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A GIS-based crowdsourcing iPhone Application to Report Necessities, Civic Issues, and Public Events

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Abstract

Civic issues in a society can be reported through a crowdsourcing web application. People can download the application on their smartphones and report the issues such as a pothole or broken streetlight. The report is submitted by taking a photo of the issue and additional information is entered. At first, the reports are submitted to a call center and after analyzing they will be transferred to organizations responsible for this type of events. In such a crowdsourcing project it is very vital to motivate people to participate in the project. The reports are supplied by users and without an acceptable number of users the application would be useless. In addition, having the exact location of a report is very helpful to facilitate the process of solving civic issues. Positioning with smartphones is not very accurate as they do not have strong and accurate GPSs. Therefore, there is a need to improve the accuracy of the positioning process and consequently accuracy of the spatial data. The aim of this thesis is to investigate how to employ GIS to help reporting civic issues and how to design an interesting client interface for such an application, in order to motivate user to download and use it. The goal is also to find out shortcomings and weaknesses of the positioning with smartphones and find a way to improve its accuracy.

Some of successful similar applications' structures and their interfaces were reviewed. In addition, a survey among existing users of crowdsourcing applications has been done in order to find out how to design the application to be interesting for users. Furthermore, some techniques and methods were chosen in order to improve the GPS accuracy especially in the places with a low GPS signal strength. These methods exploit WLAN and some of embedded features in a smartphone such as microphone, camera, accelerometer, gyroscope to improve the positioning accuracy. In the end, along reporting civic issues the user is able to report and get information about cheap and appropriate necessities and public events in different geographical areas through a map-based application. Furthermore, he or she is benefited by some location-based services such as online-food or taxi. The client application's interface was designed for iPhone.

This GIS-based mobile application would be an appropriate alternative for the old reporting methods like phone call or mail. Nevertheless, reporting civic issues itself, cannot be necessarily a strong motivation to attract the user to download and use the application. Therefore, desired feedbacks of the crowd need to be found out in order to encourage them to spend their time for the application. User needs to get motivated to use the application and considered additional parts can be very helpful to reach this aim.

Keywords: Civic issues, iPhone, Crowdsourcing, Mobile GIS, Smartphone, GPS, WLAN, Xcode 4, Interface Builder

Acknowledgements

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List of Acronyms

CS	Creative Suite
CSS	Cascading Style Sheets
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
GPS	Global Positioning System
GUI	Graphical User Interface
HAPEL	Hidden Access Point Estimation-based Localization
HTML	Hyper Text Markup Language
IDE	Integrated Development Environment
iOS	iPhone Operating System
OS	Operating System
PNG	Portable Network Graphics
RSS	Received Signal Strength
SDK	Software Development Kit
TDoA	Time Difference of Arrival
VGI	Volunteered Geographic Information
WCL	Weighted Centroid Localization
WLAN	Wireless Local Area Network
WSN	Wireless Sensor Network

1. Introduction

Citizens can report their civic issues through a GIS-based web application. The idea of designing a GIS mobile application with an appropriate user interface which motivates the citizens to download and use the application is continuously pursued. The goal is to find out the accurate positioning techniques with a smartphone. During the research, success factors of crowdsourcing and many successful similar applications were taken into account. In addition, a comprehensive survey between existing users of crowdsourcing was performed in order to find out the most appropriate feedbacks and user interests. Furthermore, some methods were presented to improve the localization accuracy.

1.1. Civic issues and crowdsourcing

In a society people are facing many different civic issues such as pothole, car accident, slippery road or walkway, broken streetlight, graffiti, traffic, trash, abandoned bike, gang activity, and so on. Sometimes, it is very vital to be able to handle some of civic issues and it requires having prior information about them in a database. For example it is easier to handle traffic or gang activities if we know where they usually occur in the city. Moreover, it costs a lot of money and time to collect the required information about the issues from all over the society especially in big cities. Therefore, crowdsourcing would be an appropriate solution to access a large amount of free data and fresh ideas (Spiegel 2011). In this way, citizens are helping the authorities and organizations to find out the civic issues in their society.

The term "crowdsourcing" was introduced by Jeff Howe in June 2006. It returns to the idea of outsourcing a job to a large group of people or community in order to take advantage of the public's talent (Howe 2006). Nowadays it has become very popular and many successful projects such as Wikipedia, Linux, Google, Yahoo! Answers, Amazon and YouTube have been done in this area (Doan et al. 2011). "Citysourced", "Crime Tips", and "Waze" are some examples of GIS-based crowdsourcing mobile applications which take advantage of geographical information provided by crowd. They are using mobile devices' GPS or broad band in order to collect this information (Heipke 2010). Citysourced and Crime Tips are employed respectively to report civic issues and crimes (Citysourced 2009) and Waze provides users traffic information (Waze 2006).

VGI (Volunteered Geographic Information) and PGIS (Participatory GIS) are other examples of crowdsourcing where "individuals voluntarily create, assemble, and disseminate geographic data" (Goodchild 2007; Brown and Kyttä 2014). But, crowdsourcing is also known through some other titles such as user-powered systems, user-generated content, collaborative systems, social network, collective intelligence, wikinomics, crowd wisdom, and mass collaboration (Doan et al. 2011). It provides a large amount of free data from public which could be very expensive to acquire for an authority or a company. It also allows experts to interact more with citizens and work based on their needs (Fienen and Lowry 2012).

The data coming from crowd need to be accurate otherwise it is going to mislead the project. Therefore, crowd must be managed and focused in order to reach a higher rate of accuracy. Generally, there are four main steps in a crowdsourcing project: 1) Build

and unify a crowd, 2) Give them a web platform, 3) Manage and market the crowd, and 4) Utilize the information (Blur 2011).

Sometimes it happens right in front of us, an accident, a fight, or we face something annoying like a dirty seat in a train station. Usually when you are furious about a civic issue you would like to complain about it to the responsible organization. Normally, you go to the municipality's website to report the issue and then you face lots of different options under the "contact us" tab. You may forget about your claim as it takes too much time to find the right option, or it can be confusing. So it leads to a decrease of the interaction between people and authorities and reporting the issues. Therefore, a faster and easier way is needed, and it can be done through a special web application. In this application users report civic issues simply by choosing a category for the issue, pointing its position on the map, and optionally write some details about the issue (Citysourced 2009).

1.2. Web GIS

Having such an application can facilitate the distribution of aid, in case if any natural disaster happens. People can report the damages and based on the registered reports in the database, priorities can be determined. Time is very vital in such a situation; therefore, georeferenced reports are worthwhile for authorities to accelerate the distribution of relief (Crooks and Wise 2013). Web GIS or web-based GIS is a content which is referring to taking advantage of GIS functionalities through the internet. Internet has the possibility to connect people from all around the world. And they can then share different types of information and data easily and quickly. Why should not GIS take advantage of this precious tool?

Web-based GIS is very popular as it can facilitate a lot in the GIS world. Spatial data and map services on the web can be accessed from anywhere and consequently GIS users can save a lot of time, energy, and money. In addition, the GIS developing process would be extremely facilitated as web-based GIS applications and data can be easily integrated with other systems. Finally, Web GIS provides the possibility for people that do not have any GIS knowledge to be more in touch with GIS. They would then be able to take advantage of GIS functionalities, sometimes without even knowing what GIS is. As a result, Web GIS tremendously helps to spread the GIS utilization throughout the world (Dangermond 2008).

GIS functions and tools can be represented to users through a web application. The usage of these kinds of applications is increasing rapidly regarding to the great advantages of GIS. Based on their needs, many organizations and companies hire developers in order to develop GIS-based web applications or they link to already existing applications in their websites. Developers may employ software like ArcGIS Server or programming languages such as Java, JavaScript, HTML and CSS in order to build up such an application. The applications are accessible by entering a link in a browser and users can interact with the interface which is usually composed of different views and actions.

1.3. Smartphones

Mobile phone technology is growing fast. The usage of smartphones is increasing due to their capabilities and you can use them as your pocket computer (Eagle 2009). With a

smartphone you can access the internet and its applications almost everywhere. Given the fact that we carry it all the time, it is a perfect tool to capture and report "unpredictable events" as well as civic issues (Fienen and Lowry 2012, Kanhere 2011). Different types of spatial and non-spatial data from different data sources can be loaded and represented in the application in a very convenient and seamless way. There is no need of installation and it is loaded very fast. Everything is placed on the server and users can save a lot of memory space in compare of desktop software.

Adding GPS to the mobile phones was a revolutionary approach which made them very powerful tools. In addition, possibility to take a photo is a great advantage as one image is worth a thousand words (Kanhere 2011). As soon as user takes a photo, his position may be recorded automatically through GPS. Pressing a few buttons, the civic issue will be reported with its photo, category, and detail (Citysourced 2009). The reports can then be sent to the responsible organizations in order to offer people better services in the society.

However, there is a need to improve the accuracy of the positioning with smartphones. A smartphone has three main global positioning systems namely Cell-ID, WLAN, and GPS where the GPS has the highest accuracy. GPS has the accuracy of 10 meters and the problem is that GPS does not perform well indoors or in the areas with low signal strength. Therefore, GPS shortcomings need to be covered somehow in order to solve this problem and improve the localization accuracy.

1.4. Aims and research questions

The capabilities of crowdsourcing, Web GIS, and Smartphones can be employed in order to handle the civic issues. A GIS-based crowdsourcing mobile application is a key to achieve the project's goals. Crowdsourcing provides the free data coming from crowd whereas Web GIS takes care of data management and mapping. Finally, Smartphones facilitate the process by their capabilities and being more accessible.

Crowdsourced data is provided by users and the number of users that actively report the issues is very crucial for the success of the project (Fang and Neufeld 2009; Ke and Zhang 2009). Therefore, the application would not be successful without an acceptable number of users. The number of members would be sufficient when the project has the potential to achieve its goals (Sharma 2010). It is very important to make a useful, interesting, and user-friendly application which motivates user to download and use it (Spiegel 2011). In addition, an accurate position of the reported object is necessary for providing services and further analysis. Therefore, the following research questions are put forward:

- Which benefits and feedbacks will users get by using the application?
- What else do users want to report to government, organizations, or other people?
- Which information would users like to receive by this system?
- How can it help them to have a better society and better life?
- How accurate is the spatial data represented through the application?
- Is there a way to improve the data accuracy?

The application should be free to download and it should be useful, interesting, easy to access, easy to use, reliable, user- friendly, and compatible with different types of devices and platforms in order to be successful (Sharma 2010). The goal is also to develop a conceptual design of such an application related to urban environment. A

comprehensive review on previous research and literature is needed to get an outline of crowdsourcing success factors and suitable GIS tools and functionalities. In addition, a vetting on some of successful similar applications helps to have some ideas to design a powerful, user-friendly, and attractive interface. Furthermore, a survey among existing users of crowdsourcing applications is necessary to find out how to design the application to be interesting for users.

The following design process is based on the literature review, people's desires, and the structure of successful similar applications. The project should be flexible based on users' needs and desires (Pratt 2012). It means users' interests will change the project and its goals (Sharma 2010). Although the client application is designed for iPhone, it can be developed for other devices and platforms later.

The capability of having a map is one of the most significant advantages that we have in this type of web applications. Indicating the position on the map is much easier and faster than email or telephone. For example, there is no need to spend much more time to explain and clarify the issue and its position for the authority. In addition, it would provide a useful database about the issues and their positions which enables authorities having an overview of civic issues in the city. Having prior information about an issue is so helpful to control or even prevent the issue.

As all the coming reports from people will be automatically categorized in different groups (Citysourced 2009), each report will be referred to the responsible organization to be considered. Such categorization will help to find a special issue in a vast database easily. Moreover, it would be a valuable and great resource for media. Based on crowdsourced reports people will be informed about the news and existing conditions in their city and they would be able to criticize it. Furthermore, similar reports at the same place and period of time can be grouped into one report with their distinctive frequency for further analysis and use (Citysourced 2009).

