SMART PARKS

Digital Tools to Collect and Share Information Related to Parks

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ABSTRACT

The thesis approaches a problem to bring technology into public parks in a way that visitors can interact with each other. The HAMK Built Environment Landscape department attempts to reach exactly this kind of solution with their project Smart Parks.

Starting by describing two modern and well-known technologies today the thesis gives examples on how they can be implemented and a solution can be formed regarding the current technical knowledge. QR codes, GPS and a self-developed application from HAMK disclose different tools to approach the problem.

The main aim of the thesis is to evince a platform that visitors of public spaces can use technology in the nature and share thoughts and experiences through it.

The thesis answers research questions related to the topic and attempts to give information such as different technologies with their benefits or a solution for a platform to Smart Parks. Furthermore, it compares those developments and lists advantages and disadvantages of them. For a final step, the thesis describes an existing tool and tries to improve it for an all-in-one solution for Smart Parks.

Keywords Smart Parks, QR Code, GPS, DigiTrail

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1 INTRODUCTION

Due to the constant increase of Information Technology, companies try to find new opportunities in different areas. The HAMK Department Built Environment Landscape is also looking for a new idea. They want to bring in modern technology, especially in nature and public parks. The goal is to encourage visitors to interact with others and make the park more alive. The department has started a project to develop a product out of this idea. This project is still in its infancy. That's why this thesis is intended as a template and first approach for a ready-made solution. The HAMK Department Built Environment Landscape will use this thesis to gather information, gain knowledge and thus create a first version of a Smart Park.

The goal of this thesis is to gain knowledge about current technologies that may be useful for the project. In this thesis they are examined and compared. Also, research of an already existing application is taken. Finally, a first attempt to create a solution is given.

To address these issues to a large extent, the following research questions are set up which will be discussed and analysed in this thesis:

- Which technologies could be used for the solution?
- What is needed for the collecting and sharing part?
- How can DigiTrail be extended that the requirements can be reached?

The thesis is aimed at the department for HAMK University of applied sciences. Furthermore, readers who are interested in new technologies and solutions to bring Information Technology into public parks or just want to find out about latest technologies in this area could find some benefit out of this thesis.

2 INITIAL SITUATION

Modern technology is everywhere and accompanies the lives of human beings. It is constantly evolving and expanding to a point where it represents such an important role for many individuals. Televisions, personal computers and smartphones for example take essential parts in our lives in order that people cannot live without these kinds of technologies anymore. Not only the invention of the computer was an important step for the world but the idea of the Internet. People can communicate with each other, even if the life thousands of miles away in another country. (Ismail, 2017)

As well as for individuals, companies benefit strongly from modern technologies. If it is for communication with customers or other companies, especially manufacturer or suppliers, improve processes or extinguish errors, technology will have a solution. But maybe the most important part is that modern inventions have increased the productivity of almost every industry in the world. (Ismail, 2017)

Technology is expanding rapidly all over the world in the last years. It is an excuse that people struggle with keeping up with certain technologies that are getting discovered because of the amount and its speed. It is al-most impossible to know every invention. The expanse rate is to quick. (Lamey, 2018)

Even though modern technology appears in an enormous large segment of our world, there are still certain areas where it can be implemented. In a big city for example technology is used everywhere. But how does it inter-act with the nature for example?

2.1 Smart Parks

Due to the modernization, more and more technologies are developed and implemented everywhere. The Smart Parks project expands the standard of public parks by allowing visitors to communicate with each other in a specific way and participate in improvements. The goal is that visitors can share their own experiences and thus strengthen socialization. In addition, this idea contributes to sustainable development of the parks. (HAMK, 2018)

2.2 Solution

The solution is a platform and must be seen from two different views. First, users are able to read neutral stories about a park or a station in it, which represents a statue or a monument in a park. Such content can also contain pictures or video messages. Additionally, park visitors can share their own experiences, upload photos and videos or write stories. External systems serve as a support for uploading images. This material can be viewed and read by other users. Furthermore, visitors can comment on uploaded files from other users or report offensive material in order to remove it.

On the other side is the management of the system. These people provide and maintain the platform and are admins with special rights to it. They write basic stories to each park and each station in an environment for public visitors. Moreover, they provide connections to external software for the uploading part of pictures and videos. The platform also needs a database to properly link shared material of users to the right place. All that is stored server, which the management is responsible for as well. But the main goal of the management is to improve public parks. The possibility to track shared information is the most important feature of this view of the platform. To be able to read and extract information out of every station, for example by analysing the number of visitors in each park or station is essential to get improvements to a park.

The management will adapt public places according to the visitor's voice. If any messages are pending when a statue is being rebuilt or maintained, the management may also send alerts or even warnings to visitors, such as recent announcements about new statues or, for example, a new route in the park. It is also possible to start surveys on parks or stations where visitors can participate in order to improve them. And finally, it needs the function to remove reported material of the user.

2.3 **Possibilities**

In order to present a solution to the problem, the possibilities must first be considered. The idea of a Smart Park is to include technology in the park. For this concept to work by sharing and retrieving stories, images and video files, some form of ICT needs to be integrated. One possibility would be to place a computer next to statues and monuments in public parks, which makes all this possible. However, special hardware for such purposes can become expensive very quickly and they also need to be serviced regularly. In addition, there is a risk of vandalism or damage that may be caused by the environment or animals. The solution should therefore consider a method that hardware is not provided by the management, but by the users themselves.

