your app will be compatible with 99.8% of the active units on Google Play Store[3]. But just because NFC is part of Android does not mean it exists on all Android phones. It is still up to the manufacturers to add the hardware required to make use of NFC.

4.3 Smartphone

When choosing a smartphone two important aspects were considered. It had to be an Android smartphone and it had to be NFC capable. From a user perspective it is easier to use a system you are used to. Then one could argue that the selection should be made among the most common smartphones like a Samsung S-series or a Sony Xperia Z-series since these are the most sold

[2] http://www.idc.com/prodserv/smartphone-os-market-share.jsp Accessed: 2015-09-09
[3] https://developer.android.com/about/dashboards/index.html Accessed: 2015-09-09

smartphones, according to the employees at four different stores that sell smartphones. After all a user study was going to be conducted using the smartphone, so the smartphone should be user friendly. A different route would have been to pick a smartphone that it is easier to develop applications to. This would be smartphones with a clean Android installation like the Google Nexus. The benefit of this is that you do not have to wait for the manufacturers updates. When Android updates so does your smartphone. The Nexus is co-developed by Google, which makes it easy to use in relation to Android Studio, which is also developed by Google. This means that the Google Nexus is the best choice from a programmer's perspective.

In this project the Sony Xperia M4[4] were used. It is a smartphone that looks and feels like the Z-series in all intents and purposes. The main difference from the Z-series is the performance and price; it is a little bit slower but a lot cheaper. The users will still be familiar with the overall look. A nice thing with the Sony Xperia M4 is that it is waterproof up to 1.5 meters and 30 minutes. Depending on the environment that the users will test the prototype in this might come in handy. The Sony Xperia M4 has Android version 5.0 Lollipop so the prototype was programmed with API level 21. This aims to make the experience of using the application more pleasant. The prototype could have been developed with a lower API level to make sure it runs on more devices, but higher API levels have more features available.

4.4 Server

A RESTful approach was used for the server, REST stands for Representational State Transfer and it is the standard architectural style of the World Wide Web. The server was implemented in Python Flask, which is a micro web application framework well suited for REST actions, which is what was needed to implement the server. The Flask code is written in Visual Studio 2015 since it provides integration with Github and a nice IDE. The relational database SQLite3[5] is used for persistent data storage, which is accessed via the SQLAlchemy toolset and Object Relational Mapper[6]. The server was placed on a virtual machine running Ubuntu 15.04 Vivid, and was during development reached via the SSH/Telnet client PuTTY and ran locally.

When deploying the server for the user tests the same virtual machine was used, but with an Apache2 web server on it. The mod_wsgi module was used to route the requests between the web server and the Flask server. This module is built to be an interface between a Python web application and an Apache server.

[4] http://www.sonymobile.com/se/products/phones/xperia-m4-aqua/ Accessed: 2015-09-15
[5] https://www.sqlite.org/about.html Accessed: 2015-10-07
[6] http://www.sqlalchemy.org/ Accessed: 2015-10-07

5 Questionnaire

This is a summary of the results from the questionnaire that was sent out. The survey had multiple purposes. It aimed to find out:

- Satisfaction level with the current method of time registration.
- Smartphone attitudes.
- Usefulness of a new system.
- Ideas about functions and design in a new system.
- Willingness to participate further.

The questionnaire existed on Google forms. The form was shared on Facebook and sent to three department heads that sent the questionnaire to their employees. See Appendix A - Survey questions to read the full questionnaire. The questionnaire was constructed with help of the guidelines in [16] [18].

5.1 Results

75 persons answered the questionnaire to completion. The answers came from 49% male, 49% female and 2% intergender participants, see Figure 1. The age of the participants reaches from 15 to 60 as illustrated in Figure 2.

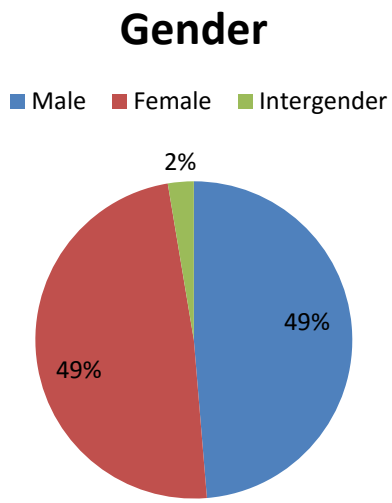

Figure 1: Gender distribution of the participants in the survey.

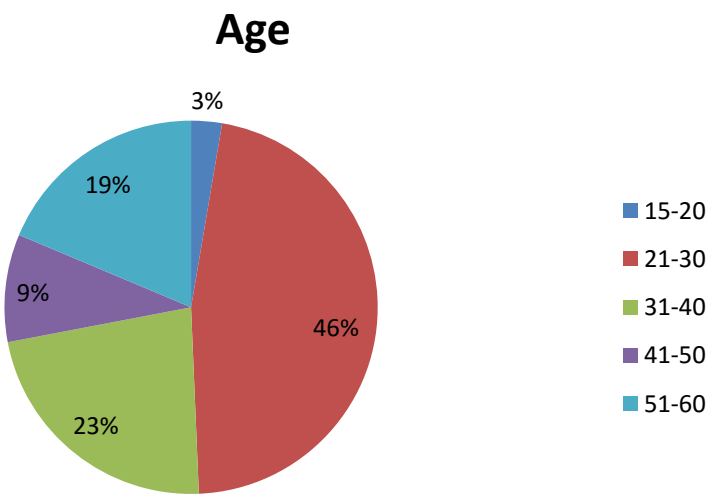

Figure 2: Age distribution of the participants in the survey

5.1.1 Work registration

The questionnaire asked about three common types of work registration. As can be seen in Figure 3, a majority of 76% of the respondents register their working hours. A trend can be noted that the more detailed the logging were, less people were required to do it at their workplace. Another interesting detail inferred by the data is that if you have to register how your time is spent on individual tasks you most likely register the less detailed information as well.

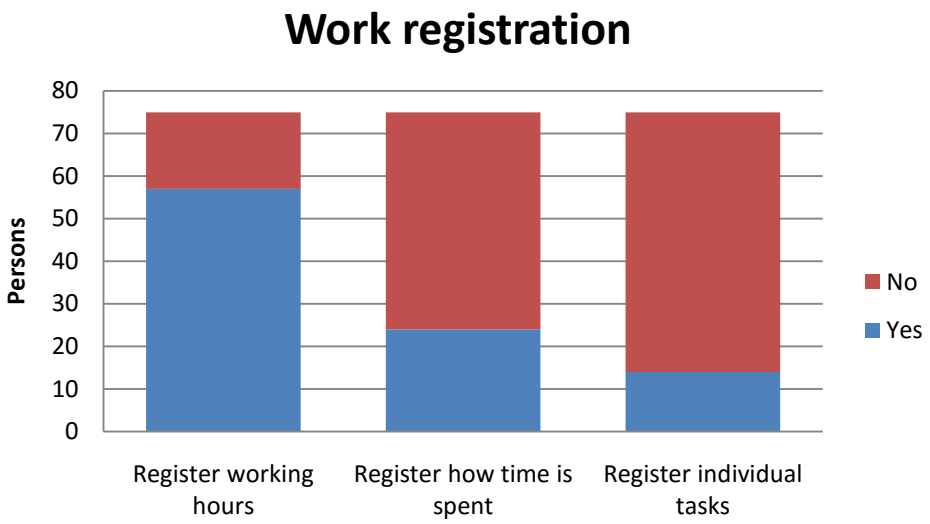

Figure 3: Work registration among the participants.

5.1.2 Time reporting strategy

In the questionnaire the respondents got to describe how they report their time. The summary of their responses are visualized in Figure 4. 63% of the participants use a technical aid in their time registration. Still, 28% of the participants do not have a dedicated tool or software for their reporting and have to do it by other means. This is inaccurate and more time consuming than a working

dedicated system. It is also noteworthy that among the respondents there are 22% that do no follow-up at all regarding their work time.