2. Literature review

A successful crowdsourcing that attracts people to participate is an essential key in the project. Therefore, crowdsourcing success factors need to be determined. Therefore, scientific papers, websites, and other literature were studied and some of the ideas and experiences were taken into account. All the considered ideas were selected based on their compatibility with the project's function, characteristics, and capabilities. It means the vetting should be based on the fact that this is a GIS-based mobile application which is supposed to deal with ordinary people in the society. In addition, there is a need to improve the accuracy of the positioning process in the project. Therefore, a literature review is done about smartphones' localization techniques and their accuracy. Three main global positioning systems in a smartphone namely Cell-ID, WLAN, and GPS were compared where the GPS has the highest accuracy. However, the problem is that GPS does not perform well indoors or in the areas with low signal strength. Therefore, some related scientific papers were reviewed in order to solve this problem and improve the localization accuracy.

2.1. Application idea

Based on the literature review six factors: idea, crowd's desires and needs, reliability, accessibility, interface, and feedbacks were considered as essential to make a successful crowdsourcing. In addition, some techniques were selected in order to improve the positioning accuracy which are presented in the section "Accurate localization". In a crowdsourcing project the main idea of the project and its goals determine the crowd's overview and perception of the project (Sharma 2010). A strong and useful idea is always acceptable to the people and they will support it. This happens because it helps people to solve some certain problems or somehow facilitates their lives (Gordon 2009).

When a citizen reports civic issues, he or she will be benefited by solving the issues and getting services from the authorities and it is a reason itself which motivates the user to use the application. In addition, contribution to make a better society is a good feeling which is a motivation factor itself (Heipke 2010). Basically, it should facilitate and accelerate solving civic issues with minimum effort.

Being compatible and usable for different cultures and societies is helpful to attract even more people to be involved in the project. Consequently, the project can be benefited by many worthwhile ideas from people with different ethnicities (Lohr 2009). These ideas can be employed in order to improve the project based on the crowd desires (Ebner et al. 2008; Leimeister et al. 2009). Therefore, having a flexible structure lets the project always being able to be improved by people and be updated based on their new requests. Furthermore, to be able to utilize the crowdsourced ideas an experienced team is necessary to execute them (Blur 2010).

2.2. Application qualities

Being reliable is one of the most important factors in a crowdsourcing project. People should trust the project and they should not face any unpleasant consequences by participating in the project. For example, if any rewards or feedbacks are promised in the project, they must be given to the user exactly as they are described otherwise it can

destroy the trust and consequently decrease or stop the participation (Sun et al. 2015). The privacy of the users should always be considered and the need of private information should be minimal in the project. However, if the project is dealing with users' private information, they should be well-protected, otherwise the project will meet a lower participation (Kanhere 2011).

The project would be more trustable among people if it is based on scientific grounds and is linked to universities or well-known and expert companies. Supporting the project by an experienced team in case of any problem or bug can help growing of the participation. In addition, the crowd participation would be even wider if the project is supported by government, corporations, or stakeholders (Sharma 2010). A crowdsourcing application should be easy and cheap to access. Nowadays we are facing a vast variety of computers and mobile phones. People with different tastes use different devices. Therefore, the application would be more widespread if it is accessible through different types of devices and operating systems (Sharma 2010).

The costs of accessibility to the application are very effective on the success of crowdsourcing as the lower costs guarantee the higher participation of the crowd. There are two main fees to access an application, hardware fee and software fee. The first one refers to the cost of computers and mobile phones and the application should have the capability of working with cheap devices. In addition, the application itself should be free or very cheap to download and use in order to attract people. Most of the prosperous crowdsourcing projects and applications such as Wikipedia are free and accessible without any restriction.

Sometimes different projects have the same idea, but they express it in different ways. Some small differences can separate a successful project from an unsuccessful one. For example, Facebook, Yahoo! 360°, or Orkut have had the same idea, but only Facebook is popular. This indicates that the application interface is one of the factors which has a very important role to attract users. A smart and meaningful design of the client interface for the project can attract more users and it leads to surpass the rivals. Moreover, a simple and user-friendly interface leads to a participation increase as users feel comfortable working with it (Sun et al. 2015). Basically, the application's interface should be customized to be usable by non-expert people (Pratt 2012).

User-friendly interfaces refer to concepts such as "human user friendly" or "computer friendly" (Rui 2004). In this study the first one will be discussed. A user-friendly interface is "easy to learn, to develop, and to maintain" (Rui 2004). This project is focused on making the interface friendly for user. It should be understandable with a little effort as the less complex the interface is the higher user's self-efficacy (confidence to deal with the interface) will be (Sun et al. 2015). To be able to make a user-friendly interface some factors such as being easy to navigate between the pages, having friendly search tools, appropriate and complementary colors, a consistent design and layout, an appropriate and easy to understand language need to be taken into account (Jordan 2003).

Offering people up to date and accurate data through the application is very important as it helps to earn their trust. Obviously, it spreads the usage of GIS data among people (Pratt 2012). The application should also be fast to load; normally an appropriate loading time is less than three seconds. Using offline maps which are locally stored on the phone is a very good idea in order to reach this aim (Pratt 2012). Furthermore, a shallow interface which does not have many subdivisions helps a user to reach his demanded information with the minimum number of clicks and scrolls.

2.3. Crowd's desires and rewards

A project would be supported by people even more if it fulfills more common desires between people (Chaordix 2009). For example, desires related to basic needs are common between all humans and people are dealing with them continuously. Maslow's hierarchy of needs clearly shows the most common needs between people. Physiological, Safety, Love/Belonging, Esteem, and Self-actualization needs are the five orders of the hierarchy. The hierarchy starts with the basic (physiological) needs such as food, sleep, and sex. The higher needs cannot be met unless the basic needs are satisfactorily fulfilled (Maslow 1943).

The general needs placed in the hierarchy, especially basic needs, are not exclusive and all the humans are motivated by them (Maslow 1943). Therefore, motivation of the crowd to participate in the project will get higher if the project is facilitating and helping people with these essential needs. As a matter of fact, wider participation in the project leads to increased numbers of download and usage of the application. Therefore, having users from all over the society is the key to increase reporting civic issues. Therefore, the application should be intended to attract as many people as possible in the society and not be limited to some special groups.

In a crowdsourcing project the reward that the user gets participating in the project determines his tendency to continue to use the application. He should feel that he benefits enough for the spending of his time and energy (Chaordix 2009). The reward can be either financial or nonfinancial (De Ridder 2010). The considered financial reward should be affordable for the project. However, low financial rewards can lower the participation rate (Sun et al. 2015). The valence of the reward has a linear relationship with the user engagement (Vroom 1964). Therefore, a higher value of the reward may increase the participation. However, it is certainly cheaper to use nonfinancial rewards such as a good reputation, having fun, getting information, or learning something.

It can be about people's passions in the community such as their favorite activities and events (Spiegel 2011). People can share information and be benefited by exchanging knowledge. In this case, people are more likely to participate when the information is "public good" rather than being in the interest of any specific organization or authority (Wasko and Faraj 2000). Sometimes using both financial and nonfinancial rewards together is more effective. However, the best is to find out the most appropriate reward for the crowd (Spiegel 2011). It could be different for different societies and cultures and it can be discovered through a survey. The rewards can be improved over the time and approach to the crowd's desires.

3. Methodology

This study involved a mixed method approach. In order to start the project, literature and materials related to the topic were studied. The result was a schema of crowdsourcing success factors and some methods to improve the accuracy of the localization with smartphones. To be able to design an interesting and user-friendly interface, the interfaces of some successful applications were reviewed. They were mostly chosen from the App Store. Finally, some existing users of crowdsourcing applications were interviewed in order to clarify the users' desires and ideas.

3.1. Interface design

This chapter describes different methods of designing mobile application interfaces especially GIS user interfaces. Some of the similar applications need to be reviewed in order to clarify the strength points and bugs. Every application has a GUI pattern design which connect the elements of the application and present it to the user. The idea is to compare relevant GUI patterns in order to build a collection which can be used to design the application interface. There are many useful experiences behind studying the applications interfaces which lead to improve the knowledge of developing the application user interface. Given the fact that the project is about a GIS-based mobile application the GIS aspects must be presented to the user properly and the GIS components should be well placed in the application interface.

3.1.1. Mobile application interface

In addition to the literature review some of the successful similar applications' interfaces and their key features and advantages were reviewed. A vetting on some of similar applications in iPhone App Store was performed as well. Different factors for similarity were taken into account. The proposed application has the characteristics of being crowdsourced, social, map-based, location-based, etc. And the vetting was mostly based on these characteristics and different appropriate interfaces. Therefore, the reviewed apps were similar to the project from different points of view.

All the apps in iPhone App Store are categorized into different categories such as Games, Entertainment, Social Networking, Utilities, etc. (Apple 2011). Given the fact that this is a social crowdsourcing project, similar apps are mostly placed in the "Social networking" category. Meanwhile, some of the other similar apps can be found in other categories like "Utilities". The most popular apps are easily accessible under the tabs "Top Free" and "Top Paid". Approximately over five hundred web applications were reviewed in order to get some ideas about the application's function and interface.

Screen size is a very important feature in a mobile device. Different mobile devices have different screen sizes and the application should be designed in a way that suites all the screens with different sizes. The whole screen should be used in a proper way where no space should be left useless. Utilizing the whole screen in a proper way helps user to have the possibility to access as many as tools and functions as possible at the same time. It means that user do not need to go back and forth between pages and does many click to find his desired information or access the desired data. It also helps to make the application simple. The more less click user need to do the less complicated application would be.

In the mobile devices the problem of having a small screen is very significant. This means that it is not a good idea to put a lot of elements at the same time to show to the user because it is very small for the eyes and working with the application user gets tired quickly as he needs to concentrate all the time to see the every small elements in the screen. For making it more easy for the user application can be designed in a way that just the important and necessary information and data is shown for the user and all the other content can be presented in a desktop client or a bigger screen. Another limitation in mobile devices is that there is not any mouse or other tools to deal with the interface. User is interacting with the interface directly with his fingers. Therefore, the icons and buttons should be big enough to cover the human fingertips. It could be a little bit bigger to make sure to cover the all fingertip sizes.

Presenting data and information in a small screen demands many challenges. There are some useful methods in order to display the information to the user. These methods could be customized based on the capabilities of different mobile devices as they have deferent screen sizes, operating systems, and hardware. One of the most demands in mobile GUIs is listing and grouping information and data in a simple and user-friendly way for the user. The listing process should be able to lead user to his desired information in an easy and quick way without any complications and ineffective clicks. This could be presented by horizontal frames that have the height bigger than a fingertip and the width equal to the width of the screen. The width can be dynamic and be customized both in portrait and landscape view to fill the screen.

A summary of the information behind the list can be presented as a title and subtitle on the frame and a picture related to the section could be very useful to give user an image of the information and data presented in the section. These frames can be repeated until they fulfill all the desired information which is supposed to be displayed in the page and a horizontal scrolling is necessary for the user to be able to go through all the frames. An arrow on every frame could be very helpful for the user to understand that this frame is referring to another page and is clickable and it is not just a frame to show some information. This method has been used in many applications throughout the world and is one of the most effective and user-friendly technique for categorizing data in mobile devices with small screen sizes.

Another challenge of small screens in mobile devices is horizontal scrolling. In a context the volume of information presented is always more horizontally because the words are coming after on another in a sentence whereas there is always space between one line and the next line. This causes missing more information when user is scrolling horizontally rather than scrolling vertically. Therefore, it is very important to scale the text or the lists in a way that fits the page width and at the same time is eye-friendly and easy to read. Double clicking on a context to fit the width of the context to the width of the page would be very useful in this case. It is a very easy way and the user can skip the pinching for zooming in and out all the time which can be very disturbing in a small screen.

