Usability, accessibility and responsive web design utilizing Google Maps API

Marianna Kapari
Abstract

Usability, accessibility and responsive web design utilizing Google Maps API

Marianna Kapari

This Master’s thesis describes the development and evaluation of a responsive, map-based website intended to support book sharing in public places. The book sharing concept focuses on allowing a user to locate a book in a public place, register it online and share it again once they have finished reading it.

In order to measure the usability of the website, two tests were conducted, which compared the website with another website for book sharing. The first test was conducted using questionnaires, with 24 participants, whereas the second test focused on observations and interviews with four participants.

Moreover, in order to measure the accessibility of the thesis website, an expert evaluation and an evaluation using accessibility evaluation tools were conducted.

The results from the usability tests showed a need for improvements, for instance in the form of supporting documentation and addition of undo/redo options. The results of the expert review were positive while the results of the accessibility tools showed compatibility issues depending on the browser that the website is accessed with.
Acknowledgement

I would like to thank my parents for their understanding and support throughout this master degree. It was a decision that had its difficulties but in the end it worth. I would also like to thank my friends who supported me and gave me courage while going abroad to study. In addition, I would like to thank anyone who participated in the website test as their answers were beneficial for the completion of this thesis. Moreover, I would like to thank Mats Lind for his assistance and support on the thesis report.

I would like to end this acknowledgement page with a quote from Anais Nin (The Diary of Anaïs Nin, Vol. 7: 1966-1974):

“We travel, some of us forever, to seek other states, other lives, other souls.”

This thesis is dedicated to my mum; I miss you so much.

Thank you,
Marianna
# Contents

1 Introduction and project purpose .................................................. 8  
1.1 Purpose ..................................................................................... 9  
1.2 Research Question .................................................................... 9  

2 Terminology .................................................................................... 10  
2.1 About maps ............................................................................... 10  
2.2 Geographic Information Systems .............................................. 10  
2.3 Web mapping ............................................................................ 11  
2.4 Web accessibility ....................................................................... 11  
2.5 Percentage of users of mobile devices accessing the web ........... 12  
2.6 Responsive Web design ............................................................ 12  

3 Background .................................................................................... 14  
3.1 Online community ..................................................................... 14  
3.2 Online communities and web mapping applications ................. 14  
3.3 Library systems and web mapping applications ......................... 15  
3.4 Usability .................................................................................... 15  
3.4.1 Usability testing methods .................................................... 15  
3.5 More on Questionnaires ........................................................... 19  
3.5.1 Questionnaire types ............................................................. 19  
3.5.2 Questionnaire’s question styles ............................................ 19  

4 Methods .......................................................................................... 21  
4.1 Literature reviews ..................................................................... 21  
4.1.1 Mobile usability and history of geographic locations ............ 21  
4.1.2 Accessibility ......................................................................... 21  
4.2 Design and implement a prototype ............................................ 21  
4.3 Evaluate the usability of the new design ................................... 22  
4.3.1 Questionnaires .................................................................... 22  
4.3.2 Usability testing using Observations .................................... 23  
4.3.3 Interviews ............................................................................ 24  
4.3.4 Expert evaluation of the website’s accessibility ................. 25  

5 Results ............................................................................................ 26  
5.1 Results of the literature search .................................................. 26  
5.1.1 General issues of mobile design ......................................... 26  
5.1.2 Responsive Web Design ...................................................... 36  
5.1.3 Geographic data representation .......................................... 37  
5.1.4 Usability issues of Geographic Information Systems ........... 40  
5.1.5 Results of the literature review on accessibility ................. 41  
5.2 Implementation of the design of a prototype .............................. 44  
5.2.1 Layout of the website .......................................................... 44  
5.2.2 Presentation of the website’s pages .................................... 44  
5.2.3 Database Model ................................................................. 49  
5.3 Usability evaluation of the design ............................................. 50  
5.3.1 Questionnaire results ........................................................ 50  
5.3.2 Observations and Interviews .............................................. 52
5.3.3 Comments on the websites from the observations and interviews .......................... 54
5.3.4 Expert review on accessibility ................................................................. 55
5.4 Summary and analysis of the usability evaluation ........................................... 56
5.5 Redesign .................................................................................................... 56

6 Conclusion and Discussion ............................................................................. 59

7 Future Work .................................................................................................. 60
1 Introduction and project purpose

This Master’s thesis is an enhanced version of the bachelor thesis that was written in 2013 under the title “Usability enhancement of bookcrossing.com website with the implementation of a book tracing functionality utilizing Google Maps” (Kapari, 2013). The bachelor thesis focused on the concept of the bookcrossing website, which is that a user can locate a book that another person has left in a public place, find an id that is in the book (this id is a reference that the book is from bookcrossing.com), register the book online and share it again once they have finished reading it (Thurston S, 2011). By registering the book online then other users can locate the books. The concept of bookcrossing dates back to 2001 when Ron Hornbaker launched the website bookcrossing.com (Reading worldwide, 2012) that now serves as a portal of almost 1.6 million bookcrossing followers. With the use of this website, 11 million books have traveled to 132 countries (Bookcrossing.com, 2016).

In the bachelor thesis, a website that allowed its users to add/edit and search for books that other users had added to the system was implemented. The website was a simpler version of bookcrossing without containing all the extra functionalities that bookcrossing offers such as a forum or a store. In addition, the Google Maps API was used in order for the users to see the book results on a map format or add/edit a book with the use of a map. The Google Maps API could be shown on a specific set of web pages so as to show books that the users have around the world or so as to add a book in the database or edit an existing book. The Google Map could be shown with the use of PHP and MySQL. Data were added in a database using MySQL code and handled using various queries and PHP code and presented in a table and Google Maps format. For the master’s thesis website’s database data, latitude and longitude were used, and once the user click on the map the coordinates of the countries that the books were found.