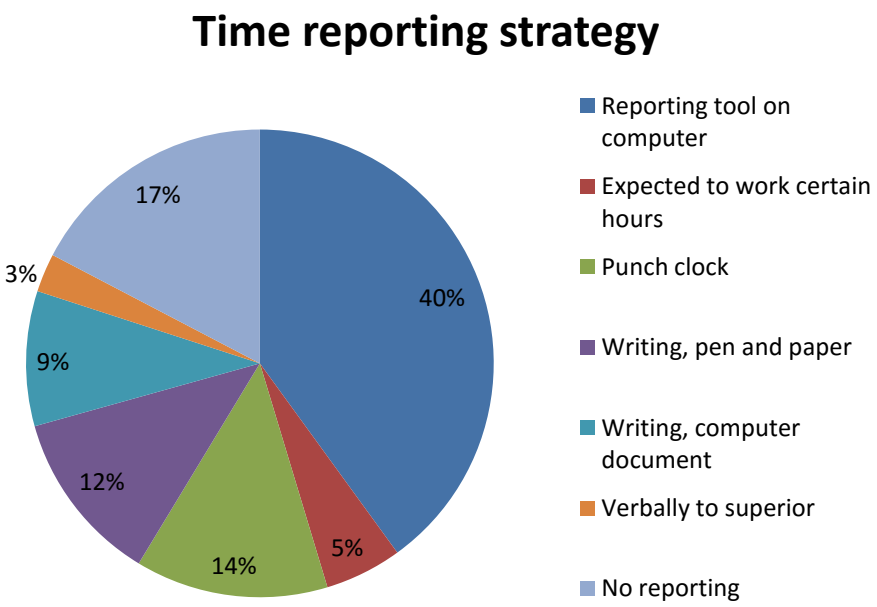

Figure 4: Time reporting strategy at the respondents' workplace.

5.1.3 Current system and change

When the respondents were asked about how satisfied they were with their current system a majority of 58% answered that they were satisfied or very satisfied. The willingness to improve and/or change the current system illustrated in Figure 5 was at 49%. Unsurprisingly, the willingness to change the system increases with how unsatisfied the respondent was with the system, as can be seen in Figure 6.

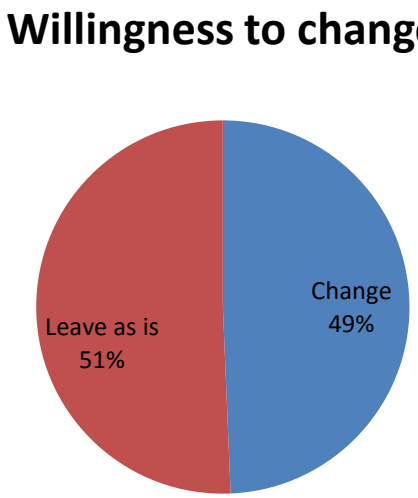

Figure 5: Participants willingness to change the current system.

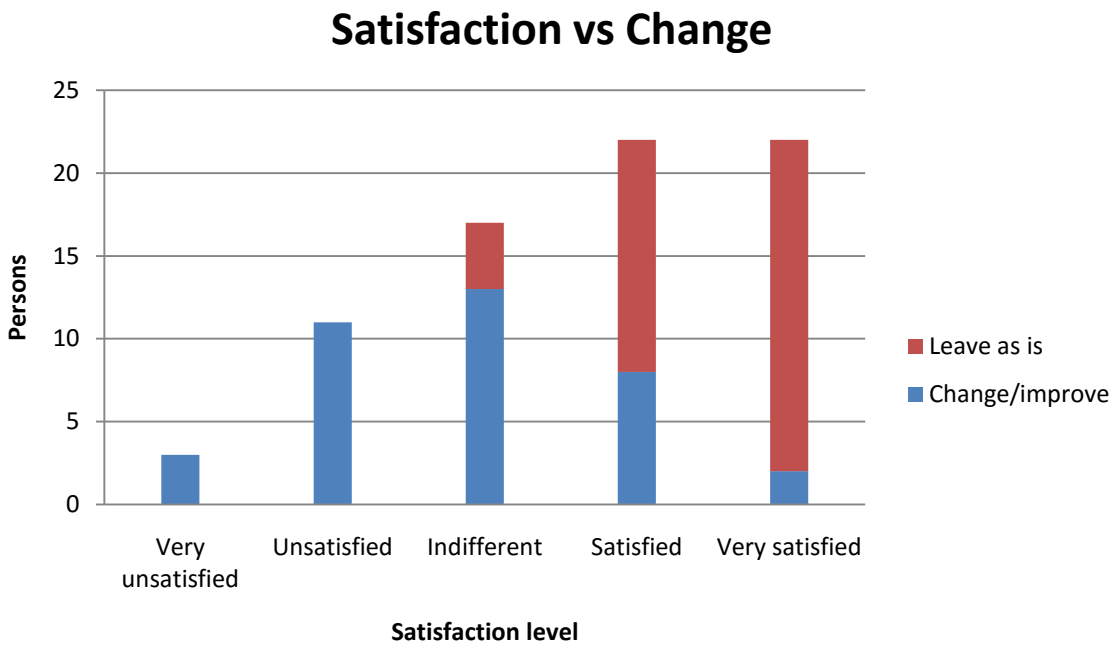

Figure 6: Satisfaction level versus how open participants are to changes in the system.

5.1.4 Smartphone application usage

Among the respondents, application usage is something that the majority is used to. Only 15% of the respondents are not an experienced app user, see Figure 7. This means that the majority is familiar with using applications and the threshold for learning a new application will be low if it is formed in a similar manner as current applications. 7% of the respondents do not even use a smartphone. The non smartphone users are represented in the different age and gender dividers and cannot be categorized.

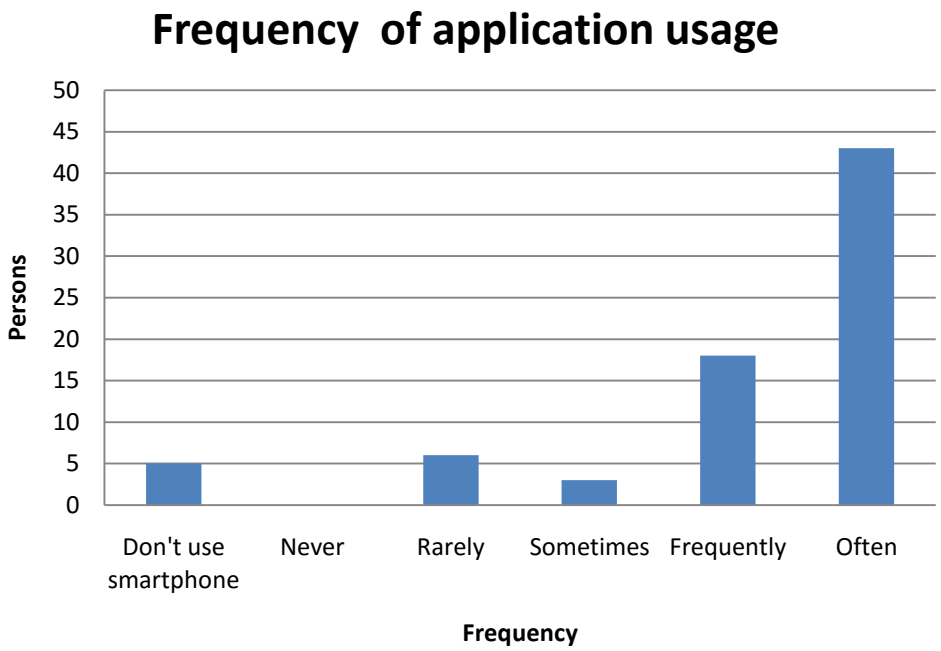

Figure 7: Frequency of application usage on a smartphone, excluding regular texting and phone calls.

5.1.5 Requested functionality

In the questionnaire there were questions that aimed to improve the understanding of what functionality the respondent wished were available. The answers are summarized in the following list of main requirements.

In the prototype you should be able to:

- Show current task with a timer displaying time spent on the task so far.
- Create and erase NFC-tags in a simple way.
- Start and stop tasks without an NFC-tag.
- Show the history of logged tasks.
- Manually edit events in the history and they should be marked as changed.
- Write free-text when starting a task.
- Show a variety of statistics.

