Beaconlogin - an Efficient Way to Register Presence on Construction Sites

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Abstract

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As of January the first, 2016, all companies working in the Swedish construction industry must follow a new law. The law makes it mandatory for anyone carrying out construction activities to have electronic staff registers on their sites. Failing to present a correct registration of all personnel present at the construction site will result in a fine ranging from 15,000 SEK to 25,000 SEK. Our solution for a simple way of registration builds on Bluetooth technology combined with a smartphone application. Together with Bluetooth devices the registration can be done automatically which eliminates the need for construction workers to actively search for the e-staff register.
Sammanfattning

Den första januari 2016 infördes en ny lag för företag inom den Svenska byggarbetsbranchen som gör det obligatoriskt för alla som utför byggverksamhet att ha elektroniska personalliggare på sina byggarbetsplatser. Om man inte kan visa upp en korrekt närvaroregistrering av den personal som befinner sig på byggarbetsplatsen riskerar man som företag böter på mellan 15 000 SEK till 25 000 SEK. Vår lösning för att sköta närvaroregistrering bygger på bluetoothenheter i kombination med en mobilapplikation. Med hjälp av bluetoothenheter kan registreringen ske automatiskt vilket tar bort behovet för arbetare att aktivt själva behöva sköta sin registrering.
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1 Introduction

Almost all technical systems have one common denominator which will, eventually, make them fail. The human factor. By reducing the risk of human caused errors in technical systems we are able to potentially save time and money for companies.

Employers within the construction industry are required by law to register the presence of all personnel on their construction sites. This is done on electronic ledgers to reduce the unreported employment and promote fair competition in the construction sector. It is common praxis by The Swedish tax Agency to make unannounced visits to construction sites and demand extracts from the ledger. If the employer fails to provide a full extract from the ledger they could be penalized with a fine ranging from 15,000 SEK to 25,000 SEK. It is therefore of utmost importance that the employees remember to register their arrival and departure from the site.

Our solution to the problem is to minimize the risk of employees forgetting to register their presence by automating the registration process. This was done by developing an application that, together with Bluetooth technology, handles the registration. The functionality of the application is dependent on Bluetooth beacons strategically placed on a construction site to create an area where automatic registration is possible.

2 Background

As of January the first, 2016, there exists a new law for companies working in the Swedish construction industry to follow [Ska17b]. Every person working on a construction site needs to register at arrival and when leaving. The purpose of the registration is to prevent unreported employment and promote a healthier competition in the industry.

The law requires that every construction site is provided with an electronic ledger. The ledger contains the time of arrival and leaving of each individual at the site. The law does not require a specific type of ledger as long as it fulfills its purpose. As a result, the market of ledgers consists of different solutions on how to accomplish this. There exists key cards and applications for smartphones that can be used but yet has no automatic solution been created.

By using multiple beacons with Bluetooth technology together with our mobile application, employees are being able to automatically register their presence when they enter the worksite, as well as register when they leave.
2 Background

2.1 Beacons

A beacon is a Bluetooth device that continuously broadcasts radio signals which other devices can pick up and process [Kon18]. The signal contains metadata such as a unique ID. This ID is primarily used to identify a beacon. By using an online platform, one can configure the beacon and later, by knowing the ID number, a connection can be established. For instance, when a device equipped with a Bluetooth antenna is in range of a beacon it is able to detect it, identify it by its ID and then use whatever telemetry available from the beacon.

The beacon uses Bluetooth, which is a wireless protocol to transmit data between devices within a relatively short range of distance [Nie16]. The technology has been used since the beginning of 2000 but is now with the phenomenon “Internet of Things” being used more than ever. Internet of Things is an umbrella term for the network of embedded computer systems [Say17] which allows them to connect and exchange data. Around 90% of all mobile phones are equipped with the technology of Bluetooth making beacons compatible with devices most people use on a daily basis all around the world [Nie16].