The master’s thesis website’s purpose is to allow a user to be able to search for a book in the database, to add or edit a book or to see the history of a book. The user can either be a member or a regular visitor without a membership. The website as mentioned previously, has been developed using the concept of bookcrossing and the master’s thesis website does not have all the features of the bookcrossing website (such as a store, a forum) as it focuses solely on the search/adding/editing of books. A user can use the search bar of the website that is located on the home page and look for a specific keyword such as the author of the book, a country (so as to see where the books are located, from which users and which are the book titles), a location or a user’s username. If the user is a visitor of the website and not a member, they cannot perform certain tasks such as adding or editing a book but can see the books that exist in the database as well as their history. If the user becomes a member, then they can have access to additional features such as adding or editing of books. Furthermore, the database’s information, which appear once the user searches for a particular keyword, will appear on a Google Map with specific markers and a table below the map showing in a detailed manner the book’s country, title and so on. In the case that there is no book with the title or author name that the user is looking for, then an appropriate message will appear so as to indicate this.
1.1 Purpose
In this master’s thesis, the main focus is on redesigning the existing design solution of the bachelor thesis website in order to be highly usable on a mobile device and to find a usable way of representing the history of the books.

1.2 Research Question
In order to fulfill the purpose, the following research questions were formulated:

- How can the design solution be adapted to a mobile phone in order to be highly usable for users with normal vision as well as for people with impaired vision
- How can the history of the books be shown in a usable way
2 Terminology

In this section various terms that will be used on the master’s thesis website (the mobile version) will be described. The terms that will be described are: map, GIS, web mapping, responsive web design and web accessibility. All of these terms are important because the master’s thesis website will be on a mobile version (responsive web design term) utilizing Google Maps API in order to perform certain tasks such as adding, editing or searching books. Moreover, the term web accessibility is described because an expert evaluation will be conducted following a set of guidelines in terms of the accessibility of the mobile version of the website.

2.1 About maps

A map is a representation of the world. There are different kinds of maps such as a mental map that can be stored in the brain, a printed map or a map that can be accessed online. A dynamic map is a map which is subject to a change or an interactive representation of the earth. A dynamic map can be shown via a mobile or other device and refers to how this kind of map can be delivered to the end user as well as how it can be used, rather than to its content. The most important part of a dynamic map is that it targets a wider group of people rather than practitioners of GIS. Additionally, a dynamic map allows the user to perform changes to the map, zooming in or out or selecting different map features of their interest (such as to show or hide a road or animation and so on) (Campbell and Shin, 2011).

2.2 Geographic Information Systems

The term G.I.S or else Geographic Information Systems is part of the field of Information technology and focuses on questions relating to the what, when, how, why, where of the world. GIS is about maps and other aspects such as the visualization, organization, analysis of information and data derived from different historical periods (Campbell and Shin, 2011). GIS can be a computer program, a service that can be accessed online, a tool or a system. As a computer program, GIS is used in order to be able to store, edit, process and present information relating to geographic data and maps. Furthermore, mobile and online mapping services as well as location-based ones, focus on promoting mapping applications to a greater number of people (Campbell and Shin, 2011). Geographic Information systems focus on concepts such as maps and mapping services. A map is important as it serves both as an input and output. Additionally, geographic information systems use concepts from cartography, maps and mapping (Campbell and Shin, 2011). A technique used in G.I.S is polylines. Esri defines the term polyline as “a shape defined by one or more paths, in which a path is a series of connected segments. If a polyline has more than one path (a multipart polyline), the paths may either branch or be discontinuous” (Esri, 2016).
2.3 Web mapping

In the last few years, the demand of using mapping applications is quite high and this is a result of using web mapping APIs. An API, or else an application program interface, is a set of functions and classes which allow a user to perform some tasks without having to create everything from the beginning. There are different web mapping APIs that exist, such as Google Maps API, Bing Maps, OpenLayers, Leaflet and many others depending on the users’ needs. Some of those web mapping services are free and others are free to try for a specific period of time (Penn-state, 2014).

In order to be able to describe an earth point, the terms latitude and longitude are used. Latitude and longitude coordinates are used by GPS devices as well as web mapping applications. These coordinates show different earth locations and may have an error of two centimeters. The values of latitude and longitude coordinates are of decimal type (DuVander, 2010). Additionally, the latitude and longitude coordinates have positive and negative values. Latitude values can be found in the vertical axis providing information on how north or south can a location be. Furthermore, the value zero for the latitude coordinate is the equator. The longitude values can be found in the horizontal axis providing information on how east or west can a location be. Due to the reason that there was no natural equator, then it was decided, by the scientists and politicians, to use the zero value (DuVander, 2010).

2.4 Web accessibility

Web accessibility refers to the concept that people having disabilities are able to access the web. A person with disabilities (motor, cognitive, hearing, auditory, neurological etc) just like someone having no disabilities can navigate a website, interact, write something on the web. Besides people with disabilities, elderly people that acquire a disability due to aging factors, are benefited so as to access the web (Oestreicher, 2011). Additionally, users with low bandwidth internet connections, new users or users who are not frequent visitors of the website, as well as users who are not fluent in the language or have low literacy, can be benefited by any accessibility improvements on the website (Thatcher, 2006). An example of web accessibility is to use the alt attribute within the html code. This alt attribute is used in an image that is displayed and is used when a person is blind instead of having the image displayed on the browser. The text is written in order to describe what is this image about. The code that is written in html in order to show this alt attribute is the following:

```html
<img src="sun.jpg" alt="a picture of the sun"/>
```

The above html code shows that there is an image with the title sun and the alt attribute describes that this image is a picture showing the sun. The alt attribute can be a) read by browsers supporting voicing options and from screen readers, b) can be displayed by any graphical browser in the case that the pictures cannot be downloaded and c) can be displayed by any text browser (Thatcher, 2006).
2.5 Percentage of users of mobile devices accessing the web

The adaptation of the website on a mobile version was due to the excessive use of mobile devices in the recent years so as to access a website. According to Bosomworth (2015), the percentage of mobile users have exceeded in relation to the previous years. 80% of the users use smartphone devices, 47% tablets and more than 90% computers. Other devices, which are gaining a greater user access, are smart TVs, smart watches and smart wristbands. A higher percentage of users using mobile devices, spent most of their time through mobile applications (this results to an 80% percent of users) whereas a smaller percentage (around 8%) prefers accessing the web. The responsive adaptation is used in order to answer the research question "How can the design solution be adapted to a mobile phone in a highly usable way?"

2.6 Responsive Web design

The term Responsive Web design, was coined by Ethan Marcotte and refers to the adaptation of techniques that adjust to the user’s needs as well as the devices that the user will use. For example, a user may use a laptop device, a smartphone or a tablet in order to access a website. If the user accesses a website from their laptop device, they will have a wider screen size so as to be able to see all the information that they need. Whereas, the same website designed for a laptop would be more challenging to be accessed from a tablet or smartphone device. Therefore, when the user switches from a laptop to a smartphone or tablet device, the website is adjusted according to the screen size of that device. With this automatic adjustment, there is no need to create a different design for smartphone or tablet devices(Knight, 2011).