In addition to this the respondents also had some input on the user interface. The most important features according to the respondents are:

- A well structured menu, with few levels to avoid having to click too much.
- A thought through button placement, to avoid irreversible mistakes.
- Not to small buttons.
- Some sort of notification when scanning an NFC-tag, visual and/or audible.
- The navigation buttons on the phone should work.

5.1.6 Obstacles in having a mobile system

Some obstacles were noted by the survey respondents. The most noteworthy and frequently mentioned problem was the Big Brother issue, the feeling of being surveilled. When asked about possible obstacles in having a mobile time reporting system one of the partakers in the questionnaire answered the following:

"*Total control which might give the feeling of non-existent trust in the employee and his/her honesty regarding working times.*"

About 10% of the people who answered the survey had similar feelings, pointing out that it is ethically wrong to force employees to use such a rigorous system. Meanwhile, these respondents are already being watched in some regards at their work just with a different system, according to their own answers. The morality of having a system like this is something that has to be considered by the decision-makers at each workplace.

Most of the issues however, were related to the smartphone itself. Some of the issues mentioned were:

- Battery drainage by using the application all day.
- Mobile phone ban or mobile phone unfriendly workplace.
- If your smartphone is broken or you lose the smartphone, how do you report your time?
- Having a slow smartphone or no smartphone at all.
- Bad mobile service, being able to access every function of the system at all times.

6 Design workshop

Five participants were selected for the workshop. The participants were two females and three males with an age ranging from 18 to 25. A decision was made that for the sake of the prototype a wider age range was not necessary, this because there were no noteworthy differences in the frequency of app usage between the different age groups. Although people from an older age group may have different requirements due to impaired vision or other age related issues. These requirements are not important to catch since most modern smartphones, including the Xperia M4 that was used for this project, have accessibility settings to handle these issues.

The workshop participants differed in their frequency of daily application usage, this to ensure that the prototype could be used by both novice users and more experienced users. They also differed in their occupations. The group consisted of:

- CAD operator
- Hotel cleaner and nanny
- Customer representative
- CNC operator
- Laboratory assistant

With different occupations requirements were discovered that would not have been discovered if only one profession had been present. As an example the CNC operator works in a loud environment and will not hear audio notifications, he wished for visual notifications or vibration feedback.

6.1 Prior time registration experience

The participants all have prior experience with different time registration systems and felt that all of these systems have both good and bad traits. The participants aimed to improve the experience of using a system that tracks work efforts based on the knowledge of these previously used systems. Collectively they have used the following methods for reporting their work:

- Punch clock for when you get to work and leave.
- Time book where you write your own times and leave it to the administration at the end of the month.
- Dedicated software where times, what has been done and project number is entered upon switching task.
- Reporting verbally to a superior at the end of each day.
- Write down times in a predefined document template that is sent to a superior at the end of the month.
- Report the completion of a task via filling in a proof that is sent to superiors.
- Report the completion of a task by calling a specific number and enter numeric codes on the dial pad.

Apart from the punch clock all of these methods are disruptive and takes away time from the work you are supposed to be doing, according to the participants.

6.2 Design

For the workshop the requirements that the survey participants had requested, See 5.1.5 Requested functionality, were put into a document that were handed to the design team. The design team had to take these requirements and realize them in a manner they deemed suitable.

The workshop started with refreshing the team's memory of the purpose of the prototype. The team got to familiarize themselves with NFC-tags, see how they work and know their limits. The tools that the team had to work with during the workshop were regular office supplies and to scale cutouts of a Sony Xperia M4. To make the team feel comfortable that their drawing skills were adequate they were lead through the design of a login screen. Since this is a familiar view in most applications they gave suggestions on how it should look like and work, their input were discussed and drawn on one of the templates. This encouraged the team to take own initiative when it came to designing the prototype. Figure 8 shows the design team in action and the tools that they used. When the team was finished with the design they conducted a chauffeured prototype test on the workshop facilitator. The facilitator interacted with the paper prototype and the design team simulated the systems functionality, this to improve the understanding of the design and the team's expectations on the prototype.

Figure 8: The design team at work during the workshop, working with pen and paper.

6.3 Workshop results

The workshop resulted in the paper prototype shown in Figure 9, for a closer look at each screen see 15 Appendix C – Paper prototype and prototype application. Each view has a description with what can be done in the view and what happens when you interact with individual elements in the view.

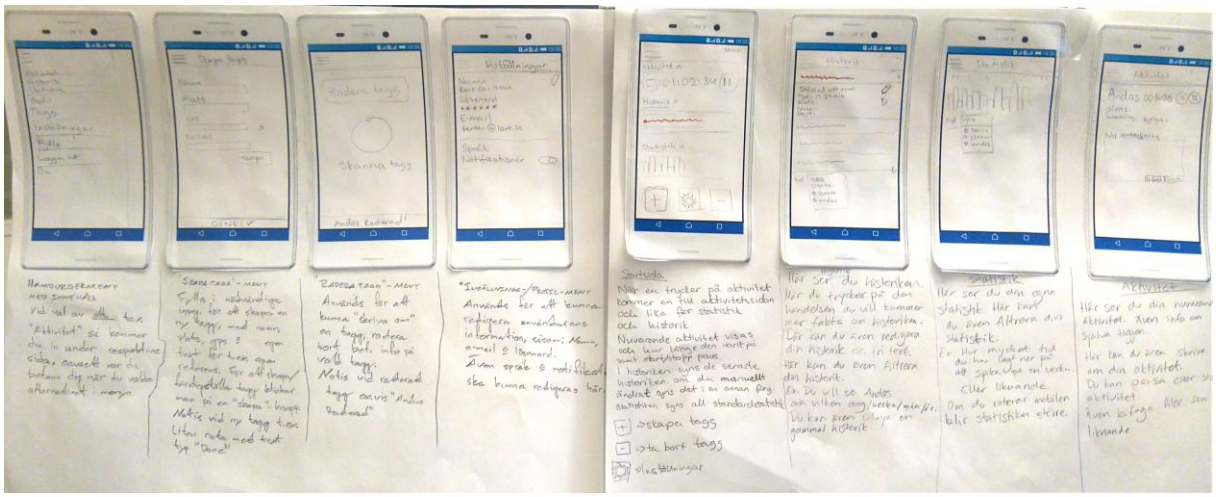

Figure 9: The views that the team designed. With a description of what can be accomplished in each view.