The Bluetooth hardware used during this project are “Estimote Bluetooth location beacons” [Est18] (see Figure 1). The hardware provides supplementary telemetry such as: Temperature, ambient light, motion, pressure and magnetism [Est18]. Estimote is a company located in both the United States and Europe and has been working with sensor networks and low-power software since 2012.

The backside of the beacons is covered with an adhesive which makes placing them anywhere simple. How many and how they are to be placed depends a lot on the use of them. They must for example cover a very specific area on a construction site so that the personnel will not accidentally check out while still be well within the parameters of the site.

Figure 1 Estimote Bluetooth beacons [Tho13]
2.2 Stakeholder

The third party stakeholder for this project is a company called Sisyfos Digital. Sisyfos is a privately owned corporate group that owns, invests and develops businesses within real estate development, building technology, app development, education, events and communications.

Sisyfos Digital is currently using Bluetooth beacon technology in some of their real estates for various applications. Since Sisyfos is engaged in both construction/building technology as well as app development they have an interest for the application we are developing in more than one area. For instance, it is an application for them to continue developing, as well as an application that can solve a problem with electronic registration at construction sites.

2.3 ID06 cards

ID06 is an identification system and was first launched in 2006 by the Swedish Construction Federation. It was created to encourage fair competition within the construction industry as well as a safer working environment. The system is used to allow easy and efficient identification of the personnel currently on the construction site and link them to an employer [ID018]. There are 70,000 companies currently using the technology.

The ID06 system is based on the following three principles:

- The company using the service must, in real time, meet all the statutory agreements within the construction industry
- Personnel using the ID06 must have one, and only one, confirmed identity
- The relationship between the employer and employee must be ensured within the ID06 system

The traditional, physical, cards are based on NFC (Near-Field Communication) [NFC10] technology which is a radio standard for contactless transmission of small data volumes over small distances. This standard is being replaced with a mobile phone version which incorporates an application. However, this application relies on a manual registration by the user.
2.4 The Swedish Tax Agency

The Swedish Tax Agency, called “Skatteverket” in Sweden, is a state administrative authority in Sweden for matters within the tax administrations entire area. Their main tasks are to collect taxes and manage the public records [Ska17a]. They have constructed different regulations to make sure that the country sustains a well-functioning society and counteract crimes.

As mentioned earlier, a new law concerning companies within the construction industry was passed in the beginning of 2016. According to the law, every construction site need to be equipped with an electronic personnel ledger. The Swedish Tax Agency can visit unannounced and if they do, the construction site must be able to provide the presence registration of all personnel at site. There is no need for the system managing the registration to be certified as long as it meets the requirements written in Skatteförfarande- deförordningen (2011:1261) chapter 9, section 5 [Fin11] and The Tax Agency’s Regulations SKVFS 2015:6 [Ska15].

3 Purpose, Aims, and Motivation

When working on a construction site one is required to register when arriving and leaving the area. Today this is done at most sites by swiping an ID06-card [1Of17] at a card reader. This requires the workers to get to where the card reader is placed and also remember to do so. After the shift is over the workers are also obliged to sign out which, likewise for when signing in, is something the workers need to remember to do. According to our stakeholders, Sisyfos, it is not uncommon for personnel to be registered at multiple construction sites around the country because they forgot to sign out. The main purpose of this project is to facilitate this process for the construction workers.

The main objective of the project is to provide a way to effortlessly register when construction workers arrive and leave a construction site. By streamlining the registration process the personnel can focus more on the tasks at hand. This is achieved by using a combination of Bluetooth beacons and an application which is available on the user’s smartphone.
The Swedish Tax Agency can do unannounced workplace visits to check that all workers on site are registered. An incorrect registration results in a fine for the company. It is therefore important that all workers register their presence. The available tools for registrations today have flaws where for example using ID06-cards (see Section 2.3) personnel can forget to check in or out. There also exist applications for smartphones where workers can register their presence but here as well as with the card the possibility of forgetting is still a risk.