A device that has become prevalent over the last few decades and is suitable for a hardware solution is the mobile phone of the visitor. According to eMarketer, in 2015, 57.3% of the world's population had a mobile phone. Today, this number reached up to 61.1% and is expected to increase up to 62.6% in 2020. The exact figures from 2015 to 2020 are explained again in Figure 1. (eMarketer 2016)

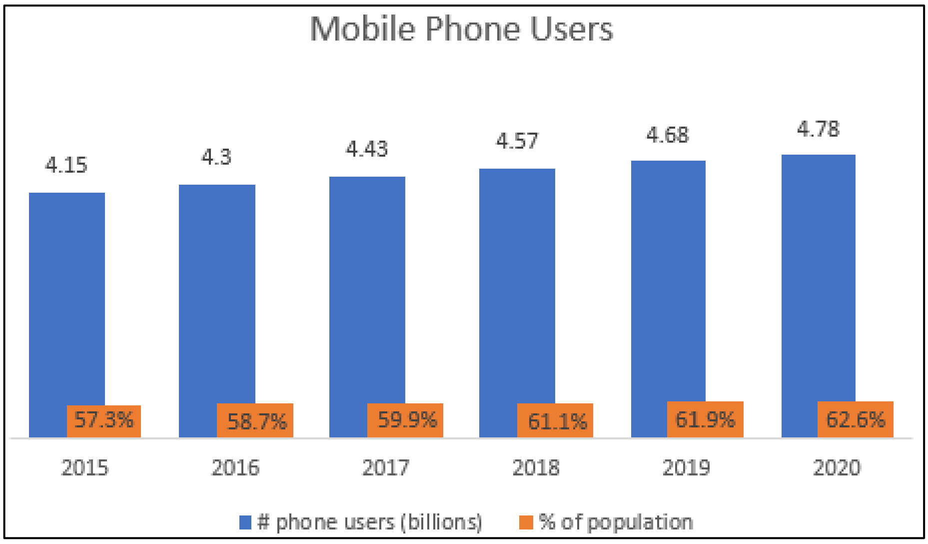

Figure 1 – Mobile Phone Users (eMarketer, 2018)

What needs to be said about the graph is that the numbers are heavily dependent on regions. For example, North America has the highest rate in this of mobile phone users with 78.7% in 2016. Europe is also well above average. The project Smart Parks has its origins in Finland and the percentages there are significantly higher. By 2018, there are about 4.6 million mobile phones out of a population of 5.5 million, which represents a rate of 83.6%. (eMarketer, 2016) (Statistia, 2018)

3 QUICK RESPONSE

QR is the shortcut for quick response. The technology was developed in 1994 in Japan. It is similar to a normal barcode found on every item in a supermarket. However, the QR code is two dimensional, which means that it can be read from any direction. In addition, a QR code may contain more than 230 times more data than a conventional bar code. Thus, text, images, email addresses, websites or even entire business cards can be retrieved by scanning this code. These square all-rounders became very famous in Japan before being used all over the world. Their versatility makes them ideal for advertising or promotion of products, brands or services. But they are as well a big part in the manufacturer business. (WhatisaQRCode, 2018)

3.1 Features

For a solution of Smart Parks, these little symbols serve the purpose and are much more advanced than original barcodes. There are a bunch of different features and benefits of QR codes which give reasons to put them into a public park for visitors.

3.1.1 High Capacity

QR Code can decrypt up to 7.089 digits in one symbol. This data is approximately the size of 3 kilobytes. In addition, the data may appear in many different forms of data, such as numbers, letters, kanji, kana, hiragana symbols, binary or control codes. The number of characters that can be stored in one symbol relies heavily on the format. For example, the maximum amount of characters for only alphanumerical data is reduced to 4.296. If special characters are used, the amount decreases further. (Meeteed, 2018) (QRCode, 2018a)

3.1.2 Printout Size

The fact that the QR code stores information horizontally and vertically makes it much more compact than an original barcode. The symbols can be printed up to 10 times smaller compared to their predecessor. For even smaller sizes, Micro QR Codes can also be used witch although have a much smaller data store capability of only 35 numerals. (QRCode, 2018a) (QRCode, 2018e)

3.1.3 Kanji & Kana

The fact that the QR code was developed in Japan, it can also decode Chinese Kanji or Japanese Kana letters. Although the code can't decode every single letter in those languages. Because the Japanese or Chinese language have much more characters than for example the English alphabet, it is not possible to integrate all letters from Kanji and Kana. (QRCode, 2018a) (Gautam, 2015)

3.1.4 Resilient

QR code has a troubleshooting capability. The information stored by a code can be recovered even if up to 30% of a codeword has been contaminated or destroyed. The codeword is that unit, which represents the structure of the data. For the QR code, a codeword is 8 bits. However, if more of the codeword is unreadable, the data may not be fully recovered. In total, four levels of troubleshooting are possible. Each of them is stronger than its predecessor, but they also need a larger QR code. Recovery possibilities range from 7% of the weakest level up to 30% of the best. The strongest is most often used in sensitive areas such as outdoor places with high damage potential to the code. (QRCode, 2018a) (QRCode, 2018b)

The ability to recover the data requires at least twice the codewords of the QR code for debugging than for the data. Which means that two-thirds of the icon is responsible for troubleshooting. In the case of a larger message behind the QR code, it is usually not possible to fully recover the data because the amount of data requires much more space of the symbol and there is no room for the backup data. (QRCode, 2018a) (QRCode, 2018b)

3.1.5 All round Readable

The codes can be read from 360 degrees at high speed. This is ensured by three position detectors at the corners of the symbol. These patterns also help to avoid negative background effects. This feature makes it extremely comfortable for users of the QR codes. It is a big improvement to the barcode, which must be scanned with the laser exactly through the code to get access to the information behind it. (QRCode, 2018a)