7 Implementation

7.1 System architecture

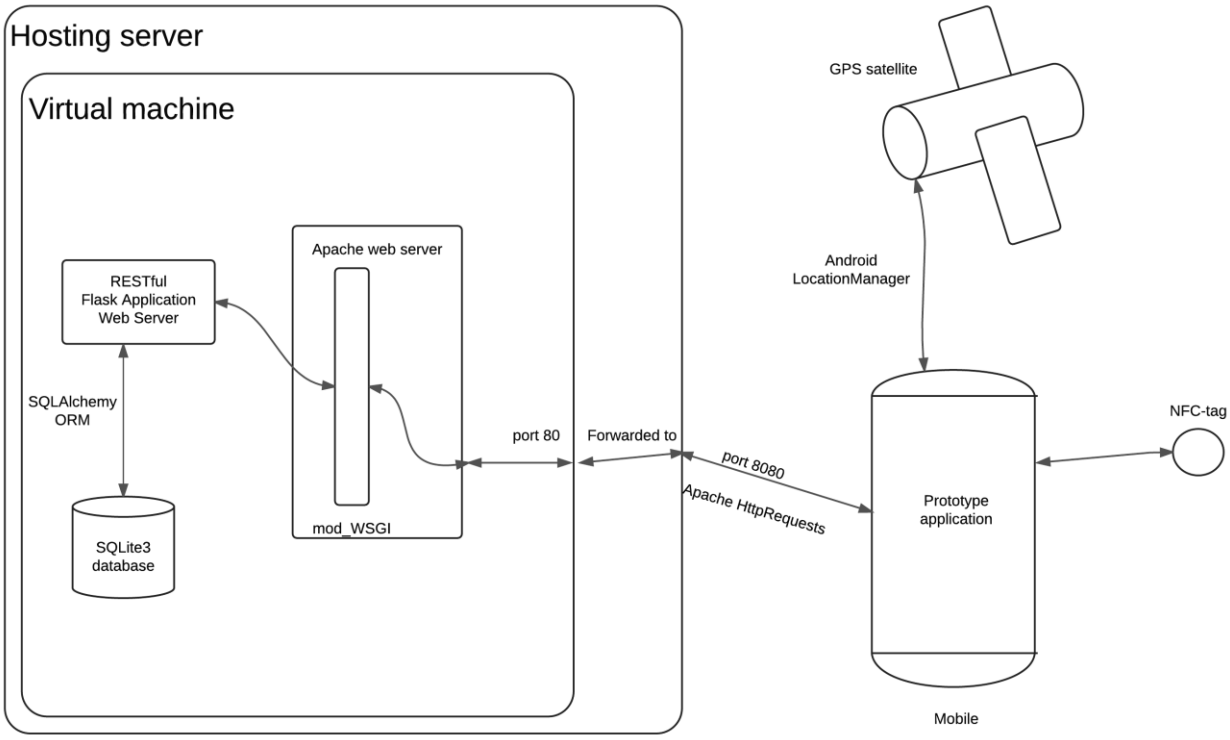

Figure 10: Architecture of the complete system.

The system is using the client-server model, communicating over HTTP. The web server for the application is running on a virtual machine that is hosted on a private server. The Android prototype makes a request to the main hosting server with a specified port so the hosting server knows where to send the request. The request is forwarded to port 80 on the virtual machine since it is a web service request. On the virtual machine an Apache web server is running that redirects the requests through the WSGI module to the actual Flask application web server.

The prototype application also communicates with the NFC-tags to enable quicker registering of tasks and with GPS satellites for getting position coordinates for the creation of new tags and the registering of a task that is done on the fly.

7.2 Server

The prototype server has eight separate endpoints, seven that are used in the prototype, see Figure 11. All of these endpoints perform CRUD operations on the database. The functionality of the server is easily extended by adding new endpoints to the server. If more iterations would have been made in the prototyping procedure this would have been handy.

Endpoint	Method	Description
/worktasks	POST	Creates a new task to the DB.

/worktasks	GET	Get a list of tasks.
/worktasks/<id>	GET	Get specific task.
/worktasks/<id>	PUT	Update a task's info.
/worktasks/headers	GET	Get all the different task headers.
/worktasks/headers/<header>	GET	Get all tasks with a specific header.
/worktasks/headerstime	GET	Get the sum of the time spent on the different task headers.
/droptable	GET	Endpoint used during testing and development to reset the database.

Figure 11: The server endpoints.

7.3 Database structure

For the sake of the prototype only one database table was needed. The entries in the table all serve a purpose and correspond to some functionality that was requested by the survey participants and/or the design team. In a real system that is to be deployed the database model used would have to be different. For instance you would need a table for the users. There could be a table for the different kinds of tasks that has been performed by the user, to make sorting easier, improve scalability and to improve the performance of the system. From a prototype perspective the current model is enough to demonstrate the concept, since the structure of the database is not visible to the tester and the performance is good on a small scale.

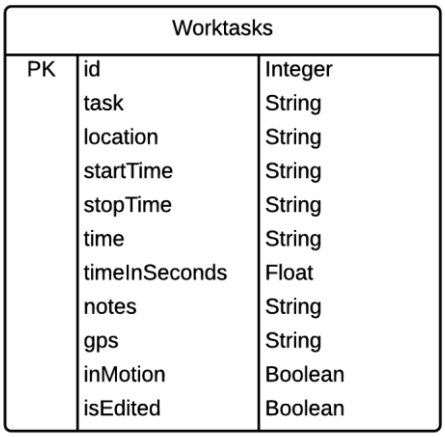

Figure 12: Database scheme for the prototype.

7.4 NFC-tags

The prototype is NFC-enabled. It has the capability to create and erase NFC-tags that can be used to enhance the experience of using the prototype. The tags enable faster and simpler registration of repetitive tasks by touching the tag reader to the tag. When a tag is created they are created with two records, one application record and one data record. The application record tells the Android

device what application to use with the tag. If a tag is scanned without the prototype application being the active application it will be started. The data record stored on the tags consists of a string that is in the JSON format.

7.5 Prototype application

7.5.1 Overview

The resulting design from the workshop was used as a template for the implementation of the system, in accordance with the method of throwaway prototyping. For a closer look at the screens designed by the design team and the screens available in the prototype look at 15 Appendix C – Paper prototype and prototype application.

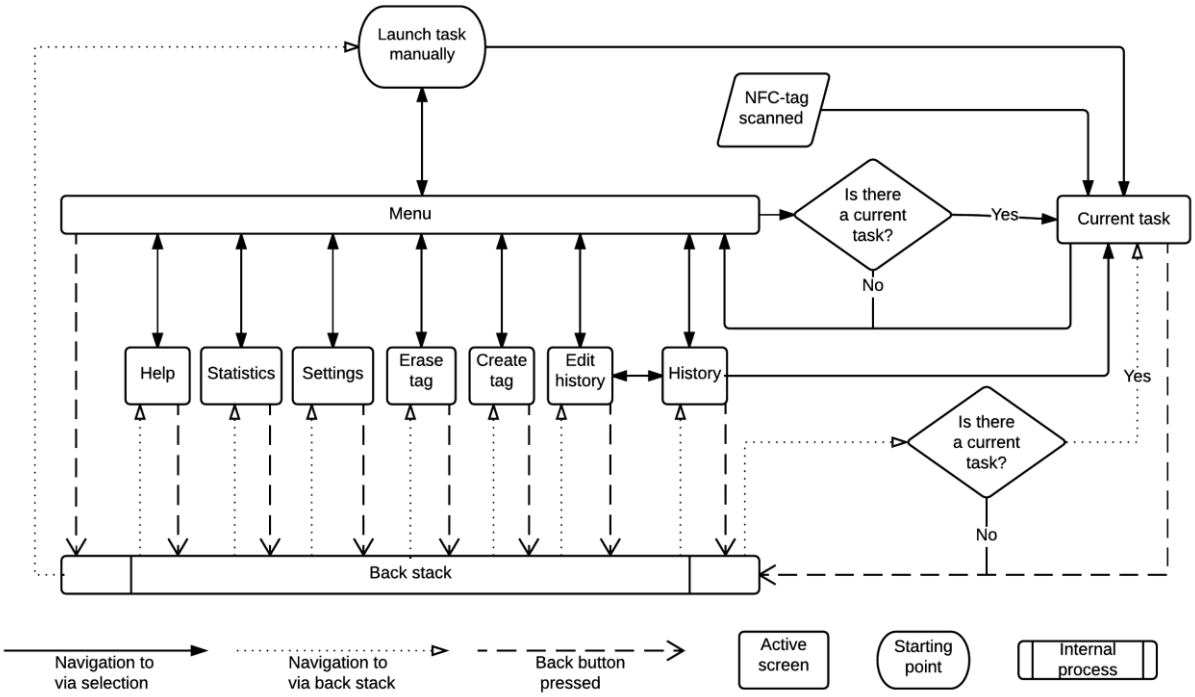

Figure 13: Application navigation overview.

Figure 13 depicts how navigation in the prototype works. If the prototype is started from scratch the entry point to the application is the screen “launch task manually”. If the prototype is already running it continues from where it was exited. At any point in the lifecycle of the application it is possible to scan an NFC-tag, that brings the application to the screen “current task”, if there is relevant data on the tag. This makes changing which task you currently are performing quick and easy. The menu is accessible at all time to make navigation easy throughout the prototype.