The pictures and unified content can be scaled to fit and the context can be change based on the width. This means that the number of the words in a line can be decreased in order to fit the line to the extent of the screen. This approach could cause prolonging of the page vertically and the user would have to scroll more horizontally. However, as mentioned above the missing context would be much less compare to the horizontal scrolling and the space between the lines make the context more friendly to the eyes. Another solution is to switch between portrait and land scape view when needed. Even

though the height is less it present more context to the user just by switching to landscape (Figure 3.1). Because the horizontal context is always more than vertical context as the words are placed after one another despite the vertical context that is every line is separated by some space.
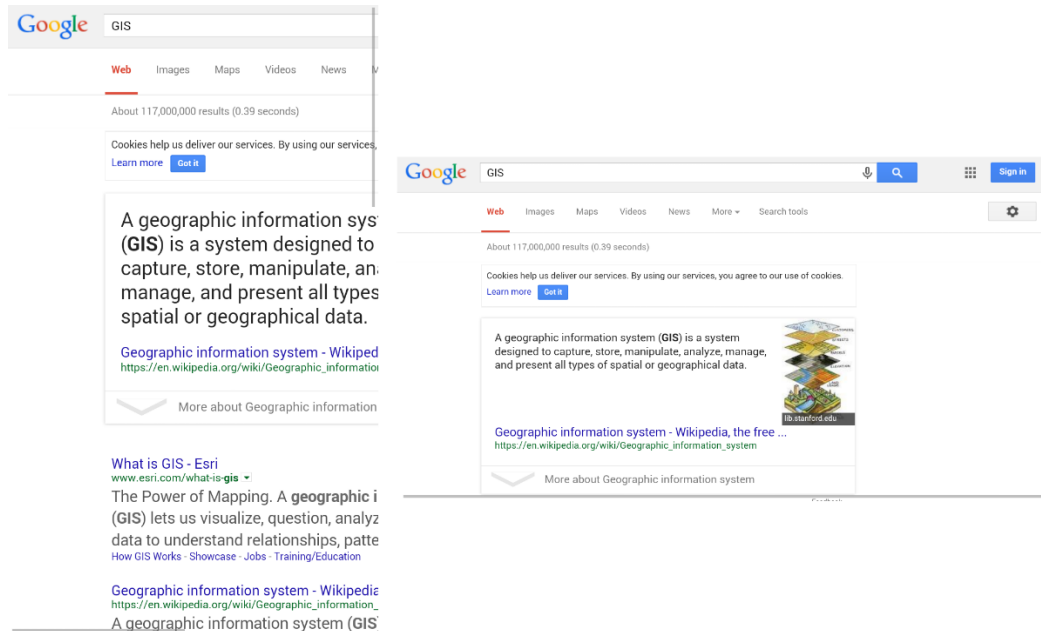
Figure 3.1. Switching from portrait to landscape

In mobile devices with touch screen a virtual keyboard usually in the bottom of the page is an alternative to a physical keyboard. This virtual keyboard is used by many different applications interfaces frequently. The disadvantage with this approach is that when the keyboard pops up from the bottom of the page it covers almost half of the content shown in the page (Figure 3.2).
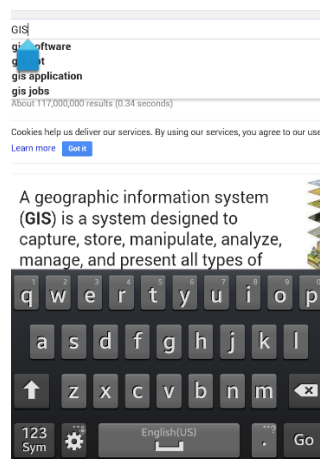
Figure 3.2. Keyboard covering the content

It could be very interfering especially when there is a drop down list in the content. It blocks the drop down and the user is not able to see the choices. It could be solved by shrinking the whole page and scale it to fit to the upper part of the screen where the keyboard does not block the content. Adding a vertical scrolling function to the content

the user would have the possibility to use keyboard and at the same time see the whole content in the page by scrolling (Figure 3.3).
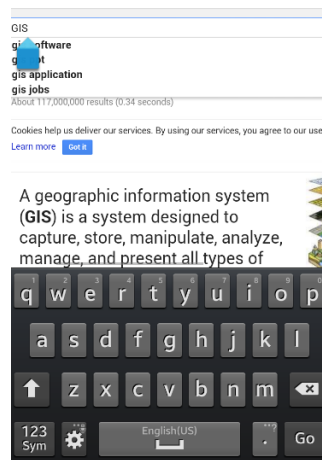
Figure 3.3. Possibility to scroll content above the keyboard

Using virtual keyboards in mobile devices is challenging as the keys are very small and the user is not able to use one or two fingers at the same time for typing. It makes it difficult and time consuming for a user to write text in a mobile devices compare to a desktop computer with a physical keyboard. Therefore, there is a need to simplify the texting process and replace it by some other methods. One approach is to memorize the user's frequent used text by mobile device and present it to the user while typing. It means an algorithm can be written to guess the next word that user is going to write in a sentence and display the word on the screen. In this way user have some alternative words to select every time he or she is typing. This alternatives can be shown in a toolbar on top of the keyboard and the user can choose between them by tapping on the desired word (Figure 3.4).
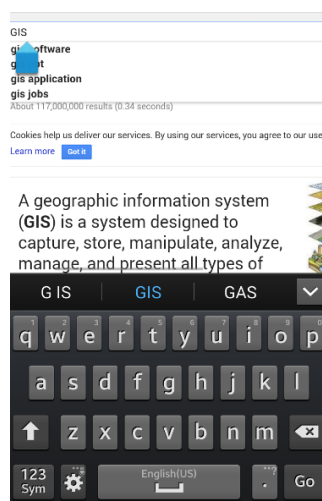
Figure 3.4. Suggested words on a toolbar above the keyboard

This leads to an easier and quicker texting which saves user a lot of time and energy. These autocomplete words can also be loaded from external databases for different languages. Hence the user has always an alternative to choose even he or she is just started to use the device. In addition, all these contexts coming from different users can

be connected and stored in a database in order to help other users. This is another aspect of crowdsourcing in designing the user interface of mobile applications.

Some of these techniques and modifications might seem small and basic. However, these changes have an important role to make the application friendly in the eyes of users. And as it mentioned before a user-friendly application is a key to attract users and spread the application usage. Everything in the application's structure must be meaningful and have a logic behind it and well-placed in the application to make a stable and easy to understand structure. In this way application can build a connection with the user and surpass its rivals which is very important in a competitive market nowadays. The idea of making the application friendly for non-expert users must be kept in mind always as most of the crowd are people that have no expertise in the field of GIS and have no idea about GIS functions and tools. In the end the application should be designed in a way that is compatible with different smartphones and computers and it should be free to download in order to spread it and increase the number of users.

In this chapter some techniques and methods were provided in order to boost the application's performance and make it easy for the user. These techniques facilitate to work with the applications and consequently help to increase the number of users. It is about to make the user confident working with the application and remove any confusion or difficulties from the application. This application is providing users a vast range of information and data. Therefore, it is very easy to be confused and have difficulties to find the right information if the interface is not appropriately designed. It should be easy to navigate between the pages and the functions and the most frequent used data and tools must be prior to others. Finally, using the right colors and shapes for each section is makes it even more friendly for the users.

3.1.2. GIS user interface

Nowadays geographic data are being used in many areas of science and businesses. This involves of the use, analysis, and implementation of the geographic data and consequently developing different software or web applications in order to present the data to the user. Therefore, it is very important to consider all techniques and methods to present this data and information in a simple and user-friendly way. This demands a set of user interface design skills specialized in GIS and customized for spatial data and maps. A map view and its dimensions and position in the interface has a key role in building a GIS application as it effects all the other elements in the application. This is because all the information and data presented in the application are somehow related to the map or are interacting with spatial data.

GIS software or applications perform a lot of different tasks. It could be as simple as showing a special map or showing some statistical data to performing complicated analysis. By the time the knowledge of GIS is improving and expending and respectively the number of tools and functionalities in GIS software is growing. These tools and could be confusing the user instead of helping him if they are not offered to the user in a simple and understanding way. The problem can be even bigger if the software is presenting tools and solutions for complicated tasks and analysis that involves a lot of steps and demands a high level of skills and expertise. In addition, visualizing and dealing with GIS data which are standardize in many different formats is another issue which adds some other complications to the interface.

Given the fact that many GIS techniques and methods are created way before the computer era and some of these techniques are based on paper and physical tools, these techniques must be changed in order to be compatible with digital computers and their capabilities otherwise it could be difficult and confusing for the user to use the software. This problem is more likely appeared in operations such as working with 3D data which is not possible on a normal paper. The software ArcGIS desktop from ESRI is a very good example. There are hundreds of tools and functions gathered in this software which are displayed to the user in different ways. ArcGIS's toolbox contains over 500 tools which is used for different kinds of analysis and modelling. Even though they are categorized in different headings and subheadings, it could be a challenge for a GIS student or a person experienced working with GIS to find out the right tool without a previous education. Therefore, there is a need to simplify such a software in order to increase the usage of it and consequently propound GIS.

Different methods and solution could be used to achieve this aim and make the interface friendly for the user. Many GIS tasks and functionalities that are in a lower level than the others could be hidden for user and be performed automatically. For example, the requirements of joining GIS data can be skipped and be done automatically. This includes transformation and joining tables and so on. It could be just a drag and drop to join the data. Then the coordinate of the primary data changes to the coordinate of the secondary data and a relationship could be well established based on the spatial overlay between the two dataset. Some of GIS functions have many sub-functions which are necessary to be able to use the function. Going through so many steps could be time consuming and challenging for GIS users. Therefore, all the sub-functions can be merged into the actual function and be done automatically. An alternative could be standardization of GIS databases in a way that the software can detect the standard column names and join them automatically which could be more challenging than the overlay method.

By increasing the internet accessibility and speed nowadays there is a tendency to use simple GIS web application instead of complicated GIS desktop programs. Such a complicated software can be replaced with one or more simple web applications performing the same task. It would be much less confusing for the user to look at the functions and tools that he just need to perform a task rather than having a comprehensive GIS software containing a wide verity of GIS tools and functions which are unnecessary and just confusing.

3.2. Human tests

This project is a GIS-based mobile application which is going to be used by people in the society. Therefore, it needs to be based on people desires and needs. Thus, in addition to the research and testing devices and applications humans need to be involved and test the project. It could be a survey or interview that first familiarizes the people with the project aspects and then collects their ideas and thoughts about the project. In addition, social aspects of GIS need to be reviewed and possibly applied in the project as it is a GIS-based application.

3.2.1. Interviews

A comprehensive survey is one of the best ways to determine the motivation factors. Therefore, to be able to find out the people's desires and to determine the best feedbacks some of the existing users of crowdsourcing were interviewed. Fifty respondents with the background knowledge and working experience with crowdsourcing applications were picked. They were mostly students in University of Gävle and inhabitants of Gävle municipality. It tried to choose the respondents from different social and cultural positions and different ages in order to get a better overview of the society and receive different ideas. An overview of the respondents and their specifications is presented in table 3.1.

Table 3.1. Specifications and skills of the respondents

Specification	Selection	Number	Percentage
Gender	Male	23	46
	Female	27	54
Age	<20	3	6
	20-40	32	64
	40-60	12	24
	>60	3	6
Ethnicity	Asian	27	54
	European	18	36
	African	5	10
Education	Undergraduate	36	72
	Graduate	9	18
	Ph.D.	5	10
Occupation	Student	37	74
	Employee	11	22
	Employer	2	4
Crowdsourcing experience	Yes	48	96
	No	2	4
Application development experience	Yes	8	16
	No	42	84
Use a smartphone	Yes	49	98
	No	1	2
Favorite platform	iOS	34	68
	Android	12	24
	Windows Mobile	4	8

The respondents had to be informed about the project, the way that it works, the facilities and the limitations that it has, and so on. Otherwise it is not possible to reach desired information about the motivation factors and feedbacks which users wish to get through the system. The project should be capable of covering these feedbacks and they have to be compatible with the system.

Given the fact that there are many crowdsourcing projects offering different services, the application should provide people some new or more useful feedbacks and services to be able to compete with other project in the market. Therefore, the application needs to give people a strong motivation which other applications cannot. Facilities such as having a map, having the application on mobile phones, GPS, taking a photo shall be considered. This is an application specialized for a city or a municipality and it needs the internet to run. Furthermore, it can be connected with the municipality, other organizations and authorities as well as connecting with other people.

The interview's main advantage over stereotypic and online survey is that it is more flexible and we can make sure that the candidate is cleared about the project. In addition, there is a possibility to go through the details and explain more about the situation. After clarifying and answering and discussing some questions they are ready to give their own vision and ideas about the project which was very helpful.