3.1.6 Dividing Structure

Finally, a QR code can be converted into smaller QR codes containing only parts of the original symbol. Thus, data can be stored with up to 16 different symbols. Each converted symbol gets additional information about the original code such as a position value and a total number of symbols from 1-16 and a parity. This information connects all the small symbols. (QRCode, 2018a) (Morovia, 2017)

3.2 Versions

QR Code has different versions which range from version 1 to version 40. The differences in the versions relate to the size of the symbol and therefore to the amount of data that a QR code can store and encode. Starting with version 1, which has 21 modules. A module refers to the black or white dots in the symbol which means the smallest symbol can be 21 dots by 21 dots. For each higher version the QR code increases by four modules. The largest version 40 can store most of the data. This has a total of 177 modules. Each QR code has a maximum amount of storage space, data types or debug levels. Thus, if one of these points is exceeded, a higher version is needed. (QRCode, 2018c)

3.3 Standardisation

As well as many Information Technology tools and processes, the QR code is standardized. Since the development, the symbol was recognized by various companies. In 1997 it was accepted as AIM International (Automatic Identification Manufacturers International) standard. In 1998 and 1999, Japan standardized the QR code twice until it was finally recognized as an ISO standard in 2000. This June 2000 acceptance was the breakthrough for the QR code. From that point on, it was officially and internationally recognized. Since then, he has been used more and more often all over the world.

Four different categories about the QR code were standardized. First, the symbol size. 21 x 21 to 177 x 177 modules have been implemented to this day. Furthermore, the types and the number of data are specified. From the smallest QR symbol, which can store up to 1'817 letters up to version 40, which can play up to 7'089 letters. Third, troubleshooting with the four levels becomes standard. And finally, structured dependency has been standardized, which can split the symbol into up to 16 smaller QR codes to represent parts of the original symbol. Every symbol follows the same rules in those four areas. (QR Code, 2018d)

3.4 Type of Usage

QR Codes find many uses in everyday life. From simple printed matter such as flyers or business cards for personal use up to complicated payment systems. The symbols can be used in many ways. And since standardization, they are spreading faster and faster. With high functionality and simple design, there are no limits to the possibilities. Basically, an added value is expected for the use of QR codes. In most cases this consists in the increasing efficiency in the use of the symbols. It often happens that the error rate of employees is significantly increased. Thus, they can also serve as a solution for the Smart Parks.

3.4.1 Traceability

Raw material is sent to the customer in large quantities for further processing. With a QR code, the contents of the large boxes are recorded on the packaging. Once in the factory, the producer can sort the raw materials simply and easily with the help of a QR code scan. After the final product arrives in the department store, the raw materials of the finished product can be traced. (DensoWave, 2018)

3.4.2 Picking

The QR code scanner is programmed so that specific products can be sorted out. The warehouse employee, for example, then scans all the articles and receives a message every time a product is found that they are looking for. Since searching for products is often a tedious process, the QR code provides a quick solution. The amounts of errors made by the employee is also reduced compared to a solution where every product must be spotted by hand. (DensoWave, 2018)

3.4.3 Inventory Management

If a customer in a goods shop asks for the availability of a product, the employee often must check by himself whether the product is still available on the shelf. With a QR code, every item is registered with such a symbol and the employee can simply scan the QR code from a list of products to retrieve its status. It can be seen directly, how many pieces are still available or when the next delivery comes. A very efficient and fast solution which makes it more comfortable for both customer and employee. (DensoWave, 2018)

3.4.4 Inspection

When a large delivery arrives in a department store, it is troublesome for the recipient to examine it, since there are often similar products that are virtually indistinguishable just from the eye. This process therefore can quickly take a long time. In addition, errors can easily occur. Using the QR code, employees can scan the icons on the freight list and compare them with the QR codes for each item. A missing product or one that is delivered wrong can be spotted in a short period of time. (DensoWave, 2018)

3.4.5 Production Management

Another use of QR codes is the management of a production. From the management of raw materials and the selection of individual materials to the production of products that no longer exist, to the shipment of the finished goods, the QR Code offers support. Another example is a fully automatic sorting system. Through channels above the production, the produced goods can be sorted directly in a storage hall. Each product is packed in crates with QR code. With automatic scanners the package flows directly to the right place on the shelf. (DensoWave, 2018)

3.4.6 Data Entry

Especially in hospitals, it is very tedious to fill out medical forms. With QR code, such a test can be sent by e-mail to a patient. He can access the form using a QR code scan and fill it out directly. The results can be viewed directly by the hospital. This method is defining a solution similar to the project Smart Parks. People use QR codes to get certain information and share information related to this exact form. (DensoWave, 2018)

3.4.7 Dispensing

Prescriptions from doctors are usually very hard to read when hand-written. Thus, in pharmacies can quickly pass mistakes and the wrong drug is issued. By a QR code, which equips the doctor with the required information, the pharma assistant can scan it and conveniently receives the required recipe. Thus, mistakes can be avoided and this solution saves a lot of time due to the fact that employees in pharmacies don’t need to decipher unreadable recipes from doctors. (DensoWave, 2018)

3.4.8 Admission Control

For tickets, the QR codes also provide help. When assigning a ticket, the QR codes are awarded. Examples are train tickets, flight tickets or event tickets. When booking online, a customer receives the entry card directly with a QR code equipped. This ticket can be shown comfortably to the doorman when entering and he sees directly, if the code is correct and valid. The visitor can be admitted in an instant of the QR code scan. A further step for this solution could be that a scanner at the entrance, which will automatically open the door if the code is correct. (DensoWave, 2018)

3.5 QR Code Generation

The process of creating a QR code seems very simple at first glance. Although, care must be taken to ensure the appropriate use of the symbols on different points. Otherwise, the incorrect generation and use of the QR codes can have a bad image on the visitors. One consequence of this would be that less visitors use this function and the project Smart Parks leads to failure. However, with a few simple steps, the use of QR code can greatly support the project and provide a solution.