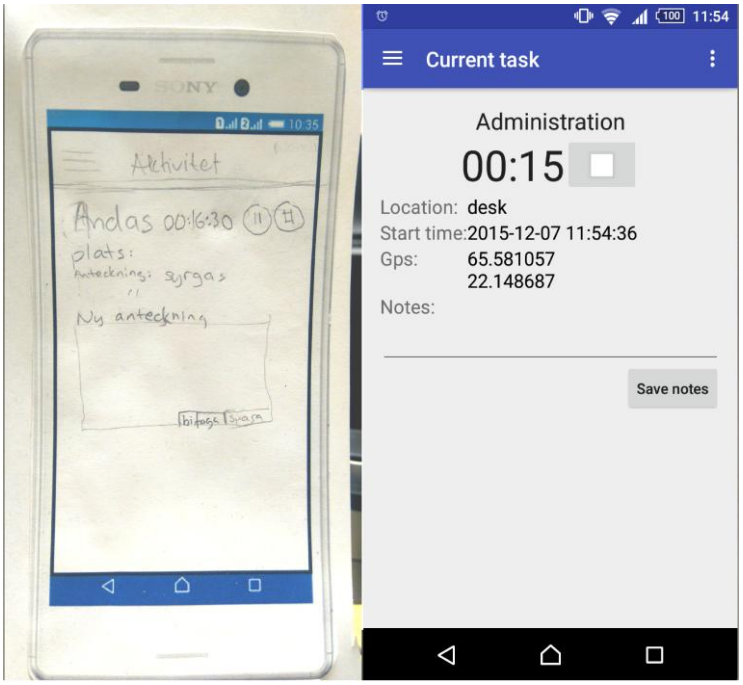

Figure 14: The screen current task in the paper prototype and the application prototype.

The similarities between the paper prototype and the Android prototype are clearly visible. As an example take a look at the screen current task in Figure 14. There is the name of the task that is running, a timer counting for how long the task has been performed, a button to stop the current task, additional information about the task and a field for entering notes with an accompanying save button. In the paper prototype there was a pause button to let the users pause a task. This functionality was omitted in the prototype due to time constraints and the fact that the functionality it provides can be achieved by using the prototype as is. There is a notification to the left in the notification bar indicating that a task is running even when you exit the prototype. The need for this was mentioned during the workshop but not drawn anywhere in the paper prototype. This is the reason it is important to be present and attentive during a workshop, important details and ideas can easily be missed if they have not been written down or recorded in some manner. In the paper prototype the input field that has been drawn could be considered to be a textbox, this conforms more to the look of web forms and windows programs. Instead of trying to make the prototype look exactly as drawn by the design team, the Android standard for input by the user were used, the EditText, this adhere to the Android design principles [19]. Several decisions like this had to be made when realizing the paper prototype into a programmed prototype.

7.5.2 Usage example

For all screens described see Appendix C – Paper prototype and prototype application. How the application works can be described with an example.

Let's think about a plumber that travels to different clients. The plumber has two distinct events that she wants to record. She is either in the car driving between clients, or at a client working. The plumber has two NFC-tags in her car, one tag representing transportation, the other representing working at a client. When the plumber starts her day she scans the transportation-tag with her mobile and heads to the client. When she arrives at the client she scans the client-tag. When scanning a tag the application displays the screen “current task”, here she can see a timer counting

for how long a task has been active and some additional information about the tag. If she keeps up with this procedure and register her progress throughout the day the application will at the end of the day have a complete record of where she has been working, and how much time she spent at the different locations. This can be observed by clicking the menu button “History” to get to the screen “History”. Here a compact list with the previously done tasks is shown. If the plumber needs to get more complete information about a separate task she can click on it and it will expand. If she needs to edit a task she can click the pen to edit the information. If the plumber left the car and forgot to scan the client-tag and remembers it when she is inside the client’s house she can launch a new instance of an old client-task by clicking the play button in the screen “History” or go to the screen “Launch task manually”, fill out the required fields and press the play button.

The plumber can also extend what she is registering if she uses more tags. To create a new tag she can go to the screen “Create tag” and fill in the tags information. To create the tag she holds down the create button and touch the tag to the phone. If she wants to erase the information on a tag she can go to the screen “Erase tag”, hold down the erase button and touch the tag. If she is unsure about how anything in the application works she clicks the section “help” available in the menu.

8 Prototype test results

The participants from the design workshop also performed the prototype tests. The participants got to test the prototype for a day each at their workplace and then evaluate the whole experience of prototyping and the prototype testing by answering some written questions and give some additional verbal feedback in an informal interview. For the questions see 14 Appendix B – Prototype evaluation questions.

8.1 Ease of use & accuracy

All of the five testers thought the prototype was easy to learn and use. They also were of the view that being part of the design team helped since they already knew about the concept and had an idea about what functions to expect from the prototype. Three of the testers noted that the fact that the prototype they tested were similar to how other applications looks and acts like made it easier to use. I.e. the important philosophy "*If it looks the same, it should act the same*" from the Android design principles were followed.

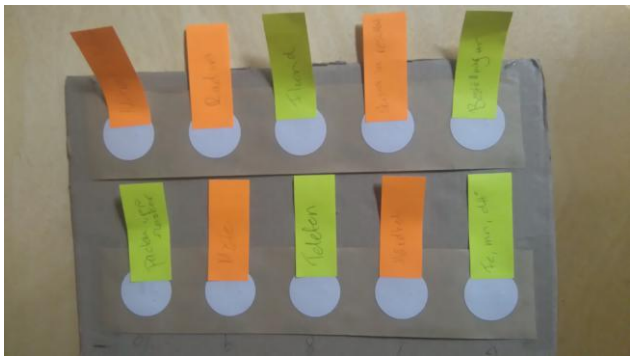

Figure 15: Labeled NFC-tags from the testing.

During the prototype testing the testers were handed 10 NFC-tags to work with. As seen in Figure 15 the tags were taped to a piece of cardboard. The testers chose what tasks to add to the tags and labeled them accordingly. The NFC-tags were perceived to be a helpful aid that enhanced the system by making registration feel seamless and less intrusive on the work. The testers all agreed that the prototype gave a result which better reflected the time spent on different tasks than their current system since this actually measures the time that they spent on the task. One tester wrote the following:

"The tags facilitate the procedure immensely. It goes quick and easy to start my work and I don't have to think about writing down the times on my own."

8.2 Current system versus prototype

The testers were asked to compare the prototype system to their current systems that are used at their places of work. The following quotes highlight the differences between the system that is currently used at the workplace and the prototype. The first quote from one of the testers indicates a wish for the higher accountability among the employees at the workplace that the prototype application provided.

"*It's two completely different methods. Right now there would be no point in having the new system since there is a lot of idle time this time of the year. During high season this would be my preferred*

method because then my boss can see how much work I actually do. It's fairer if you for instance have a colleague that's just 'doing their time' at the job. "

The next quote shows that sometimes, the work you are doing are not seen by the method of time registration used at a workplace. The fact that the prototype shows these moments was appreciated.

"What I like about this system is that it shows that I'm working even if I don't have finished a task."

The last quote is from a tester that sees the possibility of using the prototype system for better prioritizing between tasks.

"The current system only shows when I arrive at work and when I leave. It doesn't show how fast/slow things are going. When the guests arrived I was still not finished with all the rooms. If my boss would have had access to the data from the application, she would have seen that I would never have been able to clean all the rooms on my own in a timely manner. She could have reprioritized the work efforts and the new guests would not have had to wait. "

8.3 Being part of user-centered design

Regarding using pen and paper as design tools during the workshop there were no wide spread of opinions among the testers. Some of the participants were used to working with more advanced computer tools for drawing and designing, but the consensus was that using pen and paper were great since it brought them all to the same skill level. The team was pleased to work as a group and not getting to do individual designs. They felt that working in a group forced them to really think about their design choices, since they had to motivate them to the other members for them to be accepted into the design.

"I had some different opinions regarding the design. Overall I'm happy with how the design turned out. In retrospect I think I might have thought my rejected changes to be otiose if they had appeared in the prototype I tested. Therefore I think this was a good method. "

The participants all agreed that the similarities between the final prototype that they tested and the paper prototype that they constructed earlier were highly noticeable.

"I feel like you have listened to what we have said, designed and proposed during the workshop, and at the same time you have made it in your own style and thought of the practical aspects as well."