All the candidates were asked the following main questions:

1. *Will you participate in the project? If yes, under which conditions?*
2. *What kinds of nonfinancial feedbacks would you like to get if participating in the project?*
3. *What else would you like to report to municipality and other organizations through the system?*
4. *Which civic issues are you dealing with mostly?*
5. *Which organizations and authorities are you dealing with mostly?*
6. *Do you prefer to use the web application on a computer or a smartphone?*
7. *What would you like to report and share with other people?*
8. *Which information would you like to get through the system?*
9. *How can it facilitate your life more?*
10. *How much time would you spend daily working with the application with your desired feedbacks?*
11. *Which needs can you fulfill using this application that you cannot meet by other similar apps?*
12. *Do you think it can destroy your privacy?*
13. *Which opportunities can you make or get using the application?*
14. *What are your popular crowdsourcing or social networking applications?*

Afterwards based on different backgrounds and levels of knowledge everyone was asked some additional specific questions.

3.2.2. GIS social aspects

A GIS- based mobile application which is used by public in a daily life is a good example of GIS interaction with people in the society. It can be a very useful tool to spread GIS and its social aspects. Given the fact that the project is a GIS-based mobile application, the GIS aspects need to be review and properly be included in the project. This by itself helps to make a connection between the users and the application by having the same social interests in common. Therefore, it may lead to increase the number of users and access a larger crowdsourced data.

One of the most significant social aspects of GIS is connecting people geographically. Everyone has the possibility to share his or her location with his desired person. It could be a reason for more social interaction if you know where your friends are. In addition, it may be very interesting to know the proximity to the people with the same interests or similar lifestyle. People tend to interact with someone that has common interests with them and GIS can bring this joy to them and help to grow social activities in the society. In the other hand it could lead to increase being involved with technology and individualism which means decreasing social interaction in the society.

80 percent of the data in the whole world can be connected directly to a geographic position and the other 20 percent can be connected indirectly. This is an indication for importance of GIS in other businesses and organizations along with social life. The geographic information of the people and their activities in the society can be used as an open data in order to give them different services such as market to them based on their interests and lifestyle. Nowadays many different popular applications such as Facebook are doing this by employing GIS and Spatial data. These applications are also used to publish useful statistics occasionally which can be used by people to facilitate their lives. Utilizing crowdsourced GIS data in order to solve civic issue and offer public services is one of significant outcomes of this project which can help both citizens and politicians. Therefore, it helps a direct social interaction between citizens and politicians without being interfered by a third party company or organization.

People's location information could be very sensitive when it comes to security. GIS can help people by using their location information but at the same time it can destroy their privacy and even put them in danger if it is in the wrong hands. Therefore, the privacy of GIS data especially when it comes from people should be secured and be taken very serious. In addition, cost of accessibility to GIS data and information should be minimized if it is not free. This expands the GIS in public and it would be even more social if it is accessible through different types of mobile devices and computers with different operating systems.

GIS is a powerful tool which should be used correctly. It can be used to kill people or used by some evil individuals in order to reach dark goals which can ruin people resources and lives. Unfortunately, this is a fact and it is inevitable. Many people are killed every year in the wars and it is a bitter example where GIS technology is being used against human. But in the other hand it could be used to help human to have a better life and a peaceful world.

3.3. Accurate localization

Every report contains the location information of the reported object and a higher accuracy of the location can facilitate finding the object among many other nearby objects in a densely populated area. The position of a report can be automatically determined through Cell-ID, WLAN (wireless local area network), or the built-in GPS in a smartphone. The accuracy of positioning varies from one device to another depending on the GPS and other features (Watzdorf and Michahelles 2010). In addition, different applications and operative systems may provide different accuracies with the same device (Bauer 2013).

Cell-ID based positioning can be used when a network coverage of a radio station is available. The smartphone's position is determined through the coordinates of the transmitter antenna (Zandbergen 2009). This method is highly relied on the vicinity to the transmitter antenna and the accuracy is sometimes higher than 300 meters (Watzdorf and Michahelles 2010). However, the accuracy can be improved by using the 'timing advance value' (the transmission time from transmitter to smartphone and from smartphone back to the transmitter antenna) (Küpper 2005). The distance between smartphone and the transmitter can be determined based on this value and it can be combined with Cell-ID information in order to improve the accuracy. Regardless of the accuracy, Cell-ID can be used to increase the coverage where GPS and WLAN which have higher precision are not available.

GPS has the accuracy of 5 to 10 meters which is higher than Cell-ID and WLAN positioning (Küpper 2005; Sayed et al. 2005). A related research in the University of Alaska has compared GPS positioning in three different types of smartphones and 95% of the time they have the accuracy of 10 meters or less (Menard et al. 2011). Nevertheless, it has the limitation for indoor usage as the signal becomes weaker or even disappears without any signal processing (Watson et al. 2005). It also uses more battery than the other positioning systems such as WLAN or Cell-ID (Bulusu et al. 2000). However, there are some techniques that can improve the accuracy of GPS and decrease its limitations. For example, some of embedded sensors in smartphones such as microphone, camera, accelerometer, gyroscope, etc. can be employed to increase the accuracy of the GPS localization (Shangguan et al. 2014).

When a registered wireless hotspot is available, there is a possibility to take advantage of WLAN in order to determine the location. RSS (received signal strength) is used to estimate the distance between smartphone and the wireless hotspot (Bauer 2013). The positioning is done based on RSS-based algorithms that are created from received signals from different locations (Küpper 2005, Zandbergen 2009). It is more accurate than Cell-ID based positioning and it can also be used indoors where the GPS is limited. The accuracy of 30 to 50 meters can be achieved with this method but it is usually limited to densely populated areas (Zandbergen 2009).

4. Results and discussions

4.1. Results

This chapter presents the results of the methods mentioned in the Methodology section. Many application interfaces were review and techniques and methods employed in order to build a user-friendly GIS mobile application. This indicates that both mobile and GIS aspects of the project were taken into consideration in order to integrate GIS components and user interface elements in a mobile device. In addition, a comprehensive survey were performed and the respondents were interviewed in order to increase the rate of satisfaction among the user and consequently increase the application usage. Furthermore, a research was performed in order to find out the shortcomings of the localization process in smartphones and to improve it. Finally, all the methods were employed in order to create an interesting and user-friendly interface which motivates the users to use the application.

4.1.1. Interface design

Most top applications' interfaces have many things in common and their structures are almost the same. Nearly all the popular applications such as Facebook, Foursquare, Blocket, Gowalla, Citysourced, and even App Store itself are designed based on a certain pattern. For example, all of them use Tab Bar, Navigation Controller, and Table View in order to communicate with user. They each have their own exclusive symbols or colors which apply to all pages and windows. A friendly search tool is another common attribute which accelerates and facilitates the accessibility to the information.

Touch functions should be used appropriately in the interface to get the most from the application. Many different gestures can be used to make the interface friendly and skip going back and forth in pages to find the right object (Rui 2004). Putting so many buttons and tabs in the main page has no advantage except confusing the user. Swiping gestures from the sides of the screen can directly refer the user to the desired view. Double tap, pinch, and multi-finger gestures can be employed to make the user more comfortable with the interface by decreasing the steps. These gesture may seem to be more complicated than clicking on the buttons to reach the desired function but given the fact that they reduces the steps and shorten the process they will be effective in order to simplify the process and make it easier for the user (Jordan 2003).

All the buttons must be finger-friendly and clarified with the right text or icon. The content can be scale to fit until the user uses pinch zoom or double tap to make it bigger or smaller. This must be maintained during the screen rotation and scrolling bookmark must be activated in order to prevent the page from jumping to the beginning. Text can be magnified based on the screen size when scaling to fit. Although the number of words in the screen is reduced but it is more eye-friendly and easy to read. This increase the user's self-efficiency especially when dealing with applications that have a lot of text (Sun et al. 2015).

Typing process is very important in this application as the users submit the reports and reviews by typing. Therefore, it needs to be simplified for the user to type on a mobile device. The key on the keyboard should be finger-friendly and at the same time not so big to cover the content on the screen. In addition, the rest of screen should be scrollable to let the user access to the whole content when the keyboard is activated.

Furthermore, a toolbar with the word suggestions must be placed on top of the keyboard. It is very effective as the user skips to type many words.

4.1.2. Human tests

The answers and ideas of the respondents were taken into account. The idea of reporting civic issues in order to make the society a better place was highly appreciated by the respondents. However, getting feedback from authorities and eventually taking care of civic issues was a significant expectation of them. They wanted to be notified about the status of the reported civic issue and its fixing process. When it comes to taking care of civic issues, it is very important to categorize the issues and refer them to the right authorities. Among all the civic issues pothole, abandoned bicycle, and illegal activities were the most frequent mentioned issues. In some cases people did not know exactly which authority to contact to report the issue. However, the police department and the municipality were the most common choices.

All the respondents favor nonfinancial rewards, and most of them wanted to receive some location-based services through the application where they could save a lot of time, energy, and costs. The most popular feedback was getting information about opportunities and cheap and appropriate merchandises in the city. Given the fact that there are a lot of websites that are working in this area, the project's attributes, facilities, and limitations should be considered in order to filter them to the most appropriate and prevent overcrowding. All the daily or weekly needs, that a citizen is dealing with regularly, should be picked because it motivates the user to work with the application not just for some special purposes like purchase a house, car, or some other occasional stuffs. It should be something that you cannot find in websites like eBay or blocket.se. It may also be a real-time need because you always have your smartphone with you and after observing the merchandise in your city you can directly go and buy it. Therefore, having the application on a smartphone enables the application for frequent purchases like food.

The second preference in nonfinancial feedbacks was to get information about their favorite events and activities in the city. It helps them to not miss their favorite events like concerts or sport matches in their city. It is also possible to report the events by taking or uploading a photo of event, choosing its category, and writing some details about it. In the end the idea of putting some location-based services such as online food or taxi was the most popular one for all the respondents. User can order a food or a taxi just by pressing a few buttons. The location will be automatically registered and the order will be in the place immediately. Using these services there is no need to spend time and money on the phone to explain the order and address. There are many different ideas for location-based services which can be added to the project.

Privacy was another important aspect which the respondents were very concerned about. They did not wanted their private information such as name and address to be shared with anybody, except they do it themselves voluntarily. Besides, the application need to be secure itself in order to protect users' information and locations from malware and hackers. In the end, there were some suggestions to make it possible to connect the application to some popular social networking websites such as Facebook and Twitter. In this way, users would be able to share their reports from the application in their social networking websites.

4.1.3. Accurate localization

Among all the global positioning systems in a smartphone GPS has the highest accuracy. For that reason, it is the most suitable one to be employed to determine the reported object's position. However, it has the shortcomings in the covered areas which makes the GPS accuracy unreliable. This weakness can be minimized through some techniques by taking advantage of some built-in features of a smartphone. For example, a technique called HAPEL (Hidden Access Point Estimation-based Localization) uses the smartphone's digital Compass, accelerometer, and gyroscope in order to estimate the direction of movement. This information is combined with centroid localization information derived from WLAN for indoor localization. The very special feature of this technique is that not-scanned access points are exploited as well as scanned access points to make the centroid localization possible when the total access points are less than three. It has the average error of 6.371 meters and it improves the indoor positioning accuracy by 51% and 48% in compare of older techniques WCL (weighted centroid localization) and Fingerprint respectively (Yoo et al. 2014).

A major problem with WLAN positioning could be the lack of Wi-Fi access points. When the number of access point rises, consequently the accuracy of WLAN positioning increases as well. In the other hand, reduction of the access point's number leads to error increment or even can make the localization impossible. A peer-phone positioning approach has solved this problem via acoustic ranging. The localization is done based on the nearby devices' positions by transferring sound signals. Considering that the number of smartphone users is growing very fast in the world, this technique is very practical especially in densely populated areas. It improves the WLAN positioning accuracy by 80% which can lead to errors less than 2 meters (Liu et al. 2014).

Another acoustic approach uses WSN (Wireless Sensor Network) for indoor positioning which reduces the positioning error to less than 10 cm in 95% of the time. The smartphone's position is determined by TDoA (Time Difference of Arrival) which is the estimation of the sound signal transferring time between the phone and nearby acoustic beacons. It is very suitable for the places that lack GPS signal where a high accuracy of the position is needed. But the down side is that existence of acoustic beacons in the building is necessary to be able to locate the smartphone (Lopes et al. 2014).