3.5.1 Generator

The first step is to create the QR code symbol itself. There are countless providers who provide the creation of a QR code for free. Some examples are Kaywa, GOQR.me, Visualead or QR Stuff. When creating the symbol, the management has to ensure that the codes can be read by as many QR code scanners as possible. This leads to more activity for the spots in a park. However, since this is the case with the largest providers, this point is almost exclusively given. Other functions that the codes should include by the providers are the tracking and analysis of the called QR codes. This feature is also suitable for Smart Parks. (Wainwright, 2015)

3.5.2 Design & Link

Another part is the design of what the QR code should look like. In addition to the normal black-and-white symbol, the supplier Visualead offers thousands of variants of a QR code design. Thus, the QR code may even contain a certain logo and still work flawlessly. A well designed QR code can very fast attract more people in a park and lead to more traffic to the spots. (Wainwright, 2015)

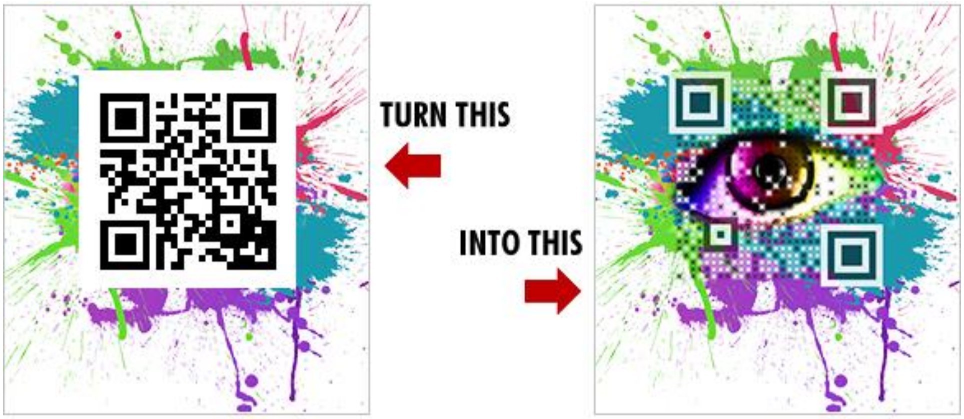

Figure 2 – QR Code Design (QRStuff, 2013)

The content behind the QR code is also in this step. What should be hidden behind the QR code? On the pages listed above, the format can also be selected from many different such as email, contact or a website. For the Smart Parks solution, a linked website would be useful where users can share and view content. With one click in the QR code scanner, all stories can be directly viewed and commented by other visitors. (Wainwright, 2015)

3.5.3 Testing

Although the QR code was generated by an external program, it is always a good idea to test it before it is used and circulated. There is nothing more annoying than a product which has been marketed that contains errors and the customer experiences this first. Therefore, the QR code must always be checked for correctness before it is placed in a park. One option would be a simple QR code scanner, which is available for free for each smartphone. In addition, the symbol should be checked by several different scanners so that more visitors can use this code and participate in the Smart Park project. Google Goggles could be a help to test the QR code. The free tool checks images, or in this case a QR code, and checks which link is hidden behind it. Testing multiple ways is always an advantage, because the chance of error detection constantly increases with each additional test. (Wainwright, 2015)

3.5.4 Track & Analyse

In order to be useful in the finished product, QR codes should be able to get tracked and analysed. Just as in a marketing campaign, all sorts of tests should be performed to improve the product's performance. Thus, the number of visitors should be determined. This can mean, for example, that a QR code that generates very little activity has to be checked. There could be an error in the symbol, a badly chosen place in the park, or it could mean a broken or dirty code. In addition, the management can also check how many visitors scan and comment on the code or upload a file. Thus, each station is constantly improved and can be entertained at the same time, if something is wrong. (Wainwright, 2015)

4 GLOBAL POSITIONING SYSTEM

GPS was developed in the USA in 1973 and is used for positioning, navigation and timing (PNT). It is based on at least 24 satellites, which make the system active around the clock, regardless of any weather conditions and without installation or subscription costs. The whole thing was developed by the US air force, which simultaneously maintains and operates the system. Originally, the satellites were sent into orbit by the department of defence for military purposes. However, these have been accessible to civilization since the 1980s. (Garmin, 2018) (GPS, 2018a)

Twice a day, the satellites circulate in a highly accurate orbit. Each of these then sends individual signals of a predetermined position, which helps GPS devices to encode and calculate the exact position of the satellite. These devices, in turn, can use this information to determine the exact location of the user. Specifically, GPS receivers measure the distance to each satellite in which the time to receive a signal is calculated. The more distances are measured by several satellites, the more accurately the position of the GPS device can be located. In this way, a running route, a map of a park or the way home later can be calculated. (Furuno, 2018) (Garmin, 2018)

4.1 Segments

The whole system of GPS is divided into three major segments. The space segment, the control segment and the user segment. All of those take a special part in the system. The US air force maintains and operates the first two segments. For the user segment, the public can constantly build devices that receive the signals of the satellites. (GPS, 2018a)