The design team got very involved with the prototype. During the planning and implementation of the prototype the designers remained connected to the project. The designers had questions regarding functionality in the prototype and came with new ideas for the prototype that they had thought of or discovered the need for.

9 Discussion

9.1 Methods

The user-centered design toolset is a big one, and to accomplish the goal of a working prototype I had to weed through the different options on what methods to use. If two or more methods could accomplish the same goal I made a choice mainly based on time restrictions and funds needed to perform the activity.

I decided to use a questionnaire to gather quantitative data since it was the most time efficient tool, relative to the amount of data it can generate. All of the participants in the survey have a connection to me or the project in some sense and one can argue that this might generate a skewed result. However, this was an easy way to collect answers without having to offer some kind of compensation for participating in the survey. I am of the opinion that the results have not been skewed by me having a connection to the participants, since they got the option to answer the survey anonymously. I gathered the answers from 75 persons. To be able to make any real statistical claims a larger sample size is needed, but for the sake of the thesis this sample size is enough.

The design workshop was not only a good way to get a design proposal, but it sparked an interest in the final product among the participants. I did not expect the participants to get as involved as they did. If time and money would have allowed me to I would have liked to have held a number of workshops with different participants, since the input I got from the workshop was priceless and strongly influenced the thesis work. It would also have been interesting to see if different constellations would have reached similar designs. That way you would know that the design you implement is the right one that most people prefer.

The prototype testing was done during a week where the testers got to test the prototype for one day each. I would have liked for the testers to test the product for a prolonged time period, that way they could have gotten a more complete sense of how the system works. Here as with the questionnaire this short testing period is enough for the sake of this thesis work. Even with a test period as short as a day, the testers could give valuable feedback. In an optimal scenario the first tests of the prototype might have been this short. The difference would then be that after the initial tests some reprogramming would have been made as a result of the feedback given by the testers, followed by a prolonged testing period. I would have liked to let the testers use the NFC-tags as they pleased and stick them to different surfaces to get a more realistic feel for the system. But since the testing period was so short it would have taken time from the testing to set up the tags in different locations and collect them again.

9.2 Results

The answers from the survey indicate that there is a lot of room for improvement in the area of time registration. About 50% of the survey participants want their current system to be changed and they seem to know what needs to change to improve the system that is used at their place of work. I think that this number would be at least this high if a larger sample group were to answer this question, since there is no such thing as a flawless system.

The prototype was very well received during the prototype testing. The consensus was that the prototype system enabled easier time registration and that the addition of the tags enhanced the experience. To see how much impact the tags had on the experience of the system I thought of

letting the users test the prototype system without tags to scan and then have them compare it to using the complete system. I deemed this too extensive since the tags are only an option in the prototype. All actions can be made without the tags, it is only a matter of which way is the most convenient at the time a new task is to be started. If the tags were used, surely they had a positive impact on the system. In addition to that, the feedback from the users strengthens this argument.

9.3 Ethical aspects

There are some ethical issues to consider when handling an application like this, especially since it incorporates GPS. In the questionnaire several of the respondents felt that they were going to be surveilled and that the administration were going to know where they are at all times. It is important to remember that the application only reads the coordinates of where the mobile is when a new task is started and perhaps not even that. If the tag is stationary the coordinates can be stored on the tag. This gives the user of the application all the power when it comes to being tracked by the application in sensitive moments.

When a system like this is to be deployed at a workplace it is important that the involved parties agree upon a reasonable scope for the registrations. A too wide scope might make the employees feel monitored and a too narrow scope gives no useful data. To make the collected data meaningful a tool for analysis of the data is required and it also aids in avoiding the feeling of being surveilled, this by not having a person look at every single registration that has been made.

The system is using a client-server model; this means that the data stored on the server have to be protected in some manner since the data stored may be sensitive, for example patient information in a hospital. This can be achieved by using encryption and having a user database that restricts access to the server. Depending on where the tags are put they might be the target for some tampering by outsiders. Encrypting the payload on the tag and avoiding that sensitive data is stored directly on the tag ensures that the data remains secure.

9.4 General remarks

When I got the smartphone that I was going to work with in this project I encountered an issue right away. There were some troubles to get it to work together with Android Studio, just as I had thought when I was picking a smartphone to work with. To connect the device to Android Studio the smartphone needed the correct drivers to be installed. These did not come with the smartphone and were not uploaded to Sony's driver page. I had to contact Sony to get the correct drivers uploaded to their webpage. They resolved the issue surprisingly fast and uploaded the drivers.

My knowledge in Android development prior to this thesis work was limited. In retrospect I would implement the prototype application in a different way since I have learnt a lot about the ins and outs of Android. Although this is not something that affected the prototype in how it looks or works, as seen from the outside by a user.

10 Conclusions

The goal of this project was to construct a working application prototype by utilizing user-centered design as a mean to connect with the intended users of a mobile time reporting system, enhanced with scannable tags. The efforts made in this project shows that time reporting can be made accurate and easy to use on a mobile unit. The thesis work also highlights the potential of scannable tags as an aid in a time reporting system. It also shows that the toolset of user-centered design forms a strong basis to work on.

11 Future work

To build further on the program written during this thesis work one has to remember that what have constructed in this thesis is only a prototype. In its current state the prototype have no security procedures, there are no login and no encryption of data on the tags or when transmitting the data. The prototype has no network handling and always assumes that there is an internet connection available. If someone wishes to build further on this thesis work and develop a complete solution, the prototype created in this thesis should be thought of as a throwaway prototype and the aforementioned functionality could and should be added.

If the system is to be used in a company it would be a good idea to implement some sort of desktop application where an administrator can handle the time registration done by several persons and get some analysis of the data. This is the tool that makes the system useful for an employer. The usability of this system could be expanded on by developing clients for other operating systems than Android.

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13 Appendix A - Survey questions

This survey is a part of my master thesis in computer science and engineering at Luleå University of technology. An integral part of this master thesis is to conduct a user study. The answers given in this study will form a basis for further discussion regarding a program that is to be developed.

Please answer the questions as best as you can and as truthfully as possible. The results of this survey will be presented anonymously on a group level and no unauthorized persons will have access to individual participants answers. Thank you for participating!

1. What is your gender?

Male

Female

Other:

2. What is your age?

0-14

15-20

21-30

31-40

41-50

51-60

61+

3. Which of the following best describes you?

I am currently employed.

I used to be employed.

I have never been employed.

When answering the following questions please think about your most recent employment.

4. What is your occupation?

(What do you work with?)

Answer

5. How many years have you been at your current workplace?

0-1

2

3

4

5+

6. Do you register your working hours at your workplace?

(Today i worked 8 a.m to 4.30 p.m)

Yes

No

7. Do you register how your time has been spent during the day?

(Example: A receptionist that registers 3h telephone time, 3h talking to customers in person, 2h other time.)

Yes

No

8. Do you register how many times you have done a specific task per day?
(Example: A call center employee registering how many calls related to a certain topic they received per day.)

Yes

No

9. Are you a supervisor/leader/manager who in some way handle employees' work time?

Yes

No

10. Please describe your current method of registering your work time/tasks during the day.
(Feel free to be as specific as possible. If you register none of these write "none".)

Answer

11. How do you feel about this method?
Very unsatisfied Unsatisfied Indifferent Satisfied Very satisfied

12. What are the good qualities in the system you use?

(If there are no good qualities write "none".)

Answer

13. What are the bad qualities in the system you use?

(If there are no bad qualities write "none".)

Answer

14. Would you like the current system you are using to be replaced/improved?

Yes

No

15. Do you have a smartphone?
(Can be a private phone or a work phone.)

Yes

No

16. Do you usually use applications on your smartphone?

(Apart from calling or texting.)

Never Rarely Sometimes Often Always

Imagine a system that enables registering what you are doing, when it's done and where it's done. The system will be using NFC-tags that contain this information. NFC-tags are small stickers with wireless technology that can send information to your phone when you hold your phone to the tag for a short period of time.