In order to adjust the device’s characteristics what is needed is to make modifications on the website’s code. Therefore, at the css declaration in the html document, is declared the media type and the device width. An example can be the following:

```html
<link rel="stylesheet" type="text/css" media="screen" and (max-device-width: 480px)" href="stylesheet.css" />
```

(Marcotte, 2010)

The above code excerpt shows that there is a link to a stylesheet (css type) and if the device that is used is of a smaller screen size such as less than 480 pixels then that stylesheet.css will be accessed, otherwise, this option will be ignored (Marcotte, 2010).

The term responsive web design does not refer only to the screen size of a device but also on how web design is perceived. Nowadays, due to technological advances, smartphones or tablet devices offer their users the choice of accessing their favorite website or media either in landscape or portrait mode. Up until recently, the only elements that could be adjusted to a website were the text and the columns. In recent years, a website can be more responsive in other ways besides columns and text, such as by resizing images to fit the screen size of the devices, by changing the structure of the layout (by having a different stylesheet document or by using code for media queries as presented at the code excerpt above), by using javascript code (using javascript so that it automatically detects
the screen size of the devices and adjusts the stylesheet accordingly)(Knight, 2011).

According to the magazine Web designer (2015), the navigation menu is important. If the navigation is complicated on the desktop version of the website then it would be difficult to have this navigation on a mobile or tablet version. It is suggested that it is better to use a menu that collapses or to keep in a higher visibility range the links, which are of most importance. Additionally, is suggested to use navigation icons that bring the concept of familiarity to the end-user without having any problem identifying them. Furthermore, it is mentioned that a form which is big in size causes no problem to the desktop version of a website whereas to a smaller device this may be problematic due to the screen size’s space. For a smaller device, it is suggested to break down the forms into smaller parts.
3 Background

This section focuses on related work in the field as well as provides an explanation of the evaluation methods used in the usability testing.

3.1 Online community

An online community is a virtual space which allows people to connect in order to exchange resources or information, to share common interests, to socialize or to explore their creativity. An important aspect of an online community is knowledge collaboration in which the members combine their knowledge in order to have a personal benefit as well as to contribute to the community’s worth. Example of knowledge collaboration include: wikipedia which allows users to add information to various articles, or an open source website that allows many people to collaborate with each other (Faraj, Jarvenpaa and Majchrzak, 2011).

An example of an online community is bookcrossing. As mentioned previously the concept of bookcrossing.com is that a user can find a book that another person has left in a public place, find a corresponding id that is in the book (this id is a reference that the book is from bookcrossing.com), register the book online and once they finish reading it, another user can read it (Thurston S, 2011). In addition to bookcrossing, there are various other websites offering similar services such as BookMooch which allows a user to share books with other users. It is a free service and the only cost that it has, is for the user to mail the book to another user. There is also the concept of points which lets the user receive one point when they give away a book and a tenth of a point whenever they add a book in the system. The term mooch refers to the concept of taking something without having to pay for it and without having to return it. Therefore, BookMooch stands for taking books without having to pay for them and without having the intention to return them afterwards. The concept of BookMooch was created by John Buckman. (Bookmooch.com, n.d.)

3.2 Online communities and web mapping applications

In recent years, web mapping applications have been popular and so their use has been extended to different websites. An example of the use of web mapping applications is in online communities. Flickr, which is a community that allows users to share pictures, uses Yahoo!Maps so as to allow users to add the location of the pictures that they have taken. Another example is Picasa, which allows users to organize their photos. Picasa uses Google Earth and allows its users to select the location in which they have taken their pictures. In addition to the use of Google Earth and Yahoo!Maps, another online community which uses Google Maps, is the Zoomr . This community focuses on photo sharing and allows its users to tag the location of the pictures. This service has an accurate geotagging process (Scharl and Tochtermann, 2007).
3.3 Library systems and web mapping applications

Web mapping applications have also been used in library systems. For example, the Texas A and M University’s library system allows the users to locate items using maps which display relevant information (Johnston and Jensen, 2009). The library of McMaster University has made available a digitized version of a historical map. They embedded Google Maps in their website and when the user clicks on an area of their choice, then relevant images appear. Moreover, the library of University of Vermont, embedded a Google Map in its website. When the user clicks various markers on the map they will be directed to the Long Trail Collection of the library, which contains thousands of images. The library of Cleveland State University has added markers on the Google Map allowing its users to click on them and read additonal information (Dodsworth and Nicholson, 2012).

3.4 Usability

According to International Standards Organization (ISO 9241-11, 1998, p.6), usability, refers to "the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use."

3.4.1 Usability testing methods

Usability testing is any technique that allows the evaluation of a product or system. This technique requires users to perform tasks in order to evaluate the product and also to be observed during this process. The tests that can range from tests with one participant to tests with many participants (Rubin and Chisnell, 2008).

The following usability testing methods can be used:

**Hallway testing:** This method focuses on choosing people in a random order. An example is people walking on the street, family, friends or other people in the same work environment. The choice of participants depends on the needs of the project. What is important is to answer questions regarding who and why as well as how much. Furthermore, the qualitative tests should be conducted with five people and the quantitative ones with at least 20 people (Bank and Cao, n.d.).

**Remote Usability Testing:** This method focuses on using people who are in different locations in order to be able to test the website. There are specific tools that can be used so as to be able to record the user’s screen and see how long it took them to be able to complete the tasks (Churm, 2012). In remote usability testing, the participant or the facilitator is not required to travel. This kind of testing provides a solution at times where there is a tight budget or people, who are located in different locations. People use their own devices in order to perform tasks thus allowing the project team to see how the participants use their devices. There are two types of remote usability testing: moderated and unmoderated. Moderated remote testing is when the facilitator and the participant are online at the same time thus allowing the facilitator to watch the test
observations, a participant is being watched and his/her thoughts can be heard while performing a set of tasks. In order to be prepared for an observation the following aspects need to be considered:

Set an objective: This part involves understanding what needs to be tested and what is not.
Design the tasks: A set of tasks will be given to the participants. These tasks will be tasks that the users of the product will most likely perform.
Using video: The recording of video is a good source of gaining information from the observation.
Determining the setting: A setting that could be ideal for an observation could have all the hardware and software needed, microphones, cameras. A setting is also not easily available therefore it is suggested to have a setting that is close to the ideal one.
Representative users: For the testing of the product, it is suggested to contact people who have a level of experience with the technology that is used in the product and also not people who are familiar with the product. (Gomoll and Nicol, 1990)

The observations were an important part of the master thesis website testing. The participants observed while they performed a set of tasks that related to bookcrossing website and the master thesis mobile version website. Further, information in relation to the questionnaires, observations and interviews can be found in the section 5: Results.