An android app called CamLoc enables a smartphone user to localize an object by taking two photo of the object (Shangguan et al. 2014). By using the two images, scale ratio of the object is determined and its distance from the smartphone's camera is calculated with the "well-known lens formula". In this approach, the smartphone's shift between capturing the two pictures is computed through the phone's accelerometer and gyroscope. Finally, the object's global position is calculated using the user's global location, the scale ratio, and the displacement information. This system can localize the object with an accuracy of 89 percent in rural and 72 percent in downtown areas (Shangguan et al. 2014).

4.1.4. Application interface

Based on the literature review, top application interfaces, and interviews, the structure of the application was designed. Beside reporting civic issues, three additional parts namely "Cheap & Cheerful", "Public Events", and "Services" are added to the

application in order to motivate user to download and use it. "Cheap & Cheerful" is the category where to report and get information about appropriate and cheap necessities like food or clothing. "Public Events" allows the user to report and know about his favorite events and activities in his city. The users are thus able to report and share their favorite information with other users as well as reporting civic issues. "Services" consists of some location-based services such as taxi, online food, and buss which is considered for the application in order to facilitate the daily life. Totally, a user is able to report three main categories namely "Civic Issues", "Cheap & Cheerful", and "Public Events".

Each of the three main categories has several subcategories. Based on an internet survey and considering similar applications the most common subcategories were determined. Subcategories are very important as they are representing the boundaries of an application's efficiency. At the same time their number should be as few as possible because having too many subcategories may be confusing and it may take a lot of time to find a certain subcategory under its main category. For example, an application called Citysourced is defining fifty subcategories for the civic issues. It may make the user confused between too many choices. In addition, the similarity between some of choices makes it even harder to find the right one. Having many subcategories may lead to reduce the number of users by making the application less user-friendly. Subcategories should be only the most common things that people are dealing with in the society. They should be very easy to understand without a need to have a prior knowledge.

Based on the above-mentioned, subcategories are determined for each part of the application as follow:

Civic Issues: Pothole, Water leak, Graffiti removal, Traffic, Public lighting & Signs, Trash & Pollution, Abandoned properties, Public transportation, Animals, Plants, Illegal activities, Other
Cheap & Cheerful: Food, Clothing, Health & Beauty, Utensil, Fuel, Other
Public Events: Arts, Sports, Entertainment, Religion & Spirituality, Academic, Scientific, Business, Cultural, Political, Other
Services: Online food, Taxi, Bus

Because subcategories are flexible, the crowd can change them and their orders by their usage frequency. For example, if a category is not reported frequently it can be removed from the list while new categories can be created based on the high frequency similar type of reports in the "Other" subcategory. So this was the purpose to place the "Other" subcategory in the three main categories "Civic Issues", "Cheap & Cheerful", and "Public Events". It gives the crowd freedom to choose the most common subcategories and it can be different for different societies and cultures. This is one of the ways that helps to make such a crowdsourcing project flexible. In addition, subcategories with high frequency will be placed at the top of the category so they are more easy to access. In the beginning, Location-based services were limited to online food, taxi, and bus schedules but it can be changed and new ideas can be added as the crowd wish. It can be found out by performing some surveys through the application or its official website.

Crowdsourcing and utilizing different opinions coming from a large crowd is a good idea to achieve a certain goal. However, spamming is a serious problem which hinders or even prevents the crowdsourcing to meet this aim (Growmap 2011). A robust rating system is necessary to limit or prevent people who are presenting false and

inappropriate information. In this way the crowd itself determines what is worthy and what is useless. It optimizes the quality of the submissions based on crowd's desires.

The system determines the level of authorization for every user which can be changed over the time. It can be done by considering credibility for every user (Balatarin 2006) where every user can increase his credibility by submitting useful and interesting reports. In addition, the credibility can be changed based on the user's activities (Balatarin 2006). Furthermore, the crowd can rate a user and his submissions in order to increase or decrease his or her credibility.

A user can submit a report only if he is registered in the system. At first the submission appears in the "Recent" section. It is possible to rate a submission by positive and negative votes. Submissions with a certain amount of negative votes will be removed while positive votes and some other factors such as credibility, number of clicks or comments can help a submission to move into the "Popular" section which helps to get more visibility (Balatarin 2006).

A user-friendly search tool was considered for the application which enables the user to search for different submissions by typing keywords. It is a very fast way to find out about desired information among a large amount of submissions. A location-based search may also be developed either for a certain area or a whole city, combined with a possibility to search within every main category or subcategory separately.

The design of the application depends on the capabilities and functions of the device, in this case an iPhone 4. This is a touch screen phone with features such as GPS, camera, accelerometer, Wi-Fi, Bluetooth, swiping features, pinch, rotate functions, expand, and so on. iPhone applications can be downloaded only from App Store and all the applications must be approved by Apple before taking place into App Store.

iPhone is an iOS-based device and just two kinds of software can be developed for it, iOS apps and Web contents (Apple 2010). Web contents are divided into web apps and webpages where web apps are webpages which are doing a certain task in a similar way as iOS apps. To develop an iOS app iOS SDK is required. It employs the iOS environment to take advantage of the iOS-based devices such as iPhone (Apple 2010). Therefore, just iOS apps and web apps can be installed on the iPhone.

As the interface should be as simple as possible and attractive at the same time it was composed of four main tabs, namely Home, My Reports, Favorites, and More. The most important software used to design and build the iPhone application is Xcode 4 which is the latest IDE at the moment. The application was designed using Interface Builder which is a part of Xcode. It is a very user-friendly tool to create GUI for iPhone apps. Enrolling in "Apple iPhone Developer Program" is necessary to be able to download and use Xcode (Gordon 2009).

As an example of a specific the crown in the application's Home page was designed using Photoshop CS4. It is composed of five main parts and twenty two different layers which are saved as PNG files in order to be used in Xcode (Figure 5).

Figure 4.1. Home

The following schema (Figure 6) represents the structure of the application which all the pages and subpages are illustrated.
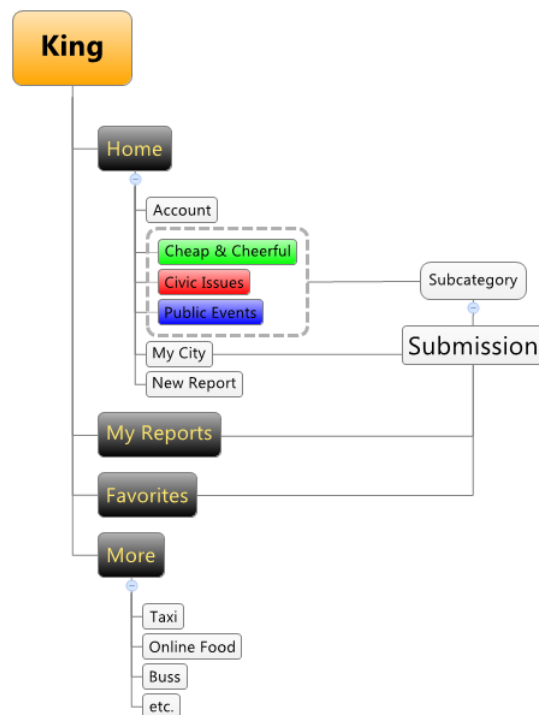
Figure 4.2. Schema of the application's structure

The home screen is the most important page in the application (Figure 5). It is the main page of the application and the most important functions that user is dealing with are accessed through this page. The home screen has six subpages: Account, Cheap & Cheerful, Civic Issues, Public Events, My City, and New Report, for the user to get further.

In the account page the user is able to view and edit his account information such as username or email. The following three pages are representing the three main categories Cheap & Cheerful, Civic Issues, and Public Events. In each of these pages the user can observe the submitted reports by other citizens for that category. All the submitted reports together regardless of their categories are observable in the page My City. A glance into this page enables the user to see what is happening in his city. The title of My City page can be changed automatically based on the user's location and be set to the name of the city that he is located in. Last but not least, the page New Report is employed to submit the reports. From this page the user submits a report by taking or uploading its photo, choosing its subcategory, and writing some details about it.

The home screen should be attractive and also be designed related to the concept of the application in a meaningful way. Here the art of design has a very significant role. Therefore, even if it is possible to put the buttons one after another in a simple way it is not attractive. For this application the interface of the home screen was designed like a crown. The idea was that a crown is the symbol of a king and here it means that the user can be the king or hero of his city. It is representing the citizen engagement in order to make a better society where interaction with other citizens and organizations leads to a better life and enhances the social connections.

The crown was designed using Photoshop CS4. It is composed of five parts where every part is representing a button. Below the crown is a "Submit a Report" button. It is the most important button which the user needs to access quickly and easily. Therefore, it has to be a big button in the main page. The body of the crown is representing the city and is linked to the My City page. It connects the Report button to the three main categories which are supposed to be reported. The three main categories are represented by three jewels with different colors. "Cheap & Cheerful" is green, "Civic Issues" is red, and "Public Events" is blue. By tapping on each one the user can access the category easily.

All the pages and buttons should be placed based on their possible usage frequency. Therefore, the city view and the three main categories were placed in the main page as they are representing the information that user is mostly dealing with. Titles of pages and keywords should not be confusing and they should directly point to the concepts. Shapes and colors are also effective. Symmetry can be utilized to put the elements together in a way that is easy to find and not confusing. Although the project's main idea is very important, it is the art of design that makes a popular application out of a good idea.

The user can see all his submissions in a chronological order in the "My Reports" tab (Figure 7). The reports can belong to any category and it is possible to edit them in case of any mistake. The user is able to remove his submission or change some of its features by using Edit button.

Figure 4.3. My Reports and Favorites

"My Reports" has one subpage where the submitted report by the user can be seen in detail. In "My Reports" page there is a possibility to search among the reports for a special submission based on location and time by using its keywords. By tapping the Search button a menu will appear to insert the information about the submission and after entering information all the desired submissions will be listed.

In the "Favorites" tab (Figure 7), the user is able to add his favorite categories and receive reminders for them. This is done through the Add button. After tapping the button, the user will be asked about the main category, subcategory, location, and keywords. Every time a report matched with the entered information is submitted, a pop-up mark will appear on the "Favorite" tab and user will be notified about it. By using the Edit button it is possible to add/remove and change the information about favorite reports. Also, "Favorites" has one subpage which allows observing the favorite report in detail.

Non-crowdsourced services are placed in "More" tab. They are represented by square icons in a table and it is possible to change their order. By tapping any of them, the user is able to access the service they represent. There are two main views for all the submissions, List view and Map view (Figure 8). The view can be switched between list and map by tapping "List View" and "Map View" buttons. In the List view all the submissions are listed by their picture, title, and other information, and the Map view is representing all the submissions on the map.

Figure 4.4. List view and Map view

Every submission is represented by a pin which special color is the same as for its main category. For example, if it belongs to the "Public Events" category it would be a blue pin. This helps to distinguish them easily on the map in "My City" view where all the submissions are displayed together. Finally, by tapping the "Popular" or the "Recent" buttons, the user can observe either top-rated submissions or recently submitted reports.

4.2. Discussions

Crowdsourcing is an appropriate solution to employ a crowd in order to help many projects, especially in the market (Howe 2006). It is a cheap and fast solution to get a large amount of free data and ideas. However, it may not be easy to attract and lead the crowd to participate in the project and utilize the crowd's talent in order to report civic issues. Moreover, all the reports need to be accurately localized to be able to track and find the reported object.

This research was about designing a GIS-based crowdsourcing iPhone application. The aim was to motivate the crowd to report the civic issues and to determine the accurate position of the reported object. Reporting civic issues, people help to solve the issues and get better services in the society which can motivate them (Heipke 2010). It can be a very fast and helpful method when the user is furious about a civic issue. Despite these advantages a user needs a strong motivation to participate in the project. Suitable feedbacks need to be given to the crowd in order to reach this aim. Therefore, based on the literature review, top application interfaces, and interviews, three main functions were added to the application. A user is able to report and get information about cheap and appropriate necessities, public events, and be benefited by some location-based services. These functions provide a very cheap feedback based on crowd desires (Ebner et al. 2008; Leimeister et al. 2009).

All the reports contain spatial data which present the location information. Having the exact location of a report is very helpful to facilitate the process of solving civic issues. Positioning with smartphones is not very accurate as they do not have strong and

accurate GPSs. Therefore, there is a need to improve the accuracy of the positioning process and consequently accuracy of the spatial data. The spatial data may be determined through the three positioning systems in the smartphone namely Cell-ID, WLAN, and GPS. Keep in mind that an accurate location of the reported object is required in the project in order to find and distinguish the object especially in densely populated areas.