As an example let's think about a plumber that travels to different clients. The plumber has two distinct events that she want to record. She is either in the car driving to a client or at a client working. The plumber has two NFC-tags in her car, one representing transportation, the other representing working at a client. When the plumber starts her day she scans the transportation-tag with her mobile and heads to the client. When she arrives at the client she scans the client-tag. If she keeps up with this procedure the plumber will at the end of the day have a record of where she has been working, and how much time she spent at the different locations. This information can be used as a basis for billing her clients. She can also extend what she is registering if she uses more tags.

17. By the given description, would you say that you grasp the overall concept of this system?

Yes

No

18. Do you think that the mobile based system that has the basic what, when, where functionality could be tweaked to be useful at your workplace?

Yes

No

Maybe

19. Do you have any concrete examples of how such a system could be used at your workplace?

(If you don't have any examples answer "no".)

Answer

20. Do you see any advantages to having such a system in the form of an application on a smartphone?

(If you don't see any advantages answer "no".)

Answer

21. Do you see any obstacles in having such a system in the form of an application on a smartphone?

(If you don't see any obstacles answer "no".)

Answer

22. Do you consider yourself to be creative?

Yes

No

23. Do you have any ideas about what functionality should be available in an application like this? (Example: You should be able to scan an NFC-tag.)

(If you don't have any ideas write "no".)

Answer

24. Do you have any ideas about how a system like this should look like? (Example: There should be a menu in the upper left corner.)

(If you don't have any ideas write "no".)

Answer

---

25. Later in this project I would like to meet some of the participants in the survey for further discussion about the application. After the meeting, a prototype will be developed. Would you be willing to participate in such a meeting?

Yes

No

26. Would you be willing to test the prototype at your workplace?

Yes

No

Contact information

27. If you get selected for further discussion I have to be able to contact you. (This information will not be shared with anyone and will be handled with your privacy in mind.)

Name

Email address

Phonenumber

City

14 Appendix B – Prototype evaluation questions

1. Was it easy to learn how to use the prototype?

2. While using the prototype did the fact that you had participated in the design process help?

3. Do you think that the prototype ended up similar to the design constructed during the workshop?

4. After testing the prototype would you like to add or remove some functions?

5. Did you perceive the NFC-tags as an aid or an obstacle?

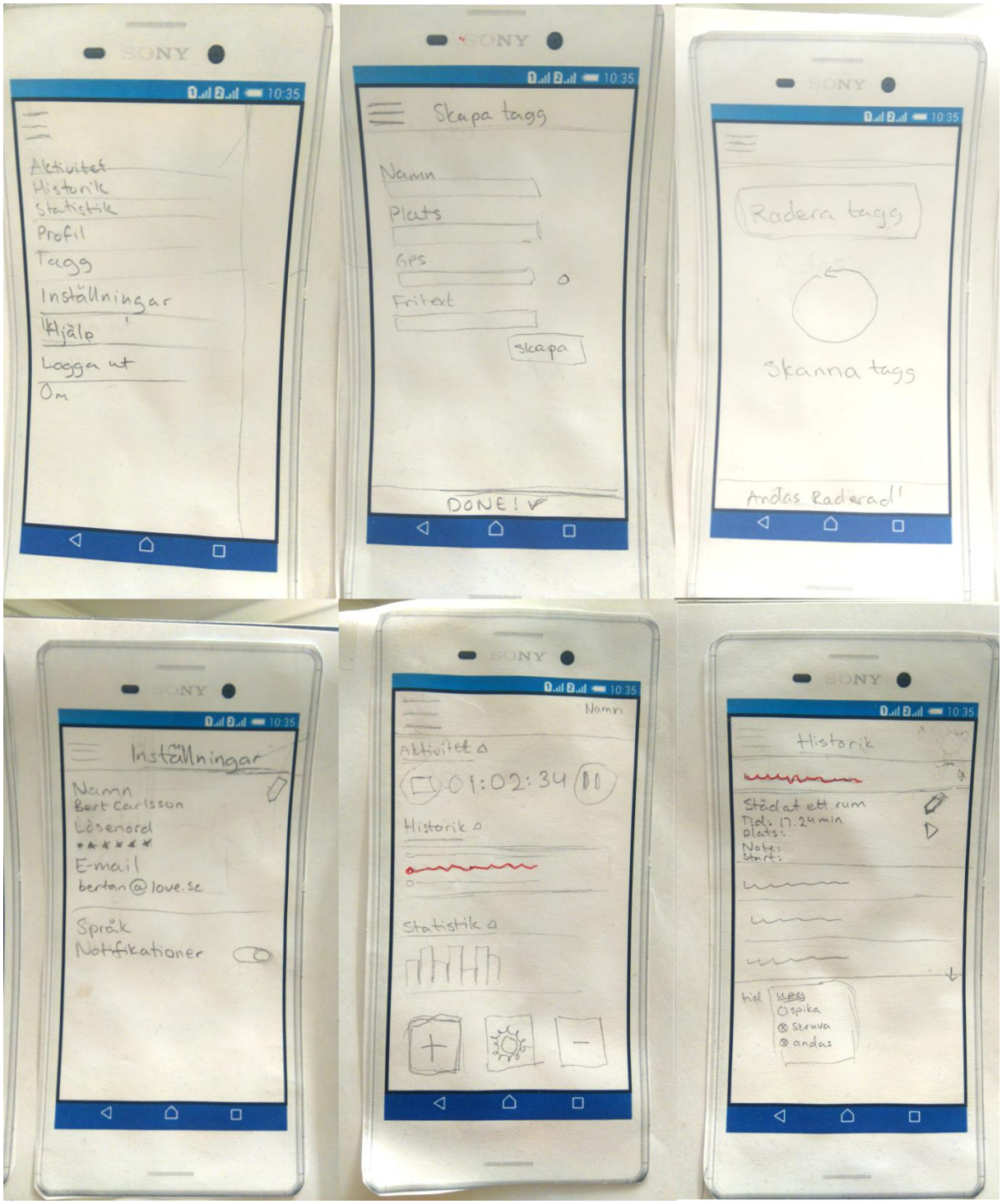
6. Compared to the current method of time registration at your workplace would you say that this method gives a result that better reflects the actual time that has been spent on different tasks?