3.1 Delimitations

There are some delimitations during this project due to time and factors that we cannot influence. In this section we will go through what they are and why they are delimitations for this project.

3.1.1 The Connection with Bluetooth

Since beacons are Bluetooth devices they require that the receiving device has its Bluetooth enabled to be able to make a connection. Due to this, the users mobile phone needs to have Bluetooth enabled for the application to work properly. The user can on the other hand manually check in via a button in the application, making the application workable even with Bluetooth disabled, but in that case the application cannot pass as automatic.

3.1.2 The New Law of Personal Information - GDPR

“General Data Protection Regulation” [GDP16] is a new law which will be implemented the 25th of May 2018 in all members of the European Union. This law aims to give citizens control over their personal information. GDPR will replace the 1995 regulation “Data Protective Directive” [EU:16].

The main difference between GDPR and the Data Protective Directive will be the fines that can be assigned to the companies that fail to abide the regulators standards. These fines can range from 10 to 20 million SEK, which is comparable to the fines a company can get if they were to break the Swedish labour laws.
3.1.3 Operating System

We have chosen to only optimize the application for usage on devices running newer versions of iOS (version 9.3.5 and newer). This choice was made because of the time constraint of the project. Another reason was that there are a lot more factors to consider when optimizing for Android since there exists so many different devices. The devices can have different features to consider such as screen size, outdated hardware, different ROMs depending on manufacturer and service provider etc. Whereas for iOS you only have to consider a few different devices that all run the same OS since there is not a lot of differences when comparing the last few versions of iOS. At least no differences that would interfere with what we are trying to do with our application.

4 Related Work

To our knowledge there currently does not exist any similar solution for this problem. On the other hand, there do exist other applications that can be used as personnel ledger and other applications that uses beacons as complements.

4.1 Other Solutions to Personnel Ledgers

There exist plenty of mobile applications on the market that construction sites can use as a personnel ledger. Some examples are applications like “Nuba” [Nub18] or “Personalliggaren” [Per18]. They are all implemented quite similar, where the employee is registered to a specific work site and can then register their presence by manually pressing a check in button within the application. The difference between the already existing ones and the one that is being implemented during this project is the manual versus automation aspect, where ours helps negate the risk of forgetting to check in.

Another solution is that employees at work sites register their presence by using RFID cards (specifically called ID06-cards) (see section 2.3) which is a personal card requiring the employee to physically touch some kind of station with their card at the work site. Some companies are using both solutions to be able to register employees that do not own a smartphone while still offering the convenience of using a mobile application for those who owns a smartphone.
4.2 Beacons Together with Mobile Applications

The use of beacons on mobile application has been done before. There are many examples that can be mentioned. There is for instance an application designed for a museum in New York called The Guggenheim Museum to give the visitor a better experience [Gug17]. They have placed beacons in the museum making it possible to track where in the building a visitor is located. Based on that information content of the nearest artwork is pushed to the application.

Bluetooth beacons are also currently widely used in the marketing sector [Urb18]. Beacons can for example be placed within a store or similar where it sends out signals. If a person nearby has an application that recognize the beacon’s signal, a promotion, discount or information about products can be seen through the application. Marketing like this is called location-based marketing.

5 Method

We have used multiple methods to structure and solve problems during the project. The plan was to first get a basic application to work where one can manually register. From there, further development towards complete automation for registering the presence was done.

5.1 React Native - The Programming Language for the Application

React Native is a JavaScript library for building user interfaces for mobile devices which runs iOS or Android. The main point with React Native is to build applications that are scalable, simple to develop and fast when being used. A notable feature of React Native is that one writes the components in JSX which is an addition to the JavaScript language. JSX is a special syntax which makes it easier to read and write the code and is within computer science called “syntactic sugar”. In this case JSX is syntactic sugar for the “react.createElement()” function. The “react.createElement()” function is what creates your elements in the background. It works by running a background process which translates the JavaScript code to native elements directly on the device it is running on, hence it is only dependent on the native SDKs (Software Development Kit). React Native was created by Jordan Walke who also created React, it was released in 2015. We chose React Native as the programming language for this project for three main
reasons:

- The development process is fast and efficient; one can get something functional in the application quickly compared to writing in a native programming language such as Swift or Java. We also had most experience writing code in JavaScript, so it was fast to learn the syntax for React Native.