GPS is the most accurate global positioning system in a smartphone which has the accuracy of less than 10 meters (Küpper 2005; Sayed et al. 2005). However, it is not as accurate as other GPS receivers such as Piksi with an accuracy of one inch in the open areas (Atherton 2013). Furthermore, GPS has the limitation when it comes to covered areas where the GPS signal is weak (Watson et al. 2005). Therefore, the positioning methods such as HAPEL, CamLoc, and acoustic techniques which are presented in the result section can be used to improve the localization accuracy.

Some techniques and methods were chosen in order to improve the GPS accuracy especially in the places with a low GPS signal strength. These methods exploit WLAN and some of embedded features in a smartphone such as microphone, camera, accelerometer, gyroscope to improve the positioning accuracy. In the end, along reporting civic issues the user is able to report and get information about cheap and appropriate necessities and public events in different geographical areas through a map-based application. Furthermore, he or she is benefited by some location-based services such as online-food or taxi. The client application's interface was designed for iPhone.

5. Conclusions and future work

The application would be an applicable alternative for the old reporting methods like phone call or mail. Nevertheless, reporting civic issues itself, cannot be necessarily a strong motivation to attract the user to download and use the application. Therefore, desired feedbacks of the crowd need to be found out in order to encourage them to spend their time for the application. User needs to get motivated to use the application and considered additional parts can be very helpful to reach this aim.

5.1. Conclusions

By using the application, the user can save a lot of money and time and avoid missing his or her favorite events in the city (Spiegel 2011). This provides a great motivation besides making his city a better place by reporting the civic issues (Heipke 2010). It leads the user to download and get familiar with the application which is a very important step in a crowdsourcing project. Because the feedbacks involve daily needs which the user is dealing with regularly (Maslow 1943), it attracts the users to always have the application available and when he faces a civic issue he can report it right away. Therefore, daily needs are a good motivation for this purpose in contrast to similar applications like "CitySourced", where the user uses the application occasionally and sometimes rarely because it is only for reporting civic issues. Gradually that can lead to the user forgetting about the application and even removing it.

A simple and attractive interface is another key-feature to attract users. All the functions and parts in the application are placed based on their probable usage frequency. Being flexible is a very important advantage of the project which makes it compatible with the crowd's desires (Ebner et al. 2008; Leimeister et al. 2009). For example, subcategories and their orders can be changed based on usage frequency. The titles of subcategories should be very easy to understand and the number of them for each main category should be minimized (Sun et al. 2015). In this application there are less than twelve subcategories in every main category. Therefore, it would be very easy and fast to choose the right subcategory, compared with "CitySourced" which has about fifty subcategories for civic issues. In addition, in "CitySourced" there are many similar and confusing subcategories' titles which make it difficult to find the right one (Citysourced 2009).

The application should be understandable with a little effort as the less complex the interface is the higher user's self-efficacy (confidence to deal with the interface) will be (Sun et al. 2015). To be able to make a user-friendly interface some factors such as being easy to navigate between the pages, having friendly search tools, appropriate and complementary colors, a consistent design and layout, an appropriate and easy to understand language need to be taken into account (Jordan 2003). In addition, offering people up to date and accurate data through the application is very important as it helps to earn their trust. Obviously, it spreads the usage of GIS data among people (Pratt 2012).

Because Xcode was used the client application is designed for iPhone. Based on the literature review, top application interfaces, and interviews, three main functions are added to the application to motivate the user to download and use the application. These non-financial feedbacks ("Cheap & Cheerful", "Public Events", and "Services") could

be the cheapest ones which are compatible with the application's system. The feedbacks can be changed slightly based on the crowd's desires (Ebner et al. 2008; Leimeister et al. 2009). However, the application should be tested in a real community in order to meet the optimum feedbacks.

5.2. Future work

After building the application, those people owning an iPhone can download it for free and report necessities, civic issues, and public events. Aside from taking care of civic issues in their city, they can also be benefited by other users' submissions and location-based services. These reports also offer a very useful resource for statistics which can be used by related authorities and organizations (Kanhere 2011). The outcoming statistics can be used very well in order to prevent the civic issues and consequently save a lot of money and resources.

The sever part is beyond this thesis as it needs a whole separate study. But the project could be further develop in the sever part. The Java programing language would be a great choice for the server part as it is very powerful and flexible to create different GIS functions and tools. The server can be written to be compatible with popular and common operative systems like Windows and Linux. There are many application servers to choose from but Jetty and Apache Tomcat are two great choices. They are both powerful and fast for the server part communication. In addition, the application performance need to be tested and optimal hardware requirements need to be determined. It is very important that the antivirus software on the server is customized to ignore the application server process. Antivirus software control the server traffic and hard disk activities. This can stop the application and or cause severe problems.

Server status need to be checked continuously in order to monitor number of active and passive users and their activities. The total number of request or request for each function give a very useful overview of the user usage. It makes it possible to know for example which functions and tools are the most popular and how many memory everyone consumes. Therefore, the interface can be change based on this information in order to make the application even more user friendly. In addition, response time for each request should be taken into account to improve the timing in the server and consequently remove the bugs which slow down or even hinder the application.

Finally, after building the application it is time to distribute it to people, so they can get to know the application and its capabilities. In the first step it needs to be reiterated in the App Store so everybody with an Apple device can download and run it. It is a very important step as all the apps in the App Store are approved by Apple Corporation. It means that they are free from any virus and in appropriate content which is a very important aspect to market the app. In this way the application is listed as a harmless app in the eye of the users.

A well-formatted website with information and pictures of the application is required to promote it (Spiegel 2011). In addition, social networking websites such as Facebook and Twitter are the best places to publicize and share information about the project (Spiegel 2011). However, the best advertisement is the application itself. If it is a useful and interesting application it will be spread out quickly and people will talk about it everywhere.

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Appendix: Interface code of the application

Xcode is a software introduced by Apple Inc. in order to develop iOS applications for Apple products. The programming language used by Xcode is called Swift which was introduced by Apple in 2014. As a part of Xcode Interface Builder is a very handy tool which enables the user to design and build the desired interface for the application. All the steps for building the application's interface are done in Xcode except creating the background images and icons which are carried out using Photoshop CS4. The following is the application's interface code in XML format which is extracted from Xcode.

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version="3.0" toolsVersion="6254" systemVersion="14B25"
targetRuntime="iOS.CocoaTouch" propertyAccessControl="none"
useAutolayout="YES" initialViewController="hnZ-WV-JTB">
    <dependencies>
        <plugIn
identifier="com.apple.InterfaceBuilder.IBCocoaTouchPlugin"
version="6247"/>
    </dependencies>
    <scenes>
        <!--Favorites-->
        <scene sceneID="Erl-7T-PAL">
            <objects>
                <viewController title="Favorites" id="jdw-hV-nZM"
sceneMemberID="viewController">
                    <layoutGuides>
                        <viewControllerLayoutGuide type="top" id="F8z-
01-H1e"/>
                        <viewControllerLayoutGuide type="bottom"
id="aj4-v8-302"/>
                    </layoutGuides>
                    <view key="view" contentMode="scaleToFill"
id="RUR-c9-WGl">
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height="568"/>
                        <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
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clearsContextBeforeDrawing="NO" contentMode="scaleToFill"
fixedFrame="YES" translatesAutoresizingMaskIntoConstraints="NO"
id="8mJ-Zc-FbS">
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width="320" height="44"/>
                                <items>
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id="P48-G0-u1o">
                                        <color key="tintColor"
white="1" alpha="1" colorSpace="calibratedWhite"/>
                                    </barButtonItem>
                                    <barButtonItem style="plain"
systemItem="flexibleSpace" id="9g1-KS-w9o"/>
                                    <barButtonItem title="Add"
id="lj9-Yd-RY9">
```

```xml
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white="1" alpha="1" colorSpace="calibratedWhite"/>
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                                </items>
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alpha="1" colorSpace="calibratedWhite"/>
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baselineAdjustment="alignBaselines" adjustsFontSizeToFit="NO"
translatesAutoresizingMaskIntoConstraints="NO" id="L9a-7n-b5f">
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type="boldSystem" pointSize="17"/>
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                                    <segment title="Map view"/>
                                </segments>
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alpha="1" colorSpace="calibratedWhite"/>
                            </segmentedControl>
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systemItem="favorites" id="5LD-hG-1L0"/>
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id="5KY-zo-D6I" userLabel="First Responder"
sceneMemberID="firstResponder"/>
            </objects>
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```
<!--My reports-->
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sceneMemberID="viewController">
            <layoutGuides>
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id="osC-fA-LzR"/>
            </layoutGuides>
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height="568"/>
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                        </items>
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```

```
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id="GJS-nF-LRG" userLabel="First Responder"
sceneMemberID="firstResponder"/>
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                <!--Tab Bar Controller-->
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                    <objects>
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                            </connections>
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```

```
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id="5UV-dz-VZZ" userLabel="First Responder"
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        </scene>
        <!--More-->
        <scene sceneID="bqP-Lu-coo">
            <objects>
                <viewController title="More" id="eCB-8W-JRn"
sceneMemberID="viewController">
                    <layoutGuides>
                        <viewControllerLayoutGuide type="top" id="Y33-
eg-8zR"/>
                        <viewControllerLayoutGuide type="bottom"
id="P7U-CF-7em"/>
                    </layoutGuides>
                    <view key="view" contentMode="scaleToFill"
id="iXR-pn-3qz">
                        <rect key="frame" x="0.0" y="0.0" width="320"
height="568"/>
                        <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
                        <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                    </view>
                    <tabBarItem key="tabBarItem" systemItem="more"
id="CfH-FT-Adj"/>
                </viewController>
                <placeholder placeholderIdentifier="IBFirstResponder"
id="HsZ-Eu-71Y" userLabel="First Responder"
sceneMemberID="firstResponder"/>
            </objects>
            <point key="canvasLocation" x="705" y="160"/>
        </scene>
        <!--Cheap & Cheerful-->
        <scene sceneID="7Gs-rY-qWi">
            <objects>
                <viewController title="Cheap &amp; Cheerful" id="28c-
wE-i9K" sceneMemberID="viewController">
                    <layoutGuides>
                        <viewControllerLayoutGuide type="top" id="4cp-
Np-Tit"/>
                        <viewControllerLayoutGuide type="bottom"
id="pb2-RC-eik"/>
                    </layoutGuides>
                    <view key="view" contentMode="scaleToFill"
id="dYt-6E-02a">
                        <rect key="frame" x="0.0" y="0.0" width="320"
height="568"/>
                        <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
                        <subviews>
                            <navigationBar contentMode="scaleToFill"
fixedFrame="YES" barStyle="black"
translatesAutoresizingMaskIntoConstraints="NO" id="kqe-uz-TmC">
                                <rect key="frame" x="0.0" y="20"
width="320" height="44"/>
                                <items>
```

```
                                <navigationItem title="Cheap &amp;
Cheerful" id="seU-xd-hgj"/>
                            </items>
                        </navigationBar>
                        <tableView clipsSubviews="YES"
contentMode="scaleToFill" fixedFrame="YES" alwaysBounceVertical="YES"
dataMode="prototypes" style="plain" separatorStyle="default"
rowHeight="44" sectionHeaderHeight="22" sectionFooterHeight="22"
translatesAutoresizingMaskIntoConstraints="NO" id="ket-eV-nWP">
                            <rect key="frame" x="0.0" y="64"
width="320" height="455"/>
                            <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                        </tableView>
                    </subviews>
                    <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                </view>
                <navigationItem key="navigationItem" id="dJb-x7-
V7k"/>
            </viewController>
            <placeholder placeholderIdentifier="IBFirstResponder"
id="ABR-fx-Nyg" userLabel="First Responder"
sceneMemberID="firstResponder"/>
        </objects>
        <point key="canvasLocation" x="-692" y="883"/>
    </scene>
    <!--Account-->
    <scene sceneID="Vzg-dg-sPV">
        <objects>
            <viewController title="Account" id="Hhs-MC-rvb"
sceneMemberID="viewController">
                <layoutGuides>
                    <viewControllerLayoutGuide type="top" id="WrO-
Ac-fqb"/>
                    <viewControllerLayoutGuide type="bottom"
id="abp-03-wpo"/>
                </layoutGuides>
                <view key="view" contentMode="scaleToFill"
id="PkC-vv-20X">
                    <rect key="frame" x="0.0" y="0.0" width="320"
height="568"/>
                    <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
                    <subviews>
                        <textField opaque="NO" clipsSubviews="YES"
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="left" contentVerticalAlignment="center"
borderStyle="roundedRect" minimumFontSize="17"
translatesAutoresizingMaskIntoConstraints="NO" id="mIz-A8-4xX">
                            <rect key="frame" x="53" y="128"
width="215" height="30"/>
                            <fontDescription key="fontDescription"
type="system" pointSize="14"/>
                            <textInputTraits
key="textInputTraits"/>
                        </textField>
                        <textField opaque="NO" clipsSubviews="YES"
contentMode="scaleToFill" fixedFrame="YES"
```