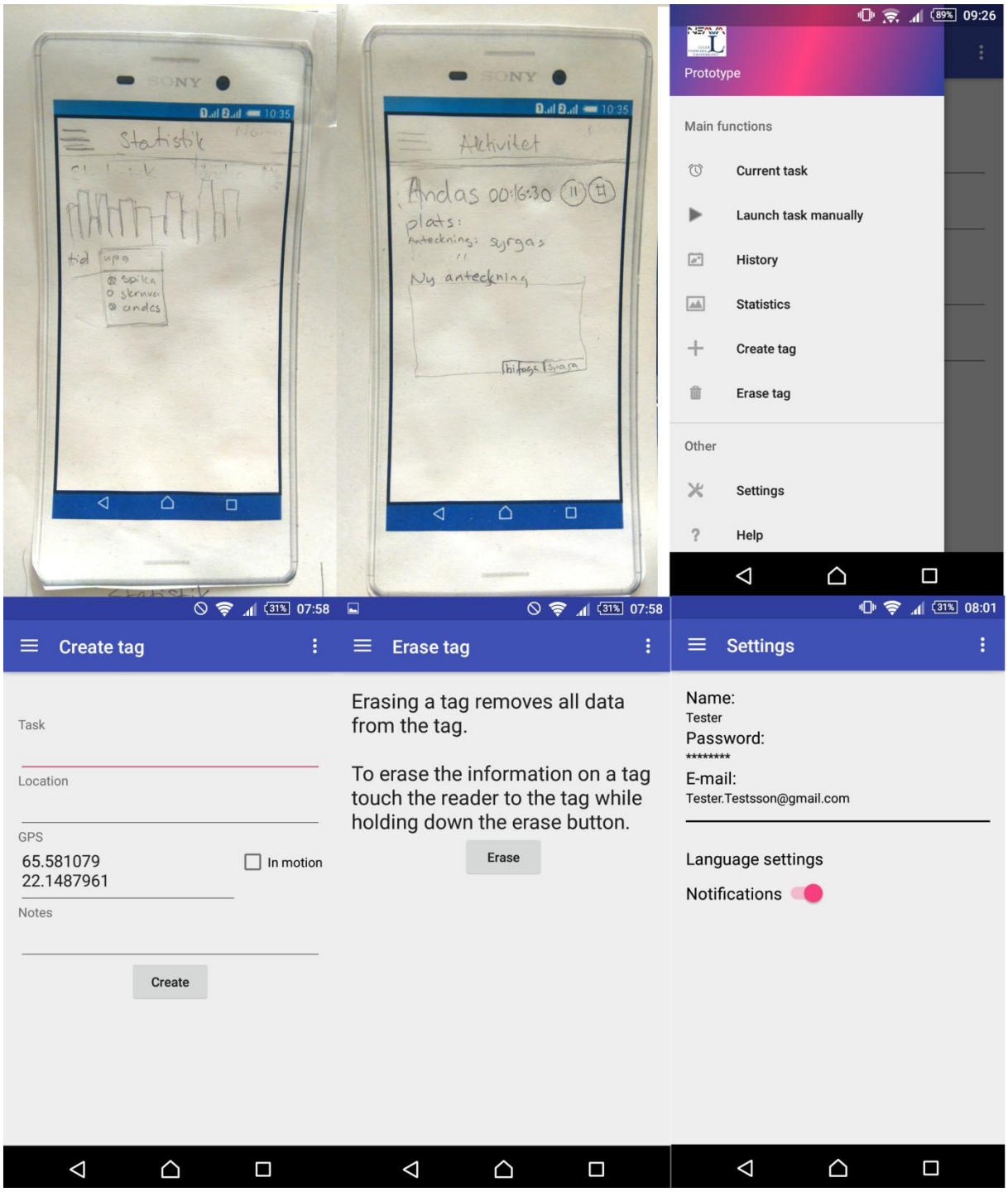
7. Would you consider using a product based on the concept that this prototype tries to demonstrate?

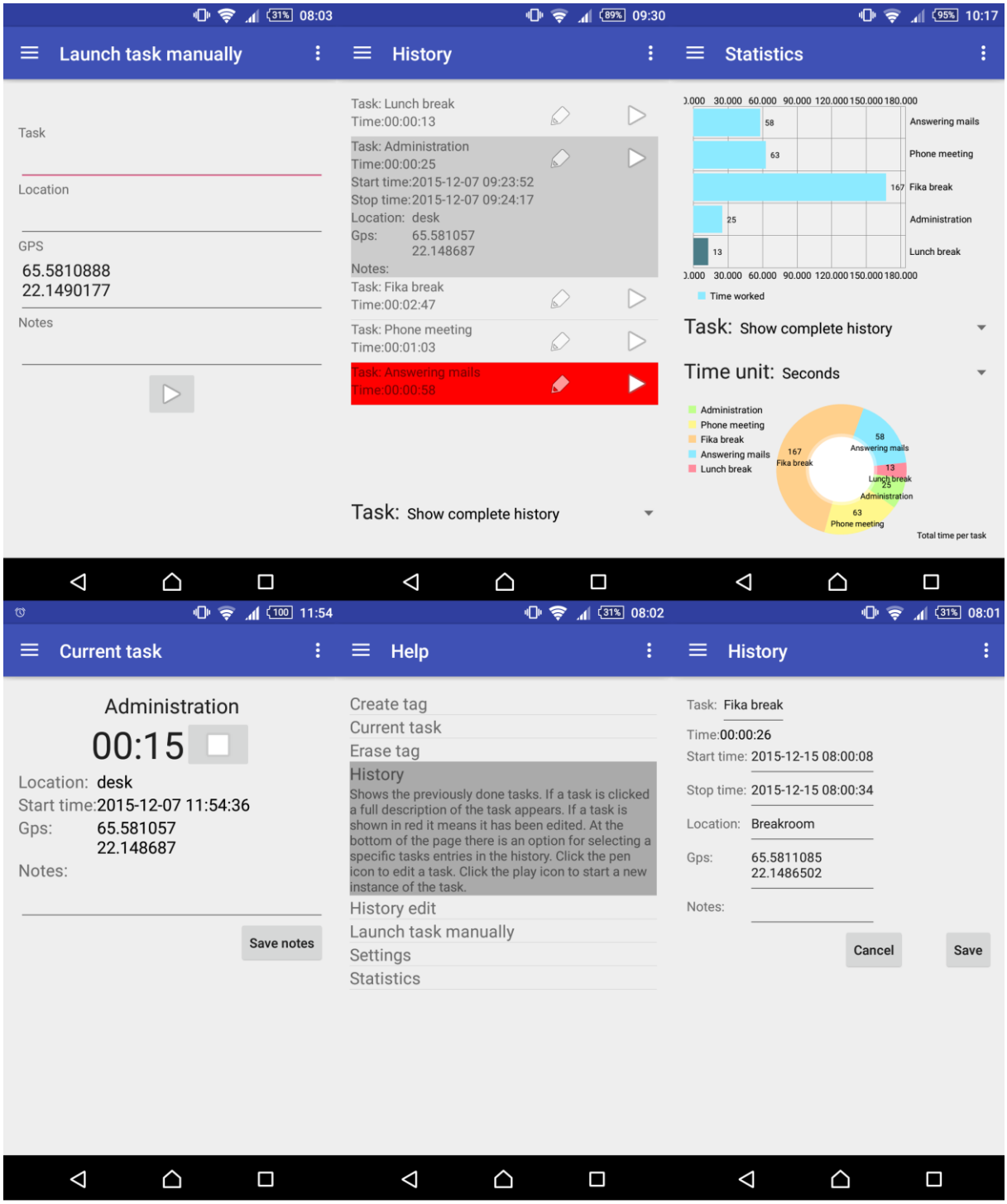
8. In retrospect what do you think about using pen and paper to create a prototype? Did it feel like you had all the freedom you necessary to design the prototype the way you wished with these tools?

9. Additional comments:

15 Appendix C – Paper prototype and prototype application




Statistik
Aktivitet
Andas 00:16:30
plats:
Anteckning: syrgas
Ny anteckning
Prototype
Main functions
Current task
Launch task manually
History
Statistics
Create tag
Erase tag
Other
Settings
Help
Create tag
Task
Location
GPS
65.581079
22.1487961
In motion
Notes
Create
Erase tag
Erasing a tag removes all data from the tag.
To erase the information on a tag touch the reader to the tag while holding down the erase button.
Erase
Settings
Name:
Tester
Password:
****
E-mail:
Tester.Testsson@gmail.com
Language settings
Notifications


08:03
Launch task manually
Task
Location
GPS
65.5810888
22.1490177
Notes
09:30
History
Task: Lunch break
Time:00:00:13
Task: Administration
Time:00:00:25
Start time:2015-12-07 09:23:52
Stop time:2015-12-07 09:24:17
Location: desk
Gps: 65.581057
22.148687
Notes:
Task: Fika break
Time:00:02:47
Task: Phone meeting
Time:00:01:03
Task: Answering mails
Time:00:00:58
Task: Show complete history
10:17
Statistics
Answering mails
Phone meeting
Fika break
Administration
Lunch break
Time worked
Task: Show complete history
Time unit: Seconds
Total time per task
11:54
Current task
Administration
00:15
Location: desk
Start time:2015-12-07 11:54:36
Gps: 65.581057
22.148687
Notes:
Save notes
08:02
Help
Create tag
Current task
Erase tag
History
Shows the previously done tasks. If a task is clicked a full description of the task appears. If a task is shown in red it means it has been edited. At the bottom of the page there is an option for selecting a specific tasks entries in the history. Click the pen icon to edit a task. Click the play icon to start a new instance of the task.
History edit
Launch task manually
Settings
Statistics
08:01
History
Task: Fika break
Time:00:00:26
Start time: 2015-12-15 08:00:08
Stop time: 2015-12-15 08:00:34
Location: Breakroom
Gps: 65.5811085
22.1486502
Notes:
Cancel
Save