Expert Review: This method focuses on using an expert in order to evaluate a website. The test is either conducted at the premises of the company who wants the website to be tested or is conducted remotely with the results to be sent out for review (Churm, 2012). Expert review is also known as heuristic evaluation. This method was developed by Nielsen and Molich (Korhonen, Paavilainen and Saarenpää, 2009). In expert review, an expert evaluates the product by following a set of guidelines or principles. This type of method is popular as it is quick to be conducted as well as cheap. The guidelines that most experts follow are the following: Visibility of system status (The system needs to provide its users with appropriate feedback so that the they will understand if the actions they performed are prone to error or if they are performed correctly), Match between system and the real world (The system needs to present information in the user’s language and not using system terms), User control and freedom (the ability of the user to be able undo or redo a specific action), Consistency and standards (the system needs to be consistent), Error prevention (to prevent system errors), Recognition rather than recall (the user does not need to remember all the information of previous tasks, therefore information need to be as less as possible. Also, in the case that the system provides instructions to the users so as to complete a specific task, the instructions need
to be clear and visible), Flexibility and efficiency of use (the ability of performing different tasks by a novice or expert user. An example is to use keyboard shortcuts), Aesthetic and minimalist design (information presented needs to be clear, visible and information that is irrelevant needs to be diminished), Help users recognise, diagnose, and recover from errors (whenever an error occurs, the user needs to be able to understand the error message that will appear and to be able to recover from the error by following the set of instructions given) and Help and documentation (it refers to using documentation so that the user will be able to locate easily information that they may be looking for in order to accomplish certain tasks) (Travis, 2007).

**Paper prototype testing:** This method focuses on creating sketches on paper that will represent the product before coding has began (Churm, 2012).

**Controlled Experiments:** This method refers to the comparison of two products in a laboratory setting. It may be difficult to be conducted but the results of it, are accurate (Churm, 2012).

**Lab test:** There are various setups relating to lab test:
- Simple single-room setup,
- Modified single-room setup,
- Large single-room setup,
- Electronic observation room setup,
- Classic testing laboratory setup (Rubin and Chisnell, 2008)

Simple single-room setup: It is a basic type of setup. This setup represents the minimum environment which is required in order to accommodate observers. In the same room there is the participant and close to them is the test moderator. The test moderator is located at a 45 degree angle of the participant and this is because they need to be close to the participant but not very close to them (Rubin and Chisnell, 2008).

Modified single-room setup: The room in this setup is larger. The test moderator is not close to the participant but is located at a desk far behind them. At his desk there is a laptop and a monitor so as to view the participant’s screen and face (Rubin and Chisnell, 2008).

Large single-room setup: It is the same concept as of the simple single-room setup though in this setup the room is larger. Furthermore, in this setup more observers can be accommodated during each session (Rubin and Chisnell, 2008).

Electronic observation room setup: The observers are not in the testing room and can see the testing process via a monitor. The test moderator is located close to the participant. The communication among the test moderator and the observers is either face to face, by using notes during the session breaks, by using instant messaging or at the end of the session (Rubin and Chisnell, 2008).

Classic testing laboratory setup: In this setup the test moderator and the observers are located in one room and the participant in another room. The test moderator and the observers view the testing session via a monitor. The
communication of the moderator and the participant is conducted using micro-
phones or by using video cameras and other equipment. 
(Rubin and Chisnell, 2008).

**Questionnaires:** The term questionnaire refers to questions that are given to people in order to answer to them without the investigator being present. The questionnaire can be either online or on paper format (Rogers, Sharp and Preece, 2011)

**Interviews:** An interview refers to questions that can be posed to participants so that they they will give specific answers. An interview can be face to face interviews, group interviewing, telephone interview or by utilizing other equipment such as a computer. There are various interview types: structured, unstructured, semi-structured, informal interviews and focus groups (Robert Wood Johnson Foundation, 2008).

Structured interviews: This type of interview has a predefined set of questions which follow the same order to all of the participants being interviewed. In addition, the questions are the same to all of the participants. In this type of interviews, the questions are open ended, meaning that questions are posed to the participants so as to share their opinion (Robert Wood Johnson Foundation, 2008).

Unstructured interviews: This type of interviews have questions which are open ended and they do not follow a particular structure. The interview time limit varies. The interviewer asks questions to the participants and the conversation continues depending on their responses(Robert Wood Johnson Foundation, 2008).

Semi-structured interviews: These types of interviews have a more formal format. The interviewer creates a list of questions and topics that they would like to discuss with the participant. Moreover, the interviewer can follow this structure but they can also make necessary changes to it when possible (Robert Wood Johnson Foundation, 2016).

Informal interviews: These interviews have an informal style; they do not follow a structured way. This type of interview, is combined with observations and is referred to as casual conversation that takes place during an observation. Focus Groups: This is another interview type. Data, from focus groups, are collected utilizing the semi-structured interview style. In the focus groups, there is a person who will be the group leader (Robert Wood Johnson Foundation, 2008).

In the master thesis, the interview type that has been used is the structured one. The questions were predefined and the same set of questions and in the same order were asked to the participants.

Various tools can be used so as to record a usability testing such as Morae studio, Camtasia. Those tools are helpful as they record the computer screen as well as to track user behaviors such as mouse clicks (Rubin and Chisnell, 2008).
3.5 More on Questionnaires

The term questionnaire refers to questions that are given to people in order to answer them without the investigator being present. The questionnaire can be either online or in a paper format (Rogers, Sharp and Preece, 2011).

There are various formats of questionnaires being used: an online version which can be located either via e-mail or on a website, or a paper format (Rogers, Sharp and Preece, 2011). The questionnaires that have been used for the master thesis project follow the website format of questionnaires. The questionnaires have been created using the Google drive’s Google Forms option for questionnaire creation.

3.5.1 Questionnaire types

There are two types of questionnaires which are: the structured and the unstructured questionnaires. In this subsection, these types of questionnaires will be discussed as well as which type of questionnaire was chosen for the master thesis project.