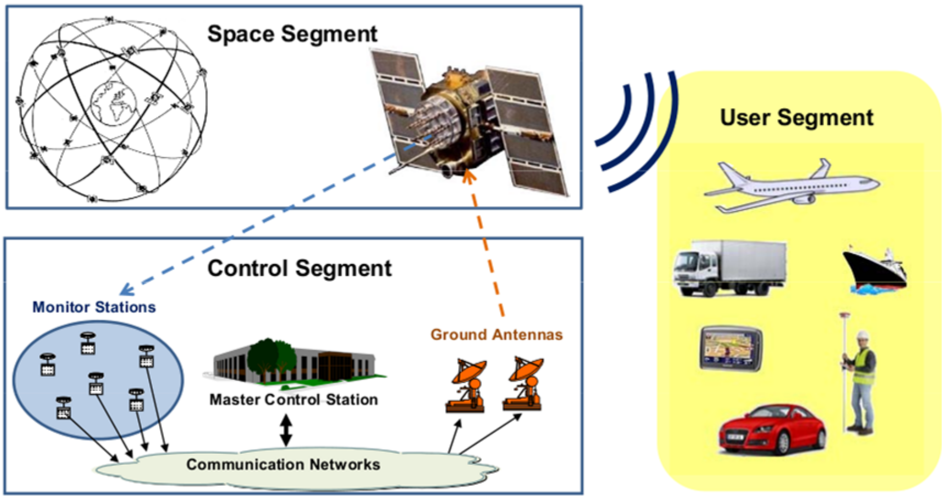

Figure 3 – 3 Segments of GPS (Navipedia, 2014)

4.1.1 Space Segment

The space segment defines the constellation of satellites that sends the signals to the user. The goal of this concept is to have at least 24 active satellites around the clock on 95% of the time. To ensure this, the US air force has been operating a total of 31 active satellites in orbit for several years. These fly twice in the middle orbit at about 20.200 km altitude and the earth. They are traveling at a speed of 14.500 km/h. The satellites are constantly arranged so that at least four of those are accessible from any point on the earth at any time. Therefore, they fly in a perfectly coordinated distance to each other. The satellites are solar powered with extra batteries to overwhelm darkness. More than 24 satellites are not necessary required for the system to work. But even in case of maintaining the satellites, more of those can help. Thus, the system gets interrupted less. (FlightCrewGuide, 2018)

Although, theoretically all 31 active stations can be addressed, which in addition can lead to better and more accurate GPS performance, only the 24 perfectly matched locations are considered at the heart of the system. Since 2011, this 24-slot configuration is active. It was built the way that it can be extended in the future. (FlightCrewGuide, 2018)

Meanwhile, the GPS constellation uses a mix of old and newer satellites, gradually replacing old ones with new ones. Newer models have a life expectancy of up to eight years, with older people holding just half. (FlightCrewGuide, 2018)

4.1.2 Control Segment

GPS satellites are constantly monitored. Responsible for this is the control segment. Through five stations distributed around the world evaluations can be made to the satellites. Namely, these are in Hawaii, Colorado Springs, Ascension Island, Diego Garcia and Kwajalein. (FlightCrewGuide, 2018)

Figure 4 – Distribution of control stations (Haseeb, 2017)

These points have been selected that they are be evenly distributed throughout the globe. During the check of the satellites, special attention is paid to the transmission rate, internal clocks, status and orbit accuracy. The most important part of the control segment, however, is to preserve the correct time. A compiled clock from all monitoring stations and satellite frequencies provides the GPS time. This time is tuned by the master clock to the coordinated universal time (UTC) to the accuracy of one microsecond. As a result, the end user does not necessarily need an accurate clock because the correct time is accurately determined by the satellites and the current location. Twice a year, the built-in atomic clocks have to be maintained, which requires about 18 hours outage for the satellite. (FlightCrewGuide, 2018)

All collected data about the satellites is forwarded via a data link to the Master Control Station located in Colorado Springs. Also at this location, the orbital parameters of the satellites are calculated. Another important instrument for the control segment is error monitoring. The 31 satellites are constantly checked for errors. Despite continuous monitoring, errors can go undetected for up to two hours, which in worst case can only be resolved after 12 hours. However, the new satellites, which are gradually being put into orbit, are much more resistant and can communicate with each other with a cross talk link for a faster finding of errors. (FlightCrewGuide, 2018)

4.1.3 User Segment

The user segment includes all GPS users, or the GPS receiver. Whether in a car or airplane, on a ship or just on the phone, this segment covers everything. It focuses specifically on the time measurement between satellite and receiver to determine the exact location. Altitude, latitude and height measurements can be made to find the exact location on earth in 3 dimensions. (FlightCrewGuide, 2018)

For the receivers, a distinction is made between single, dual or multi-channel receiver. The single-channel receiver also differentiates between slow and fast frequencies. Slowly frequented receivers track satellites one by one and data is updated every 30 seconds. Fast receivers can do this up to 200 times faster. The dual channel is used exclusively for the collection of data from all satellites. Multi-channel receivers track 4 - 12 satellites simultaneously and the data is constantly updated. (FlightCrewGuide, 2018)

4.2 **Services**

The GPS satellites have a purpose for civilization and for the US military. The free service of the GPS should be permanently and globally guaranteed. The military service, however, is to be available only to the US army and allied military forces, as well as agents for the American government. The public service lets end devices discover access to their current location. This process is very fast and accurate. A common misconception for the concept is that the US air force and the US government are tracking all GPS devices and measuring their location. However, this is not correct for this public service. In fact, the satellites only emit the signals. It is technically not possible for them to track the devices on earth. The GPS operators do not know the current location of a single device or how many devices use the system. All mobile phones, navigation devices or other devices that use the GPS service locate themselves based on the signals received from the satellites. (SSD, 2015)