```
                        contentHorizontalAlignment="left" contentVerticalAlignment="center"
                        borderStyle="roundedRect" minimumFontSize="17"
                        translatesAutoresizingMaskIntoConstraints="NO" id="ZgB-ho-4n1">
                                        <rect key="frame" x="53" y="210"
width="215" height="30"/>
                                        <fontDescription key="fontDescription"
type="system" pointSize="14"/>
                                        <textInputTraits
key="textInputTraits"/>
                                </textField>
                                <label opaque="NO"
userInteractionEnabled="NO" contentMode="left"
horizontalHuggingPriority="251" verticalHuggingPriority="251"
fixedFrame="YES" text="Username:" lineBreakMode="tailTruncation"
baselineAdjustment="alignBaselines" adjustsFontSizeToFit="NO"
translatesAutoresizingMaskIntoConstraints="NO" id="tvO-ba-4Rz">
                                        <rect key="frame" x="53" y="99"
width="84" height="21"/>
                                        <fontDescription key="fontDescription"
type="system" pointSize="16"/>
                                        <color key="textColor"
cocoaTouchSystemColor="darkTextColor"/>
                                        <nil key="highlightedColor"/>
                                </label>
                                <label opaque="NO"
userInteractionEnabled="NO" contentMode="left"
horizontalHuggingPriority="251" verticalHuggingPriority="251"
fixedFrame="YES" text="Password:" lineBreakMode="tailTruncation"
baselineAdjustment="alignBaselines" adjustsFontSizeToFit="NO"
translatesAutoresizingMaskIntoConstraints="NO" id="aNo-bb-2f7">
                                        <rect key="frame" x="53" y="181"
width="84" height="21"/>
                                        <fontDescription key="fontDescription"
type="system" pointSize="16"/>
                                        <color key="textColor"
cocoaTouchSystemColor="darkTextColor"/>
                                        <nil key="highlightedColor"/>
                                </label>
                                <button opaque="NO"
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="center" contentVerticalAlignment="center"
buttonType="roundedRect" lineBreakMode="middleTruncation"
translatesAutoresizingMaskIntoConstraints="NO" id="sFT-WT-Izo">
                                        <rect key="frame" x="137" y="294"
width="72" height="41"/>
                                        <fontDescription key="fontDescription"
type="system" pointSize="24"/>
                                        <state key="normal" title="Sign in">
                                            <color key="titleShadowColor"
white="0.5" alpha="1" colorSpace="calibratedWhite"/>
                                        </state>
                                </button>
                            </subviews>
                            <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                        </view>
                        <navigationItem key="navigationItem" id="UfY-Dp-
LJ3"/>
                </viewController>
```

```
                <placeholder placeholderIdentifier="IBFirstResponder"
id="LLo-CT-FRZ" userLabel="First Responder"
sceneMemberID="firstResponder"/>
            </objects>
            <point key="canvasLocation" x="-1046" y="884"/>
        </scene>
        <!--Civic Issues-->
        <scene sceneID="rxA-ix-9f7">
            <objects>
                <viewController title="Civic Issues" id="VV9-3k-Rhu"
sceneMemberID="viewController">
                    <layoutGuides>
                        <viewControllerLayoutGuide type="top" id="RQ6-
Pb-Wc1"/>
                        <viewControllerLayoutGuide type="bottom"
id="OZ0-jk-FG2"/>
                    </layoutGuides>
                    <view key="view" contentMode="scaleToFill"
id="NtN-co-595">
                        <rect key="frame" x="0.0" y="0.0" width="320"
height="568"/>
                        <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
                        <subviews>
                            <tableView clipsSubviews="YES"
contentMode="scaleToFill" fixedFrame="YES" alwaysBounceVertical="YES"
dataMode="prototypes" style="plain" separatorStyle="default"
rowHeight="44" sectionHeaderHeight="22" sectionFooterHeight="22"
translatesAutoresizingMaskIntoConstraints="NO" id="3sx-a0-Ola">
                                <rect key="frame" x="0.0" y="64"
width="320" height="455"/>
                                <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                            </tableView>
                            <navigationBar contentMode="scaleToFill"
fixedFrame="YES" translatesAutoresizingMaskIntoConstraints="NO"
id="foQ-z8-THX">
                                <rect key="frame" x="0.0" y="20"
width="320" height="44"/>
                                <color key="barTintColor" white="0.0"
alpha="1" colorSpace="calibratedWhite"/>
                                <textAttributes
key="titleTextAttributes">
                                    <color key="textColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                                </textAttributes>
                                <items>
                                    <navigationItem title="Civic
Issues" id="Hp4-nb-29f"/>
                                </items>
                            </navigationBar>
                        </subviews>
                        <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                    </view>
                    <navigationItem key="navigationItem" id="Cs4-9E-
e3M"/>
                </viewController>
```

```
                <placeholder placeholderIdentifier="IBFirstResponder"
id="S11-do-7XX" userLabel="First Responder"
sceneMemberID="firstResponder"/>
            </objects>
            <point key="canvasLocation" x="-343" y="884"/>
        </scene>
        <!--Public Events-->
        <scene sceneID="6vM-XE-0qW">
            <objects>
                <viewController title="Public Events" id="gUD-9o-frX"
sceneMemberID="viewController">
                    <layoutGuides>
                        <viewControllerLayoutGuide type="top" id="0If-
TU-efb"/>
                        <viewControllerLayoutGuide type="bottom"
id="n1L-DY-SK4"/>
                    </layoutGuides>
                    <view key="view" contentMode="scaleToFill"
id="Ocj-oB-reE">
                        <rect key="frame" x="0.0" y="0.0" width="320"
height="568"/>
                        <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
                        <subviews>
                            <navigationBar contentMode="scaleToFill"
fixedFrame="YES" translatesAutoresizingMaskIntoConstraints="NO"
id="qd6-dQ-Lj7">
                                <rect key="frame" x="0.0" y="20"
width="320" height="44"/>
                                <color key="barTintColor" white="0.0"
alpha="1" colorSpace="calibratedWhite"/>
                                <textAttributes
key="titleTextAttributes">
                                    <color key="textColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                                </textAttributes>
                                <items>
                                    <navigationItem title="Public
Events" id="aXs-CF-LXC"/>
                                </items>
                            </navigationBar>
                            <tableView clipsSubviews="YES"
contentMode="scaleToFill" fixedFrame="YES" alwaysBounceVertical="YES"
dataMode="prototypes" style="plain" separatorStyle="default"
rowHeight="44" sectionHeaderHeight="22" sectionFooterHeight="22"
translatesAutoresizingMaskIntoConstraints="NO" id="AnV-az-vs6">
                                <rect key="frame" x="0.0" y="64"
width="320" height="455"/>
                                <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                            </tableView>
                        </subviews>
                        <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                    </view>
                    <navigationItem key="navigationItem" id="SHm-qE-
atX"/>
                </viewController>
```

```
                    <placeholder placeholderIdentifier="IBFirstResponder"
id="Igq-pq-pIj" userLabel="First Responder"
sceneMemberID="firstResponder"/>
            </objects>
            <point key="canvasLocation" x="6" y="884"/>
        </scene>
        <!--City-->
        <scene sceneID="414-Jr-We6">
            <objects>
                <viewController title="City" id="ViV-gj-Q4H"
sceneMemberID="viewController">
                    <layoutGuides>
                        <viewControllerLayoutGuide type="top" id="4Hp-
Ve-CyX"/>
                        <viewControllerLayoutGuide type="bottom"
id="OV3-i3-r6l"/>
                    </layoutGuides>
                    <view key="view" contentMode="scaleToFill"
id="glO-uj-pDs">
                        <rect key="frame" x="0.0" y="0.0" width="320"
height="568"/>
                        <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
                        <subviews>
                            <toolbar opaque="NO"
clearsContextBeforeDrawing="NO" contentMode="scaleToFill"
fixedFrame="YES" translatesAutoresizingMaskIntoConstraints="NO"
id="vGR-qR-89A">
                                <rect key="frame" x="0.0" y="20"
width="320" height="44"/>
                                <color key="backgroundColor"
white="0.0" alpha="1" colorSpace="calibratedWhite"/>
                                <items>
                                    <barButtonItem id="mxC-XY-H4n"/>
                                </items>
                                <color key="barTintColor" white="0.0"
alpha="1" colorSpace="calibratedWhite"/>
                            </toolbar>
                            <segmentedControl opaque="NO"
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="left" contentVerticalAlignment="top"
segmentControlStyle="plain" selectedSegmentIndex="0"
translatesAutoresizingMaskIntoConstraints="NO" id="GRP-sz-BA3">
                                <rect key="frame" x="88" y="75"
width="145" height="29"/>
                                <segments>
                                    <segment title="List view"/>
                                    <segment title="Map view"/>
                                </segments>
                                <color key="tintColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                            </segmentedControl>
                            <mapView clipsSubviews="YES"
multipleTouchEnabled="YES" contentMode="scaleToFill" fixedFrame="YES"
mapType="standard" translatesAutoresizingMaskIntoConstraints="NO"
id="sdd-zi-iVT">
                                <rect key="frame" x="0.0" y="111"
width="320" height="457"/>
                            </mapView>
```

```
                                    <label opaque="NO"
userInteractionEnabled="NO" contentMode="left"
horizontalHuggingPriority="251" verticalHuggingPriority="251"
fixedFrame="YES" text="City" lineBreakMode="tailTruncation"
baselineAdjustment="alignBaselines" adjustsFontSizeToFit="NO"
translatesAutoresizingMaskIntoConstraints="NO" id="j6Z-ap-nx4">
                                        <rect key="frame" x="139" y="31"
width="31" height="21"/>
                                        <fontDescription key="fontDescription"
type="boldSystem" pointSize="17"/>
                                        <color key="textColor" red="1"
green="0.77909023509999997" blue="0.25018691240000002" alpha="1"
colorSpace="calibratedRGB"/>
                                        <nil key="highlightedColor"/>
                                    </label>
                                </subviews>
                                <color key="backgroundColor" white="0.0"
alpha="1" colorSpace="calibratedWhite"/>
                            </view>
                            <navigationItem key="navigationItem" id="MFh-Ab-
fef"/>
                    </viewController>
                    <placeholder placeholderIdentifier="IBFirstResponder"
id="jPN-IA-wuG" userLabel="First Responder"
sceneMemberID="firstResponder"/>
                </objects>
                <point key="canvasLocation" x="356" y="884"/>
            </scene>
            <!--Submit a report-->
            <scene sceneID="SL6-ea-JMf">
                <objects>
                    <viewController title="Submit a report" id="i4d-o7-
Vyc" sceneMemberID="viewController">
                        <layoutGuides>
                            <viewControllerLayoutGuide type="top" id="W4h-
F4-s80"/>
                            <viewControllerLayoutGuide type="bottom"
id="fPL-ak-eAW"/>
                        </layoutGuides>
                        <view key="view" contentMode="scaleToFill"
id="jHR-y5-0og">
                            <rect key="frame" x="0.0" y="0.0" width="320"
height="568"/>
                            <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
                            <subviews>
                                <scrollView clipsSubviews="YES"
multipleTouchEnabled="YES" contentMode="scaleToFill" fixedFrame="YES"
translatesAutoresizingMaskIntoConstraints="NO" id="slW-K6-gzS">
                                    <rect key="frame" x="0.0" y="20"
width="320" height="499"/>
                                    <subviews>
                                        <datePicker
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="center" contentVerticalAlignment="center"
datePickerMode="dateAndTime" minuteInterval="1"
translatesAutoresizingMaskIntoConstraints="NO" id="Gcs-2k-LGd">
                                            <rect key="frame" x="0.0"
y="337" width="320" height="162"/>
```