Structured questionnaires: This type of questionnaire is designed in advance, it has a set of specific questions and allows a formal inquiry initiation. Unstructured questionnaire: This type of questionnaire is used while conducting an interview, it serves as a guide to the interviewer and it is flexible. (Singh, 2010)

For the master thesis project the type of questionnaire that was used was the structured questionnaire. Participants were given in advance the questionnaire that they had to fill in after the completion of a set of tasks.

3.5.2 Questionnaire’s question styles

A questionnaire can have various question styles. In this subsection the question styles will be described.

Open-ended questions: In these questions the participants are able to express their opinion towards the subject matter. The participants do not have any limit on how to reply to that question (McLeod, 2008).

Close-ended questions: This question style refers to questions being answered with either yes or no or questions having other alternatives (Singh, 2010). The set of questions offering yes or no answers allows to obtain results which will be easily convertible to quantitative data (McLeod, 2008). Moreover, closed questions do not allow the participant to express their opinion; they just provide a set of alternative options as answers (Singh, 2010).

In this master thesis the question style that will be used is both open ended and close ended questions. The open ended questions will be used in order to allow the participants to share their opinion. For the closed ended questions the Likert scale with values from 1 (strongly disagree) to 5 (strongly agree) will be used so that the participants can rate various aspects of the tasks that they had to perform and if they were easy or not.
A Likert scale is a scale that allows the measurement of attitudes or opinions. Participants are being asked a set of questions that they need to answer and their answer is in the format of agreeing or disagreeing. This type of scale can be a five (5) point scale or a seven (7) point scale or a nine (9) point scale (McLeod, 2008). In the master thesis project the likert scale will be used and will be in the five point scale format (1 - strongly disagree, 2- disagree, 3-undecided/neutral, 4-agree, 5-strongly agree).
4 Methods

In order to fulfill the research questions, the following methods were used:
- A literature review focusing on three aspects: usability of mobile phone apps, usability of GIS systems and mobile phone accessibility for the visually impaired
- Design and implement a prototype and
- Evaluate the prototype.

4.1 Literature reviews

4.1.1 Mobile usability and history of geographic locations

Literature search was conducted using scholar.google.com as well as the databases ACM, IEEE, SAGE Reference, Safari Online Books, Springer E-books and they were accessed in July, August 2015 and May 2016. The keywords used for the research were: mobile usability, responsive web design usability, Google Maps usability, GIS and usability, markers history on maps, line connection GIS.

4.1.2 Accessibility

Literature search for accessibility was conducted in July, August 2015 and May 2016. The databases that the literature search was conducted were: using the online search engine Google so as to locate websites in relation to accessibility, Springer E-books, ACM and IEEE. The keywords used for the research were: web accessibility, accessibility, mobile accessibility.

4.2 Design and implement a prototype

For the implementation of the mobile version of the master’s thesis website various tools and programming languages have been used. The master thesis website was developed using the tool Sublime Text 2 and the languages HTML, CSS, PHP, JavaScript as well as the database language MySQL. Additional tools such as Microsoft Expression Web 4, Adobe Photoshop and InkScape have been used. Microsoft Expression Web 4 was used in conjunction with Sublime Text 2. Adobe Photoshop and InkScape were used for the logo of the website. The logo was designed using InkScape and then Adobe Photoshop was used for additional changes.
4.3 Evaluate the usability of the new design

In this subsection can be found the evaluation methods used in the new design. The methods used are the questionnaires, observations and interviews. Moreover, an accessibility evaluation was conducted following the expert review method.

4.3.1 Questionnaires

The questionnaire’s aim was to understand how the participants perceive the master’s thesis website as well as the website in comparison which is bookcrossing. Moreover, by evaluating the bookcrossing.com website, which has a similar topic to the master thesis website, will yield to inspiration of new ideas and to encounter possible problems in order to be avoided to the master thesis website design. Furthermore, another aim was to understand if the users encountered any difficulty using those websites and what kind of problems they were. This particular aim is being answered with the use of open-ended questions allowing the participants to share their opinions in relation to both websites (the master’s thesis website and bookcrossing website). The aim of the close-ended questions was to see how usable different sections of both of the websites were found by the participants. In addition, a usability aim of the close-ended questions was in relation to the use of Google Maps as well as the book representation on a map format.

The questionnaire was created using Google Forms. It was divided in two sections. In the first section, the questions focused on the bookcrossing website and in the second section the focus was on the master’s thesis website. The number of questions were 24 in total including demographic information of the participants: gender, age. The questions in relation to bookcrossing website were 10 and the questions of the master’s thesis website were 11.

Open-ended questions were used in both sections of the questionnaire. One open-ended question was used for bookcrossing and two for the master thesis website. The remaining 18 questions were in a Likert scale format. Due to a misunderstanding, the Likert scale questions were not in the form of statements but in the form of questions. However, this difference was relatively minor and no survey participants indicated any problems in answering the survey questions.

The tasks and questionnaire were sent to a group of people via: a) facebook friends and acquaintances, b) bookcrossing forum, c) they were also given at the participants’ premises and d) forwarded to a group of students at Athens University of Business and Economics. The participants who were approached via facebook, received a facebook message asking them if they would like to participate in the survey. The people who accepted to take part in the survey, received a message with an attached document that had the tasks that they had to perform. At the end of the document, there was a link of the questionnaire. The participants had to perform all the tasks in order to proceed to the questionnaire. Furthermore, there is the group of participants who took part in the test and the test was conducted with the author’s presence at their premises. This group of participants, received a facebook message asking them if they would like to participate in the survey. The people who accepted to take part in the survey, saw the tasks’ document during the testing session. Moreover, another group of participants were from bookcrossing forum. A message in the
A forum was sent asking if the members wanted to participate in the survey. In that message, a relevant document with the tasks and questionnaire, was attached. A last group was a group of students at Athens University of Business and Economics. A student from that university forwarded the tasks document to the students in order to perform the tasks.

The following number of participants of the categories mentioned previously participated:
- One bookcrossing participant,
- Seven facebook participants,
- Nine people that the testing was conducted at their premises and
- Nine students from Athens University of Business and Economics

80 people were reached in order to participate on the questionnaire but 24 people eventually participated. From the 24 participants, 17 were females and seven (7) were males. The age group of participants varied with most of them belonging to the age groups of 20-25 and 26-30. The participants before filling in the questionnaires had to perform a test and perform a set of tasks that were given to them. The tasks focused on both of the websites and after their completion the participants were able to proceed to the questionnaire.