However, there are applications, for example on the smartphone, which forward the location or a route to someone else via the Internet while the application is running. Thus, it could be implemented in the solution for the project Smart Parks. An application on the mobile phone of the visitor sends the location to the management. When the location of a statue or monument is reached, the user receives a notification on his mobile phone. This will now link to a website where the visitor can share or view content. (SSD, 2015)

4.3 **Augmentations**

GPS augmentation are all systems that help GPS to improve accuracy, integrity or availability. Or in other words everything that contributes to the optimization of positioning, navigation or temporal coordination. These systems are widely used and produced or developed in private and public sectors. Borders do not stand in the way of these ideas. (GPS, 2018b)

Some examples for systems that got accepted for GPS augmentations would be Nationwide Differential GPS System (NDGPS). This system is designed to improve the accuracy and integrity of GPS information on American oceans or big lakes. It is operated by the American coast guard. This system was developed in 2016 and has been implemented in over 50 countries worldwide. (GPS, 2018b) Further, the Wide Area Augmentation System (WAAS) was developed specifically for US airspaces. It serves to support aircraft navigation in North America. (GPS, 2018b)

The Continuously Operating Reference Station (CORS) network, led by the national oceanic and atmospheric administration, has over 2,000 tracking stations. More than 200 private, public and academic organizations are involved in this project. These collect and distribute GPS data for precise positioning. These can be used to determine centimetre-accurate locations. (GPS, 2018b) Finally, the Global Differential GPS (GDGPS) was developed by NASA to determine very accurate, real-time positioning and determinations for NASA projects. (GPS, 2018b)

5 TOOLS

The next step is to get closer to a solution for the project Smart Parks. In order to achieve this, tools for the respective technologies are shown, which and how these can contribute to the solution. Two tools got selected for this thesis to get examined.

5.1 DigiTrail

This system was developed due to the fast-growing tourism. Visitors from all over the world want to discover Finland and its beautiful landscapes. This opens up new possibilities for local entrepreneurs to offer goods and services. The rural areas around Hämeenlinna serve perfectly as a starting point for inventions and developments in nature tourism. This area already has many squares without any traffic or clean parks, which can be used by companies to provide services.

The DigiTrail project was developed at the Finnish University of Applied Sciences HAMK. The aim of this project is to attract more visitors to parks and nature landscapes and to generally strengthen nature's approach. In addition, the project aims to increase the visibility of companies in these regions. The application is available for Android devices.

5.1.1 Application

The application focuses on guiding a user's route. This is done using the navigation of Android. DigiTrail does not use Google Maps, but the mapbox map. This includes more details when it comes to remote locations, such as a park or a natural landscape. In addition, it is easier to integrate into an application and can be customized, if necessary.

Another feature of DigiTrail is the location detection of the user. Points are marked on the map, which cause a flow of information upon entering. The application receives information from the database of the current position. The server sends a notification to the application and the user receives it on his screen. All these points are stored in a database on a server.

As an addition, the user can use the application in offline mode. The GPS works without the Internet, but the user must first download all content to their mobile phone to get notifications about certain areas.

5.1.2 Limitations & Solutions

Since the GPS does not provide meter-accurate information, the application has some limits. For example, placing a route in a building is nearly impossible. The system is sometimes too inaccurate and should be used for proper handling of points 20 to 50 meters apart. This range should be maintained for optimal GPS performance. In addition, it is difficult to distinguish floors, which are located in a building. Thus, if a marked place is in one room and there is a second one directly above, the application cannot distinguish it. An interior technology is available with so-called Bluetooth beacons, which is not discussed in this paper.

5.1.3 Popups

DigiTrail automatically locates users through the help of GPS. At the same time, the application starts the search for nearby markings. Once the user is within the range of the point, which can be of a different size, a pop-up will appear on the mobile phone with a title and a button. By clicking on the last one, the user is redirected to the website in the browser. This website is located in the database on the server.

5.2 **Solution QR Code**

This solution is described in a few steps. To integrate visitors using the QR code scanner for the Smart Parks project, the QR codes are placed. Plaques placed in the parks should be considered as QR code stations. In order to prepare the visitors for the scan of the symbol, additional short instructions are written on the plaques. For example, park visitors who want to participate in the project must install a QR code scanner on their smartphone. The second step is to scan the QR code on the sticker. Thus, they will be sent a link to their mobile phone and will be redirected to a website. On this they can now read stories, comment on or even upload stories, pictures or videos.

Figure 5 – Plaque with QR code (Law, 2013)

6 METHODOLOGY

The thesis consists of a theoretical and a practical part. That the customer can expand his idea with information from this thesis, the research questions have been set up for the project. The goal was that the customer could develop his first product out of his idea and thus move one step further with the Smart Parks project.

6.1 Theoretical Part

The first thing in the thesis was based on the initial situation. Through a conversation with the customer, the criteria for the thesis became understandable. Also, Smart Park was described using the customer's existing information and some criteria for a solution were listed. The thesis later examined various technologies that could be considered for this project. From the customer's conversation came an idea of a technology that was explored in the thesis to find out if it could be used.

In addition, an application has been discovered at the HAMK University of Applied Sciences, which is currently under development, but which could offer great potential for a Smart Park solution. This was also examined in the thesis and held the knowledge of the developers. In the theoretical part, the first research question has already been addressed and attempts to answer it.

6.2 Practical Part

For the second part, which consists of practical methods, the technologies are compared. This is elaborated by showing the advantages and disadvantages of the technologies. Furthermore, a solution for the second research question is shown. A web page is to be created so that the visitors of Smart Parks can get access to all the functions for interaction with others.