- The ability to reuse components. With the ability to reuse components one has written on their own or open source components written by someone else one can easily implement functions that might have taken a long time to write from scratch by oneself. It is also possible to modify the components for one’s own needs which is really useful.

- The cross-platform ability it provides. Although we are limiting this project for iOS use we still want the ability to easily optimize the application for Android usage in future works as well. This is something that is easy with React Native compared to other mobile programming languages where one has to rewrite the code entirely.

5.2 Using Firebase as a Database Service

We use Firebase [Goo18] as our development platform. The Firebase platform handles the authentication, database and remote storage aspect of our application. It provides an API (Application Programming Interface) for managing and creating new users and for handling the database which is a noSQL [Mon18] database. Firebase is provided and maintained by Google.

We chose to use Firebase because of its simplicity and availability. It has great guides for implementing all of its functions into your application and also a great API reference. For usage in small scales it is free but can without any problem scale up in case more capacity is needed. Also because of our time constraint we did not want to write the entire backend by ourselves.

5.3 Protocol

We use iBeacon [App14] which is a Bluetooth protocol developed by Apple used by devices compatible with the protocol to communicate with smartphones and other devices using Bluetooth. The protocol is a 1-way transmission so all the logic for what
an application should do when detecting an iBeacon device has to be fully integrated within the application.

The underlying technology used by devices running the iBeacon protocol is Bluetooth Low Energy (BLE). BLE was designed to use considerably less power compared to the classic Bluetooth protocol while still providing a similar communication range.

The iBeacon protocol works by assigning each beacon three values, a UUID (Universally Unique Identifier), Major and Minor value. The standard usage for the three values is to assign all beacons within an area the same UUID value, for example, all beacons within a construction site. The major value is used for distinguishing a group of beacons, for example, all beacons located in a certain area. The minor value is used for distinguishing individual beacons within a group. All three values can be set to whatever value the user wants as long as it follows the standard [App14]. The UUID value contains 32 hexadecimal digits which are split into 5 groups separated by hyphens. The major and minor values are unsigned integer values ranging from 0 to 65535.

In order for an application to detect a nearby iBeacon device it needs to have the UUID assigned to that device. For security reasons it is not possible to scan and see all nearby beacon devices, hence to detect and get data from an iBeacon device you have to scan for a specific UUID.

6 System Structure

The application consists of three main components: the beacons, the application and a backend (see Figure 2). The application runs on a mobile device and handles the communication with the Bluetooth beacons and backend. The two main things the backend handles are the authentication of users and storing the database. The application communicates with the backend to authenticate users when signing in and to manipulate the database depending on actions taken within the application.
In order for the application to detect nearby beacons it has to poll for them. The application retrieves the UUID used by the beacons at all construction sites the user is registered to from the database. Once the UUIDs have been fetched the application scans to see if any matching UUID can be found within the phone’s Bluetooth range. If any match is found the application registers the user as present on the construction site. This polling action triggers on a set interval to see if any action has to be made depending on if a beacon is detected or not. The polling action happens even if the application is closed and the phone is locked to ensure that the user’s presence is registered accurately.

**Figure 2** Diagram of the system structure

7 Requirements and Evaluation Methods

Requirements for the application is for it to be reliable, to register an employee’s presence quickly upon arrival as well as not registering them as not present if the application does not sense nearby beacons for short amounts of time. This is implemented by sending out a push notification if the user’s device has not sensed a beacon within a time frame. The notification asks if the user is still present at the construction site. If the notification is not noticed by the user in a chosen amount of time the application will sign out the user from the construction site.