The tasks that the participants had to perform are the following:

**Bookcrossing website tasks:**
- Check the Registration page and log in
- Navigate on the homepage
- Search for a book in the database
- Check the FAQ page
- Change the language

**Master thesis website tasks:**
- Navigate on the homepage.
- Search for a book in the database
- Check the history of a book
- Become a member
- Forget your credentials
- Add a book in the database
- Edit a book.
- Check your book list.
- Search for a book while logged in and edit its history
- Resize text

**4.3.2 Usability testing using Observations**

The participants who participated in the questionnaire method did not participate in the observations and interviews. The participants in the observation were four (4). The participants belonged to the age groups of 20-25 and 26-30 of which two people belonged to the first age group and two to the second. Out of the four participants, two were males and two females. Moreover, for this test the participants that will be recruited will be smartphone or tablet users. They
will be people familiar with technology (due to smartphone or tablet). The observations aimed to understand how the participants performed different tasks while being observed at the same time. The tasks that the four participants performed were the same (except of the addition of two new tasks: register and release a book) as the ones that the questionnaire participants performed. Moreover, the main focus was on whether the use of Google Maps, so as to depict the history of books and to show book results, provided a usable outcome.

In addition, throughout the observation session, usability issues that were encountered by the participants could be depicted easier. Furthermore, another aim relating to the evaluation of bookcrossing.com website is that it will allow inspiration and show possible problems in its design so as to be avoided to the master thesis website’s design.

During the observations, a computer and a mobile device were used as well as the screen recording software Techsmith Camtasia Studio.

**Task list**

Below are listed the tasks that the participants will perform on bookcrossing website and on the thesis website respectively. A more comprehensive list of the tasks and their scenarios are provided in the Appendix section.

**Bookcrossing website tasks:**
- Check the Registration page and log in
- Navigate on the homepage
- Search for a book in the database
- Register a book in the database
- Release a book
- Check the FAQ page
- Change the language

**Master thesis website tasks:**
- Navigate on the homepage.
- Search for a book in the database
- Check the history of a book
- Become a member
- Forget your credentials
- Add a book in the database
- Edit a book.
- Check your book list.
- Search for a book while logged in and edit its history
- Resize text

**4.3.3 Interviews**

The participants in the interview session were 4 (four) and they were the same people who participated in the observation session. After the observation session, the participants were asked a set of pre-defined questions. The questions that were used in the interview session followed the structured format. A set of 24 questions were asked to the participants. The aim of the interviews was to discuss with the participants about any issues encountered while browsing...
both of the websites. Another aim was to focus on the use of Google Maps and the book history representation and what was the participants’ reaction towards them. The results of the questionnaires, observations and interviews can be found in the section 5: "Results."

4.3.4 Expert evaluation of the website’s accessibility

An expert evaluation was conducted in order to evaluate the master’s thesis website’s accessibility. The expert evaluation was conducted by following a set of guidelines from the W3.org website. The guidelines focused on: page’s headings, footer, navigation, font size, tables, search bar, forms and images. The expert review was conducted on all of the website’s pages and on each page at a time in order to see if any accessibility issues were encountered. Moreover, besides the expert evaluation, web accessibility evaluation tools were used in order to compare their output with the results of the expert evaluation. The web accessibility evaluation tools that were used are: AChecker, WAVE, SortSite. The accessibility evaluation was carried out on a Windows platform using the browsers Opera and Internet Explorer.
5 Results

This section is based on the results of literature search, implementation of the prototype and the evaluation of the design.

5.1 Results of the literature search

This section focuses on the results of the literature search. There was a vast number of results but the main focus of the master’s thesis has been on the usability of mobile devices, representation of data on a map and responsive web design.

5.1.1 General issues of mobile design

Cognitive load

Due to the reason that the human brain has a limitation in the amount of information it can process, if information exceeds then it takes longer so as to understand it and something important can be missed. In order to minimize the cognitive load the following three things need to be considered:

- Avoid visual clutter: this refers to images which are irrelevant, redundant links or meaningless typography (Whitenton, 2013).
- To build on existing mental models: People have mental models in relation to websites which are based on previous experiences. Therefore, if a similar website pattern in relation to labels and layouts is used, then people will find easier their way on the website (Whitenton, 2013).
- Offload tasks: it refers to alternative solutions in relation to design. For example whether the users need to remember information or if they need to read text. In those cases alternative solutions are suggested such as to show a picture instead of text or to present previously entered information so that the user will not have to remember it (Whitenton, 2013).

There are five cases of cognitive overload:

- Off-Loading when one channel is overloaded with essential processing demands: it is when the user is overloaded with different types of information and cannot access them at the same time. For example, a page that contains a video at the top and text at the bottom will be difficult for the user to be able to perform both of these tasks simultaneously (to view the video and to read the text and the opposite). This is called the split-attention effect as the user’s attention is split in between watching the video and reading the text. The solution to this effect is to present words in the form of narration. By following this pattern, the initial process of words is in the verbal channel and the animation’s process is in the visual channel. Furthermore, with this distinction, the visual channel’s demands are reduced therefore the user can select the most important aspects of animation. The verbal channel’s demands are in a moderate level thus the user is able to make selection on the most important aspects of narration (Mayer and Moreno, 2003).

- Both channels are overloaded with essential processing demands: Suppose there is an animation with narration presented to a user. Then, part of the narration is processed as words in the verbal channel and another part as images.
in the visual channel. In the case that the content is rich and the presentation’s pace is fast then there may not be enough time for the users to be able to organize the words in the verbal model, the pictures in the visual model and also integrate the models. The material in this case is complex. It might not be easy to proceed to the simplification of the material presented but it is possible to allow the users to process chunk of information before moving to the next one. This is being achieved with the segmentation solution. This solution refers to allowing time between the presentation’s segments thus the user can select the words and images of the segment and can organize and integrate them (Mayer and Moreno, 2003).

Another solution is the pre-training in which the users receive relevant instruction of the system. The construction of a mental model consists of two steps: to build component models (this refers to representation on how the components work) and to build a causal model (it refers to how a change that takes place in one part of the system can possibly affect another part of the system). The pre-training approach is an effective approach as the users are trained about the components and they can process in a more effective way the narrated animation. In the case that there is no pre-training, then the users will need to gain knowledge about the components and the causal links among them (Mayer and Moreno, 2003).