Finally, the thesis list functions for DigiTrail, which is the application developed in HAMK, to improve it. This step is done so that the application also counts to an All in One solution.

7 COMPARING TOOLS

Both technologies, QR code and DigiTrail which uses GPS offer a solution to the project Smart Parks. Although both fulfil the purpose when implementing into a public area, there are some differences in practical use. Companies tend to compare each product and solution they found anywhere before deciding to produce it. Therefore, this crucial step could be the factor between a successful project and a failure. To get the most information at one place, a comprehensive comparison with advantages and disadvantages of the tools is made.

7.1 QR Code

The solution with QR code convinces with a comfortable and easy handling. Attached to a plaque in a public park, it is quickly recognizable to visitors and easy to call up with a short guide. Another plus point for the square icon is that the user is not dependent on a specific application on the smartphone. He himself can decide which QR code scanner he wants to use. Be it through a referral from a friend or through a simple search in the Google Play store, he can download exactly the app, which he considers right, or which he wants to support. For management, the solution with a QR code is also advantageous in terms of traceability. Most QR code generators offer this function as soon as they are created. Finally, the stations with QR Code promote the project Smart Parks for visitors who have not heard of it yet. At each station is a little help how to get into the project and how to participate.

On the other hand, for some people, the stations could mean too much interference with nature. The park is defaced with the plaques. Another disadvantage of these plaques is the physical object. This can be destroyed or polluted at any time by natural damage, animals or dirt, which leads to errors on the QR Code and finally to an exit of the users to the website at this station. In addition, physical objects must be maintained at the location, which means additional work that does not necessarily want to be perceived by the management. The last point would be a required Internet connection at the station. The problem here is that trees often interfere with the Internet signal and thus prevent the use of the QR code.

7.2 DigiTrail

DigiTrail has the advantage with GPS that the technology is already built into the visitors' smartphones and has been used by most for other purposes. Thus, the function is largely known. People will generally get more involved in a product if they have already had experience with it or parts of the functions. Another point is the development and maintenance, which is operated by the US air force. GPS is constantly being developed and can keep up with the latest technologies, although the system was developed back in 1973. But probably the biggest plus for GPS is the strong localization performance. In all weather conditions, devices can receive satellite signals without an Internet connection and determine their exact location.

Negative to DigiTrail, for example, is the load capacity of the user's battery. The application must be constantly open for route guidance to work. This point leads directly to another. Users of DigiTrail must be constantly on the smartphone to participate in the project. The visitor cannot really focus on the nature and the wondrous sights in the park. Further, the accuracy of GPS is not given in some places. In squares with several statues or monuments, it is difficult to address each one, as the signal sometimes cannot exactly decide which attraction the visitor is located in. A solution to this would be, for example, a community space with several monuments or statues but with only one trigger for DigiTrail.

8 IMPLEMENTATION

In order to convert the two technologies into a ready-made solution, a lot has to be changed or added. A QR code for example can only contain information that can be retrieved with a scanner. Also, GPS alone does not bring a ready solution. The high-tech system from the US offers only the space and control segment. A solution for the user segment is withheld. Thus, what exactly do the two technologies need to be a ready-made solution for the project Smart Parks?

8.1 Website

Through a website that can be opened by DigiTrail or with a QR code, visitors should have the opportunity to explore stories written, uploaded pictures or videos. On this platform the user can also write own stories, upload files or comment already uploaded material. In addition, the website offers the possibility to report offensive material to the management. A logon feature is helpful because it helps monitor users better and gives management an overview. This also serves as a small protection against bots, which must first make an account to post something. Of course, this is only a very weak barrier, but a bit of effort can already be made to achieve a lot.

8.1.1 Structure

The structure of the website serves as a template for a possible solution. Table 1 includes a structure of the website, which makes it easy for the user to browse them and, if possible, find as much information as possible in a simple way. It should also be noted that the language, in this case English and Finnish, can be changed on every page and that the user can log in or register at any time. If the user is logged in, the user can also view his profile and make changes such as the personal password or email address.

Table 1 – Structure of Webpage

Name	Layer	Description
Homepage	1	Main page where users can find important information, possibly news. The current events in a park or existing errors are communicated.
Parks	1	This page lists all the parks that are on the Smart Parks project. Such parks that have withdrawn from the project are marked as archived or new parks, which will be part of the Smart Parks in the future, are also listed.
Profile	2	With a click on the park, the profile will appear first. This can be understood as a kind of general

		introduction to the park, so that the visitor can get a first impression.
Tracks	2	Also on level two below the parks are various routes to each of it. Logged in users can select them or view their already completed routes.
Stations	2	The last main point among the parks are the individual stations in a park. The user gets an overview of all existing stations in the park, where there are monuments or statues.
Stories	3	Below the individual stations, the visitor will find an already existing story for each statue, which consists of a few words and a picture. In addition, material from other visitors can be viewed and commented on. Offensive material can be reported directly to the management.
About	1	Another main page has information about the project Smart Parks. Here interested people about Smart Parks can find details about the project, how the idea came to life and more information about it.
Contact		On the contact page, an additional main page, can be communicated with the operators of the site. The contact details are provided for direct communication or a contact form can be filled in to tell them something. In the event of a consultation, the user can deposit his email address.

8.1.2 Requirements

For the website special objects are considered, which are defined as requirements for the website. The list of these objects is used to generate an overview of which elements the website is constructed from. From the two views, the management and the user, various requirements are listed. Table 2 shows this Lists these objects and describes them in detail.