Another important requirement is to store the data we are handling in a secure manner since the data consist of social security numbers and personal information. We make sure to do this by using Firebase as our backend. Firebase servers are secured by state of the art technology and offers additional security options such as two factor authentication.
7 Requirements and Evaluation Methods

authentication which gives an extra layer of protection to the backend. The two factor authentication prevent breaches from human errors such as users having their password on a post-it or similar by using a two step verification.

Since the application’s main purpose is to make the registration of an employee’s presence as simple as possible it is important that it is user friendly. The design of the application should therefore be clean and simple without too many features that can distract from its main purpose. The user should be able to easily see their current status and manually check in or out.

Since we could not get access nor have the time to test the application at a real construction site we decided to test it within an apartment building. This scenario mimics some of the scenarios and conditions that might be present at a real construction site. Although there is obviously a massive difference between an apartment building and a construction site there is still a lot of factors that are the same, and some of them are harsher in an apartment building. For example, interference from WiFi and other similar signals are a lot more present which makes the test case harder than a real use scenario. A construction site is mainly empty while there is furnishing at the apartment building which also interferes with the signal [App17]. The four things to be tested are:

- How accurate and fast the application can register that the device running the application is present when recognizing a beacon at a construction site.
- How often the application fails to detect the beacons and does a faulty sign out.
- How accurate and fast the application is to register a correct sign out when leaving.
- Within what range the application works in correlation to where the beacon is placed.

With the main focus being on how often it for some reason does a faulty sign out since we do not want it to faulty sign out people, and try to understand why it happens if it does. When testing within what range from the beacon the application can still sense it, a basic understanding of how closely beacons have to be placed at a construction site for the application to work correctly is to be made. This however varies depending on the conditions present at different sites since they are not all identical. Our ambition is for the application to sense the arrival as well as departure within 5 minutes and to not do any faulty sign outs at all unless under very special and unpredictable cases. As for the range there is no real set goal, it is only as stated before to get an approximate measurement on how closely beacons have to be placed in order for the application to work correctly.
8 Database Structure and Usage

When designing the database, we had to consider a few things. First of all, the only information about a user that Firebase stores automatically is their email and the user’s unique ID which Firebase automatically generates. This information is however not stored in the database but within the user’s profile and is accessible through pre-existing API calls. Since we need to store more information such as ID06 number and social security number we had to store it in a database.

Firebase uses what is called a NoSQL database. A NoSQL, also called non-relational database, is a database that provides storage and retrieval of data with other methods than the traditional tabular relations which is used in SQL (relational databases). Unlike relational databases, NoSQL databases allow you to build a database without defining a schema first which is one of the main differences. This makes handling a NoSQL database much easier since you do not have to redefine a schema if requirements change or data needs to be updated.

NoSQL databases can be built and structured in different ways. In the case of Firebase, the database is structured as a JSON tree where all data is JSON objects. JSON is a lightweight data-interchange format that is easily read by humans while still being easy for computers to parse.

We decided to have a root branch in the database called “users” where all the users are stored as separate nodes, containing all the information provided by the user and data about the construction sites they are registered on (see Figure 3). Since a user is only supposed to be able to read and write information to their own node we set up rules so that in order to access a node the user ID you are signed in with has to match the nodes key which is named after the user ID. Hence, users are only able to access their own node. We also needed to store all the construction sites in some manner, so we created another root branch named “constructionsites” where all the construction sites are stored with their ID as the key (see Figure 4). Within each construction site branch there is two more branches called “logg” and “metadata”. The metadata branch contains as the name states, meta data about the construction site which is: which contractor that is responsible for the construction site, the organization number for the contractor and the UUID used by the beacons at the site. The other branch, logg, is where all of the activity logs for the construction site is stored. The logs are stored as a branch named after the date they were created; a new branch is created for every date there has been activity on the construction site. Within a date branch there is a node for every activity that has been registered, which is if an employee has arrived or left the construction site. The nodes are named as a number which increases by 1 for each activity registered. An activity node contains information about the employee that triggered the action and a
time stamp of when it happened.