- Weeding and signaling when the system is overloaded by incidental processing demands due to extraneous material: For example, a user watches a narrated animation that describes certain aspects of a topic and at the same time background music is played or narrated video clips are added. Even if the material added is interesting, it is extraneous to the narrated animation and can cause the user to use a limited set of cognitive resources. Therefore, they will not engage to the cognitive process required for the topic presented in the animation. A solution to this case is the signaling approach which refers to cues which allow the users to reduce their cognitive load and select and organize the material accordingly. The appearance of signals leads to a better understanding of the material (Mayer and Moreno, 2003).

- Aligning and eliminating redundancy when the system is overloaded by incidental processing demands attributable to how the essential material is presented: this refers to the representation of important parts of the material but in a confusing manner. A solution to this problem is to align words and pictures. Separated presentation is when animation is to misalign words and pictures (for example to present the animation in one window and its text to be presented in another window). This approach leads to incidental processing as the user needs to scan the material in order to understand which parts of the animation is linked to the words. The incidental processing can be reduced when the text is placed within the graphics and close to the material that it describes. This type of presentation is called integrated presentation (Mayer and Moreno, 2003).

- Synchronizing and individualizing when the system is overloaded by the need to hold information in working memory: it occurs once the user is about to engage to essential processing (which refers to organizing, integrating material in such a way so that they explain how the system will work) and representational holding (which refers to the holding of visual and verbal representations during
Learning). A solution to this problem is synchronizing. This solution refers to the synchronization of visual and auditory material. If the auditory and visual presentation take place at the same time, there is no need so as to hold a representation to the working memory until the other is completed (Mayer and Moreno, 2003).

Moreover, the users of mobile devices are more in a rush comparing to users of desktop devices. To design for a mobile device is difficult and there are different issues that are encountered such as:
- small screens (the mobile devices have smaller screen thus fewer options can be presented),
- wrong input (a mouse is not used by a mobile device thus it may take longer to perform some tasks and also typo errors can occur due to the small keyboards provided),
- download delays (the website’s pages may take longer to load),
- mis-designed sites (websites are usable on a desktop version but they do not follow the guidelines for a usable access on a mobile device) (Nielsen and Budiu, 2013).

Screen size and Gestures

As mentioned previously, there are many design issues that need to be taken into account when designing for a mobile device and an example is the screen size. There is a difference in screen size between mobile and desktop devices. In the past, the main issue was the screen resolution but this is not a major factor nowadays. The main issue is the device’s screen size. A solution to the screen size issue is the adaptation of fluid layout (Ribeiro and Carvahais, 2012).

The screen size issue is also encountered in geo-mobile applications. The use of geo-applications on desktop devices comparing to mobile devices varies. Furthermore, another important issue to be taken into account is the users’ preferences which means their age, computer literacy and what kind of information they would like to see. The users of the geo-applications are seeking answers in relation to geographic questions and what kind of geographic needs they may have. These questions and needs can be designed in order to construct tasks that the users will most likely execute (van Elzakker and Delikostidis, 2010). Due to the reason that the mobile devices have smaller screen sizes and the users want to have an overview and insight in geographic details results, there is a constant need of the users to zoom and pan (van Elzakker and Delikostidis, 2012).

There are three issues to be taken into account while adapting a map on a mobile device and they are the following: the interaction with the map, the interaction with the device and how information is visualized on a map. For the issue of interaction and information visualization various aspects need to be taken into account such as: device’s screen size, the limitations of interactions on the device (walking and using the mobile device, speech or touch screen) as well as the connection speed. In service or client enabled maps the connection speed is important because the user will need to zoom and pan (Looije, te Brake and Neerincx, 2007).

Due to the limitation of screen space on a mobile device in order to display maps there is a need to pan. Mobile devices have limited input options like a camera (in case that exists one), joystick, touchscreen, numpad. In case the
mobile device does not have a touch screen then in order to pan the following options exist: a) to pan by using the device’s buttons (the numbered buttons or the directional arrows), b) to pan using a joystick (in case that the device has one) c) to pan using the camera while moving the mobile device (zooming in is achieved by moving the mobile device closer to the direction that the image needs to be taken and zooming out is achieved as the user moves the mobile device closer to him/her) and d) to pan by using speech commands (commands that indicate that they want to go left, right, up or down) (Looije, te Brake and Neerincx, 2007).

Furthermore, the zoom option is important as it strives for the efficiency and effectiveness of a device. A desktop device allows a user to click in order to zoom in. Most of the mobile devices, do not have a touch screen therefore the users will need to use the keypad in order to be able to zoom in. On mobile devices that there is a touch screen the following zooming options exist: a) the users can zoom in or out when clicking the screen and using a corresponding button that allows zooming in or out, b) the users can zoom in by selecting a rectangle and c) the users can use a stylus on the touch screen in order to zoom in or out (Looije, te Brake and Neerincx, 2007). Moreover, a desktop device allows the user to perform tasks using the mouse while a mobile device does not offer to its user this option. Therefore, it is important to adapt (how to size and position) various website options on a mobile screen such as buttons as the human finger is imprecise in comparison to a pointer. The mouse hover option, which is used on a desktop device, does not work on a mobile device therefore actions similar to this, need to be taken into account so that the users will not miss important information (Ribeiro and Carvahais, 2012).
Navigation

There are various navigation approaches in relation to web design and are the following:

-Top Nav Approach: This is an easy navigation approach. The navigation is at the top of the page (Crespo, 2013). It is easy to be implemented and no use of javascript is needed. Negative aspects of it are: this navigation approach is not scalable (Frost, 2012) and covers more lines (Crespo, 2013) and cross-device problems (a website may look nice on an iPhone device but not on other devices)(Frost, 2012). Moreover, this approach is best used when there are not many menu options to be shown(Budiu, 2015).