Table 2 – Requirements of Webpage

Name	Description
User Profile	The user profile is essential for uploading files and commenting on other stories. Here, personal data such as first name, name and email address are stored. Also, a username and a personal password will be created, which only the user knows.
Park Profile	The park profile is created in advance by the management. It gives a general story about the park as well as a picture representing the park.
Station Profile	Similar to the park profile, a small story with a picture is created for each item in each park.

Login	The function to let a user log in to his profile is crucial. Without, he has limited possibilities on the website.
Writing Stories	A process for visitors to write a story and then upload it is needed.
Uploading Material	For registered users it is possible to upload own material to a station. Thus, these can later be reviewed by other users.
Editing Material	Furthermore, before publishing the material for other users, pictures and videos can be edited through an external webpage.
Comment Material	Additionally, there is the possibility to comment on other user stories or uploaded materials.
Report Material	There will be a feature that allows users to report offensive material from other users. Additionally, the management will be able to remove this material from the website. A warning is issued to this user.
Contact	The user has the possibility to contact the management of the web site. With a registration form this can be done simply by sending an email to the management with the request of the user.
Language	The language can be adjusted on the website at any time. With a click of the user, he can choose between Finnish and English and display the website in the desired language.

8.1.3 IT Components

The website requires four major components. First the website itself. It is built on the above requirements and is compatible with today's smartphones, so that as many users as possible can benefit from it. Furthermore, a database is used to allocate uploaded material to the individual stations. Later, this material can be made accessible to other users so they can view and comment on it. Third, the system needs a server. On it is not only the website with all subpages and parking profiles, which is provided by the management, but also all the uploaded material from visitors. In order to keep the website up and running, the selection of the server should be given special consideration.

As a last component, there is the connection to the external photo gallery. A free online editor offers the website Ribbet.com. Unfortunately, this version is still usable only for iPhone or iPods, but an Android version is provided soon. Ribbet Processing with Ribbet offers almost endless possibilities. The website also offers a service for the creation of photo collages. In the case of Smart Parks, however, only the photo processing will be discussed. Ribbet makes it easy to edit an uploaded photo. The picture will be forwarded to the web page of Ribbet with the following link.

https://www.ribbet.com/app/?_import=**IMPORT_URL**&_export=**EXPORT_URL**&_exclude=out,home,share&_export_title=**SAVE_BUTTON_TITLE**&_export_agent=browser&embed=true

Figure 6 – Edit Material Link (Ribbet, 2018)

The fat-marked parameters in Figure 6 will be replaced by decoded URLs. The import URL refers to the URL where the image has been saved so far. This will then be forwarded to the export URL. The save button title is a parameter for the picture address, which should be used when the save button on Ribbet.com is pressed. It is important to note in this process that the images are already stored on the own homepage before transferring. First, because the import URL is not created otherwise and second because edited images are lost when the process is aborted. (Ribbet, 2018)

8.1.4 Access Authorization

The access regulation for the website must be regulated exactly. For this to be done, several different legal groups are created. First, the group of management. They receive all rights to the website so that you can manage and maintain it. They also must be able to delete offensive material, block users or delete accounts. In addition, a group for developers will be created. Their job is just the compilation of the website. Rights over user account is not necessary for them. Finally, all users and visitors of parks are merged. They can read content on the page and share own material. However, nothing can be changed on the website or delete content from other users by this group. Accordingly, a request is forwarded to the management. The rights are embedded in the user account. Thus, for example, a member of the management only has to log in and gets the necessary rights.

8.2 **DigiTrail Extension**

DigiTrail is a good template for the Smart Parks project and already has several features for a possible solution. However, the application is not yet complete and therefore needs to be extended for use. Three possible implementations for a complete DigiTrail solution are presented here.

8.2.1 Constant GPS Signal

First, it should be said that the battery life significantly decreases with the device running and permanent location. With a feature that allows the visitor to locate the site without running application, that would be an option.

8.2.2 Sharing in Application

Meanwhile, a user can go through the stations on a route and see only a picture and a small text to the respective monuments or statues with a link to the website. The website with all functions could be built into the application. Thus, the user is not forwarded via the link in the Internet browser, but can directly look in the app to stories, upload material or comment on other pictures, videos or stories. This implementation will improve the application, and represent an all-in-one solution. The entire platform that the visitor has to deal with is now DigiTrail.

8.2.3 History for Tracks

Another feature that is not yet built into DigiTrail are entries which routes a visitor has already visited in which park. For a visitor it is interesting to try a new way to get to know new monuments or statues. At the same time, it's exciting to go through the same routes again to bring back memories for the last time. One possibility, which makes it easier for the user to record the previous routes, speaks for the application.

9 CONCLUSION

In this thesis, some technologies that could be used for Smart Parks were described. Although, there are many other possibilities and in the future, there will be even more. The problem here is that the world is evolving on a constant base and if the HAMK Build Environment Landscape department finally decide to take a certain technology to bring into public places, there will be soon a better solution. Nevertheless, the start is always the hardest part of a project where decisions must be made.

With the different technologies shown in the thesis, the customers need is fulfilled. He tries to get ideas about how the project Smart Parks can go on and what type of technologies there are developed at present time. Furthermore, the comparison and the implementation of the website give an answer to another research question. Finally, with the extension of DigiTrail, the last question is answered. The knowledge given in the thesis provides information to break through the first step towards a solution for Smart Parks.

Even though bringing Information Technology sound weird at this time, companies will develop new ways and solutions eventually. Therefore, it is more than reasonable trying to invent a product now. In the future, technology will be everywhere whether people like it or not.

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