**Figure 3** Example of database structure for a user

**Figure 4** Example of database structure for a construction site
9 The Application and how it will be Used

When starting the application for the first time the user is presented with the Sign In screen (see Figure 5). This gives the user two options: Enter an email and password to sign in with or register a new account by pressing the Sign Up button (see Figure 5). If the latter is chosen, the Sign Up screen is shown. On this screen the user can input all the required information to register a new account. If any information is invalid an error message is presented highlighting the faulty information.

Once signed in the Home screen is shown (see Figure 6). The Home screen contains a welcome message varying depending on the time of day as well as information about the user’s current active construction sites. From the Home screen there are two other screens to navigate to, the Sites and Settings screens. On the Sites screen (figure 7) all construction sites the user is registered on are shown. The construction sites are presented as their unique ID and the date the user last time was active on the site. The ability to manually register as present on a site is available from this screen by clicking on the check box to the right of a registered site. A green check box means that the user is currently checked in on that site. The user can register a new site by pressing the “Register New Site” button. If the site exists in the database it is added to the list of sites on the Sites screen, if not, an error message is presented. When a new site is registered the user can see information about the site and manually check in if needed. On the Settings screen a number of settings for the application is available and a button to sign out.

The structure of the application is divided into different stacks, in Figure 8 one can see a scheme of the structure. The “Authentication Stack” is handling the screens where identification of a user is needed while the “Application Stack” is handling the screens used when the user is logged in.
Figure 5 To the left: The first screen where you can choose to sign in or sign up. To the right: The screen where you can create a new account.
Figure 6 The Home screen, here logged in as "Max"
Figure 7 To the left: The Sites screen.  
To the right: The screen where a new site can be added
9 The Application and how it will be Used

Figure 8 Diagram of the application structure
10 Evaluation Results

In this section the results of the project are evaluated to see if they meet the requirements from Section 7 (Requirements and Evaluation Methods).

**How accurate and fast the application recognizes that it is present and registers it.**

When testing how fast it detects nearby beacons and successfully registers it to the database the result was within the set requirements. It registered the user’s presence within five minutes of entering the vicinity of a beacon. In rare cases it did not detect a beacon right away, however it did detect it during the next polling period. Since this only happened once out of the 40 times we tested it, we see it as an anomaly.

**How often it fails to detect the beacons and does a faulty sign out.** During our tests this never happened since the application is designed to not sign out a user immediately if it fails to detect a beacon. Instead, the application only triggers a sign out if no beacon is detected within several polling periods. The chance of it failing to detect a beacon that is within range several times is extremely minimal. Although it might be possible, it never happened in our tests.

**How accurate and swiftly it is to register a correct sign out when leaving.**

This was no problem at all for the application. It successfully registered a sign out from the first polling period where the application did not detect any beacons. The polling period is the same as the period for registering, which is under five minutes.

**Within what range the application works in correlation to where the beacon is placed.**

When measuring this we had no exact measurement for how far away we actually were so we had estimate it. Depending on what was between the device running the application and the beacon, we got a rough range of 70-120m. In the case of having a lot of apartments between the beacon and device the range was lower than just having a wall between. However, the range seems to be lower when a lot of Wi-Fi networks are around the area as well. We believe that this is because Bluetooth LE is on the same spectrum band as Wi-Fi.
11 Results and Discussion

Other similar systems currently available on the market lacks automatization that could make the registration process easier for the users. Our system focuses mainly on the automatization aspect to ensure a more user-friendly experience with a minimal learning curve. The remaining question that rises is to see if this approach actually is superior to already existing technology.

According to the results of our tests, it does seem to help. The outcome of the project is a system that together with Bluetooth beacons automatically can register a person’s presence within a certain range. The tests show that the system registers the presence of a person who is in range of the beacon within 5 minutes. When the application no longer senses a beacon after several polling periods it registers the user as not present anymore.