```xml
                                        <date key="date"
timeIntervalSinceReferenceDate="442283107.06223398">
                                            <!--2015-01-07 00:25:07
+0000-->
                                        </date>
                                    </datePicker>
                                    <pickerView
contentMode="scaleToFill" fixedFrame="YES"
translatesAutoresizingMaskIntoConstraints="NO" id="OYv-AJ-rJK">
                                        <rect key="frame" x="0.0" y="-
1" width="320" height="162"/>
                                    </pickerView>
                                    <pickerView
contentMode="scaleToFill" fixedFrame="YES"
translatesAutoresizingMaskIntoConstraints="NO" id="tKX-NU-NbL">
                                        <rect key="frame" x="0.0"
y="169" width="320" height="162"/>
                                    </pickerView>
                                    <label opaque="NO"
userInteractionEnabled="NO" contentMode="left"
horizontalHuggingPriority="251" verticalHuggingPriority="251"
fixedFrame="YES" text="Date:" lineBreakMode="tailTruncation"
baselineAdjustment="alignBaselines" adjustsFontSizeToFit="NO"
translatesAutoresizingMaskIntoConstraints="NO" id="G2I-vJ-s0E">
                                        <rect key="frame" x="8"
y="337" width="99" height="21"/>
                                        <fontDescription
key="fontDescription" type="system" pointSize="17"/>
                                        <color key="textColor"
cocoaTouchSystemColor="darkTextColor"/>
                                        <nil key="highlightedColor"/>
                                    </label>
                                    <label opaque="NO"
userInteractionEnabled="NO" contentMode="left"
horizontalHuggingPriority="251" verticalHuggingPriority="251"
fixedFrame="YES" text="Location:" lineBreakMode="tailTruncation"
baselineAdjustment="alignBaselines" adjustsFontSizeToFit="NO"
translatesAutoresizingMaskIntoConstraints="NO" id="Qrl-xo-znr">
                                        <rect key="frame" x="8"
y="169" width="72" height="21"/>
                                        <fontDescription
key="fontDescription" type="system" pointSize="17"/>
                                        <color key="textColor"
cocoaTouchSystemColor="darkTextColor"/>
                                        <nil key="highlightedColor"/>
                                    </label>
                                    <label opaque="NO"
userInteractionEnabled="NO" contentMode="left"
horizontalHuggingPriority="251" verticalHuggingPriority="251"
fixedFrame="YES" text="Catergory:" lineBreakMode="tailTruncation"
baselineAdjustment="alignBaselines" adjustsFontSizeToFit="NO"
translatesAutoresizingMaskIntoConstraints="NO" id="qxC-BF-uwm">
                                        <rect key="frame" x="8"
y="0.0" width="81" height="21"/>
                                        <fontDescription
key="fontDescription" type="system" pointSize="17"/>
                                        <color key="textColor"
cocoaTouchSystemColor="darkTextColor"/>
                                        <nil key="highlightedColor"/>
```

```
                                            </label>
                                        </subviews>
                                    </scrollView>
                                </subviews>
                                <color key="backgroundColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                            </view>
                            <navigationItem key="navigationItem" id="Lnj-a6-
3fT"/>
                        </viewController>
                        <placeholder placeholderIdentifier="IBFirstResponder"
id="Zj4-F1-g4L" userLabel="First Responder"
sceneMemberID="firstResponder"/>
                    </objects>
                    <point key="canvasLocation" x="705" y="884"/>
                </scene>
                <!--Navigation Controller-->
                <scene sceneID="Y0h-7f-K7r">
                    <objects>
                        <navigationController id="Gvo-S5-D48"
sceneMemberID="viewController">
                            <navigationBar key="navigationBar"
contentMode="scaleToFill" id="rHJ-2X-fdh">
                                <rect key="frame" x="0.0" y="0.0" width="320"
height="44"/>
                                <autoresizingMask key="autoresizingMask"/>
                            </navigationBar>
                            <connections>
                                <segue destination="hnZ-WV-JTB"
kind="relationship" relationship="rootViewController" id="noa-DR-
jic"/>
                            </connections>
                        </navigationController>
                        <placeholder placeholderIdentifier="IBFirstResponder"
id="gnF-b3-Iea" userLabel="First Responder"
sceneMemberID="firstResponder"/>
                    </objects>
                    <point key="canvasLocation" x="-343" y="-555"/>
                </scene>
                <!--Home-->
                <scene sceneID="7tl-lj-bJD">
                    <objects>
                        <viewController title="Home" id="hnZ-WV-JTB"
sceneMemberID="viewController">
                            <layoutGuides>
                                <viewControllerLayoutGuide type="top" id="nN0-
oc-jKE"/>
                                <viewControllerLayoutGuide type="bottom"
id="3Uq-ci-aey"/>
                            </layoutGuides>
                            <view key="view" contentMode="scaleToFill"
id="HGC-UF-lKt">
                                <rect key="frame" x="0.0" y="0.0" width="320"
height="568"/>
                                <autoresizingMask key="autoresizingMask"
widthSizable="YES" heightSizable="YES"/>
                                <subviews>
                                    <toolbar opaque="NO"
clearsContextBeforeDrawing="NO" contentMode="scaleToFill"
```

```
fixedFrame="YES" barStyle="black"
translatesAutoresizingMaskIntoConstraints="NO" id="KKd-i1-QHs">
                                <rect key="frame" x="0.0" y="20"
width="320" height="44"/>
                                <color key="backgroundColor"
white="0.0" alpha="1" colorSpace="calibratedWhite"/>
                                <items>
                                    <barButtonItem title="Account"
id="Bq9-kR-zef">
                                        <connections>
                                            <segue destination="Hhs-
MC-rvb" kind="push" id="bXx-Z3-jxi"/>
                                        </connections>
                                    </barButtonItem>
                                </items>
                                <color key="tintColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                                <color key="barTintColor" white="0.0"
alpha="1" colorSpace="calibratedWhite"/>
                            </toolbar>
                            <label opaque="NO"
userInteractionEnabled="NO" contentMode="left"
horizontalHuggingPriority="251" verticalHuggingPriority="251"
fixedFrame="YES" text="King" lineBreakMode="tailTruncation"
baselineAdjustment="alignBaselines" adjustsFontSizeToFit="NO"
translatesAutoresizingMaskIntoConstraints="NO" id="M11-S9-f7H">
                                <rect key="frame" x="139" y="30"
width="42" height="24"/>
                                <fontDescription key="fontDescription"
type="boldSystem" pointSize="20"/>
                                <color key="textColor" red="1"
green="0.77909023513829601" blue="0.25018691241381685" alpha="1"
colorSpace="calibratedRGB"/>
                                <nil key="highlightedColor"/>
                            </label>
                            <imageView userInteractionEnabled="NO"
contentMode="scaleToFill" horizontalHuggingPriority="251"
verticalHuggingPriority="251" fixedFrame="YES" image="taj.png"
translatesAutoresizingMaskIntoConstraints="NO" id="MIg-Uo-uOH">
                                <rect key="frame" x="0.0" y="62"
width="320" height="367"/>
                                <color key="backgroundColor"
cocoaTouchSystemColor="darkTextColor"/>
                            </imageView>
                            <button opaque="NO"
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="center" contentVerticalAlignment="center"
buttonType="roundedRect" lineBreakMode="middleTruncation"
translatesAutoresizingMaskIntoConstraints="NO" id="Lm8-Dw-pU0">
                                <rect key="frame" x="40" y="168"
width="60" height="37"/>
                                <fontDescription key="fontDescription"
type="system" pointSize="1"/>
                                <state key="normal" title="cc">
                                    <color key="titleColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                                    <color key="titleShadowColor"
white="0.5" alpha="1" colorSpace="calibratedWhite"/>
                                </state>
```

```
                                        <connections>
                                            <segue destination="28c-wE-i9K"
kind="push" id="Ccq-5G-Xn6"/>
                                        </connections>
                                    </button>
                                    <button opaque="NO"
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="center" contentVerticalAlignment="center"
buttonType="roundedRect" lineBreakMode="middleTruncation"
translatesAutoresizingMaskIntoConstraints="NO" id="nuS-bw-I4H">
                                        <rect key="frame" x="127" y="132"
width="63" height="40"/>
                                        <fontDescription key="fontDescription"
type="system" pointSize="1"/>
                                        <state key="normal" title="ci">
                                            <color key="titleColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                                            <color key="titleShadowColor"
white="0.5" alpha="1" colorSpace="calibratedWhite"/>
                                        </state>
                                        <connections>
                                            <segue destination="VV9-3k-Rhu"
kind="push" id="C7p-g4-r7c"/>
                                        </connections>
                                    </button>
                                    <button opaque="NO"
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="center" contentVerticalAlignment="center"
buttonType="roundedRect" lineBreakMode="middleTruncation"
translatesAutoresizingMaskIntoConstraints="NO" id="btX-Tq-EzE">
                                        <rect key="frame" x="119" y="227"
width="82" height="38"/>
                                        <fontDescription key="fontDescription"
type="system" pointSize="1"/>
                                        <state key="normal" title="city">
                                            <color key="titleColor"
white="0.33333333333333331" alpha="1" colorSpace="calibratedWhite"/>
                                            <color key="titleShadowColor"
white="0.5" alpha="1" colorSpace="calibratedWhite"/>
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                                        <connections>
                                            <segue destination="ViV-gj-Q4H"
kind="push" id="sum-ie-Egj"/>
                                        </connections>
                                    </button>
                                    <button opaque="NO"
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="center" contentVerticalAlignment="center"
buttonType="roundedRect" lineBreakMode="middleTruncation"
translatesAutoresizingMaskIntoConstraints="NO" id="jG0-yb-VSV">
                                        <rect key="frame" x="91" y="292"
width="135" height="39"/>
                                        <fontDescription key="fontDescription"
type="system" pointSize="1"/>
                                        <state key="normal" title="sar">
                                            <color key="titleColor"
white="0.33333333333333331" alpha="1" colorSpace="calibratedWhite"/>
                                            <color key="titleShadowColor"
white="0.5" alpha="1" colorSpace="calibratedWhite"/>
```

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                                    </state>
                                    <connections>
                                        <segue destination="i4d-o7-Vyc"
kind="push" id="rRD-S2-gmF"/>
                                    </connections>
                                </button>
                                <button opaque="NO"
contentMode="scaleToFill" fixedFrame="YES"
contentHorizontalAlignment="center" contentVerticalAlignment="center"
buttonType="roundedRect" lineBreakMode="middleTruncation"
translatesAutoresizingMaskIntoConstraints="NO" id="tC8-ba-sTR">
                                    <rect key="frame" x="217" y="164"
width="62" height="46"/>
                                    <fontDescription key="fontDescription"
type="system" pointSize="1"/>
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                                        <color key="titleColor" white="1"
alpha="1" colorSpace="calibratedWhite"/>
                                        <color key="titleShadowColor"
white="0.5" alpha="1" colorSpace="calibratedWhite"/>
                                    </state>
                                    <connections>
                                        <segue destination="gUD-9o-frX"
kind="push" id="mgg-SJ-W7u"/>
                                    </connections>
                                </button>
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                            <color key="backgroundColor"
cocoaTouchSystemColor="darkTextColor"/>
                        </view>
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image="icon.png" selectedImage="icon.png" id="lMY-4E-dvE"/>
                        <navigationItem key="navigationItem" id="FkH-H1-
R14"/>
                    </viewController>
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sceneMemberID="firstResponder"/>
                </objects>
                <point key="canvasLocation" x="-343" y="160"/>
            </scene>
        </scenes>
        <resources>
            <image name="icon.png" width="39" height="32"/>
            <image name="my reports2.png" width="22" height="28"/>
            <image name="taj.png" width="321" height="366"/>
        </resources>
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            <simulatedStatusBarMetrics key="statusBar"/>
            <simulatedOrientationMetrics key="orientation"/>
            <simulatedScreenMetrics key="destination" type="retina4"/>
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        <inferredMetricsTieBreakers>
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        </inferredMetricsTieBreakers>
</document>
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