When implementing the system in larger and more realistic scenarios there are a lot more factors to consider that might interfere with the process. With interference, we are referring to factors such as suboptimal beacon placements which can result in bad connectivity to the users smartphone, the number of beacons placed at the construction site must be enough to cover the whole construction area, how the construction site is built up as to not interfere with the Bluetooth signal, if it is multiple floors, if it is built up with thick concrete walls or similar materials that can block Bluetooth signals, is there large areas with no place to set up a beacon? These are things to consider that we could not account for in our tests since we did not have access to a real construction site. However, when testing the application while trying to simulate the scenarios above, we got acceptable results considering our evaluation goals and requirements. We did not have time to test the application at an actual construction site because of the time constraint of the project. There was not a lot of time to develop a minimal viable product and then test it for at least a week to get some statistics to look at. It is also hard to find an overseer at a construction site and get them to test the application and allow us to put up beacons all around the construction site. Hence we tested it in an apartment building while trying to simulate some scenarios such as checking how well the Bluetooth signals could pervade walls.

Even though the application together with the beacons work as planned there are some implementations that need to be implemented before the product can be used at a real construction site. One of the purposes of keeping a personnel ledger at construction sites is to be prepared to show the Swedish Tax Agency the presence of construction workers. We have yet not implemented a way through the application or an external web interface to easily get access of the information the Swedish Tax Agency is requiring. The information is still only accessible through the database due to lack of time. Hence,
13 Future Work

the application works and you can get access of the required information but there is yet no easy way of doing it. This is therefore some future work that needs to be implemented before the application could be launched as a replacement for other personnel ledgers on the market.

12 Conclusions

We have developed a smartphone application made for companies working in the construction industry to use as an electronic personnel ledger. By using the technology of Bluetooth beacons together with the application, the registration of a construction worker’s presence at work site can be done automatically, meaning the workers do not have to manually check in by pressing a personal card against a card reader or click on a button in the smartphone application. Our application senses when the worker is within a certain range of the beacons and automatically register his or her presence. The same goes for checking out. When the application no longer senses a beacon after several polling periods it checks out the worker.

The main purpose of the application is to reduce the risk of forgetting to register, be time efficient to use and let the workers focus on their job instead of the registration. The automation of registration takes care of this. Since the connection between application and beacon is through Bluetooth, the user has to have Bluetooth enabled on their device for the automation function of the application to work properly.

13 Future Work

Potential future development of the application would be to complement it with a web interface. The web interface would complement the application by giving contractors the ability to manage activity logs, to export XML files of activity logs [Ska18] as well as possibly showing some statistics about the log. The ability to add and manage construction sites is something that would suit a web interface better too.

The database structure is something else that might be changed. If used in a larger scale with multiple construction sites, contractors and over a longer timespan a more thorough structure might make it easier and better to use. Logs are supposed to be saved for at least two years after the current year is over. Finding and extracting the needed information for that would not be too hard to fix by re-organizing the database. Currently you can extract all the information but by re-organizing the database the process
To optimize the application for usage on Android devices is something for future development. According to IIS (The Internet Foundation In Sweden) 41 percent of Sweden’s population uses an iOS device and 37 percent uses an Android device [The16]. To neglect potentially 37 percent of employees is something you want to avoid. In the applications current state not a lot of things would need to be changed for it to work with Android as well. The navigation between screens within the application and the ability to retrieve information from beacons are the two main things that differ between the two operating systems and such would have to be programmed separately for Android.

As mentioned in Section 3.1.2 the need to take GDPR into consideration is something that has to be done. However, this is something we have chosen to exclude and not take into consideration. Since the system is not complete enough to be used in real scenarios we chose to put this as future work for the application. We believe that in order to fully take GDPR into consideration the system needs to be complete. Since the database structure will most likely change, the extraction of information is to be altered as well. Also to fully understand the full extent of this new law a lot of research would have to be done. This is not our area of expertise and should be done by someone with experience within the field of law or similar.

References