Figure 1: Top Navigation approach

-Top Nav Approach: This is an easy navigation approach. The navigation is at the top of the page (Crespo, 2013). It is easy to be implemented and no use of javascript is needed. Negative aspects of it are: this navigation approach is not scalable (Frost, 2012) and covers more lines (Crespo, 2013) and cross-device problems (a website may look nice on an iPhone device but not on other devices)(Frost, 2012). Moreover, this approach is best used when there are not many menu options to be shown(Budiu, 2015).
- The Footer Anchor: This approach is used in order to free up website space. In this approach, the navigation menu is located at the bottom of the page and the header has an anchor which points to the footer menu (Crespo, 2013). The footer anchor approach, is used in order the users not having to scroll so as to reach the navigation at the footer (Rutherford, 2015). This approach is easy to be implemented and does not need the use of javascript. A negative aspect of it is that disorients the users as they need to go directly to the footer of the page in order to access the menu and it is not a usual navigation menu approach (Frost, 2012).
The Select Menu: this approach has the menu at the top of the website and under a specific option. The user clicks on a button and all the menu options are shown. This approach has the following aspects: a) it does not cover much space as the menu links reside below a menu button, b) the menu is located at the header and c) can be easily recognized and accessed. The negative aspects of this approach are that: a) there is a lack of styling and each browser may handle them in their own way, b) they may be confusing as users may have been more familiar in using select menus while filling in forms and c) the use of javascript (Frost, 2012). This approach can also be found under the name of hamburger menu. The navigation options are hidden and the user needs to click on a representative menu icon in order to make them visible. Another version of this type of menu is when the menu can be shown by using a gesture. There is no indication whatsoever that there is a menu to be shown. This approach is also used when users mostly focus on the information of the website rather than navigating among the website’s sections as well as when there is enough content shown on a website. Moreover, this approach is widely used on websites nowadays though some users may not be familiar with it (Budiu, 2015).
-The Toggle: This navigation approach is similar to footer navigation with the only difference that the menu opens on the header (Crespo, 2013). It is easy to be implemented, does not disorient the user, can be scalable. The negative aspects of this approach is the use of animation; therefore this may cause problems while running as it may not run as it was supposed to and there is also the need to use javascript (Frost, 2012).
- The Left Nav Flyout: This approach became familiar due to its use on Facebook. There is an icon that the user clicks and additional menu information is shown on a tray. This tray slides from left to right revealing additional content. This approach is appropriate when there are many menu items to be shown and take a lot of space (Frost, 2012). In addition, the slide menu can be accessed by a hamburger icon, a menu button or a grid icon. A slideout can be small with textual links or big with relevant icons or photos (Cao et al., 2016). The negative aspects of this approach are: a) that it may not be easily adapted to all the mobile devices b) does not scale well and c) may be confusing to the users (Frost, 2012).
The Footer Only: This approach is similar to the footer navigation with the difference that there is no anchor on the header. The negative aspect is that the user needs to scroll at the bottom of the page to locate the navigation thus it may disorient the users (as they may not be aware that they need to scroll at the bottom of the page). This approach is well adapted to websites that do not have a lot of content and scrolling is set to a minimum (Crespo, 2013).
The “Hide and Cry”: This approach provides a lot of space but the problem is that important information can be hidden from mobile users. Furthermore, it adds extra weight on the page and it may cause a problem when connection is slower and it may be difficult to maintain as there are different navigation menus depending on the device that the website will be accessed from. (Frost, 2012)

5.1.2 Responsive Web Design

Responsive web design allows a website’s layout optimization depending on the screen size of the device that the website will be accessed. Therefore, if the website is accessed via a desktop device its dimensions will change accordingly as well as if it is accessed via a mobile device. In this way, there will not need to be two separate website codes (one for the mobile version and one for the desktop version) but one code that is optimized for all device versions (Nielsen and Budiu, 2013).

Responsive web design is comprised of three parts:
- fluid layout
- images that are able to work in a flexible context and
- media queries
(Gardner, 2011)
The fluid layout is dynamic and user sensitive and adapts to whichever screen size a user tries to access content. A website development practice is to use the grid system. The grid system allows for website layouts to have an alignment and spacing more user-friendly (Gardner, 2011).

Flexible images and media: Images and other media options can be re-sized or a CSS file can be used. The placement of media in fluid layout will prevent from scaling below the object’s width. The use of CSS can address this issue by using the max-width property and allows the browser to scale the media objects to its container size (Gardner, 2011).

Media queries: in the fluid layouts certain usability problems have been addressed such as readability problems but they can be overcome with the use of CSS3 in order to show the content depending on the screen size. (Gardner, 2011)

5.1.3 Geographic data representation

Data items consist of two parts: a) the context in which data were obtained and b) the part that corresponds to the results of observation, measurements and calculations. The context refers to the time that the measurements took place, the location, the methods used and the entity that the properties have been measured or calculated or observed. The term referential components or referrer refers to context and the term characteristic components or attributes refers to results obtained from observations, measurements or calculations. The term referential components or referrer is defined as backdrop in Klir’s book of Architecture of Systems Problem Solving (1985). There are three aspects of backdrop: time, space and population (population is not only used for people but for a group of items such as words of a story or products) (Andrienko and Andrienko, 2006).

Elementary tasks are tasks that refer to individual time moments. These tasks are differentiated by taking into account the search target (time or spatial/location objects), the cognitive operation involved (this refers to the identification or comparison) and the search level that focuses on space and objects. There are two group tasks: the when to what+where group and the where+what to when group (Andrienko, Andrienko and Gatalsky, 2003).
The when to what+where group

This group refers to identification of characteristics of a behavior or to the comparison of behaviors at a given moment or moments. The elementary level focuses on information relating to the characteristics of objections or locations. The general level focuses on the spatial distribution of objects. An analyst wants to achieve two goals when comparing two time moments:
- to detect changes: the technique of map iteration, to compare maps which represent situations at different moments, is used for detection of changes. In order to be able to find the places that changes take place, it is needed to scan each of the maps and compare the map fragments (Andrienko, Andrienko and Gatalsky, 2003).
- to measure changes: the maps’ comparison can be effective for the evaluation of characteristics in relation to change but it may not be appropriate when estimating the amount or the degree of change. This refers to answering of questions that are in the form of: how far did an object move or how much has the unemployment rate of a specific area increased.

In order to measure changes, a suitable technique is overlaying. The location changes can be measured when the objects’ trajectories are represented as lines on a map. In the case that there are many objects with complex trajectories, then it is needed to filter the results in order the map to show specific information of a selected time interval (Andrienko, Andrienko and Gatalsky, 2003).

The what+where to when group

The main focus of those tasks is to determine when certain characteristics of objects or locations occur in a specific moment. Tasks of the elementary level can be identified by using querying facilities. The characteristics that the objects or locations have, need to be set as the constraints of the query and time need to be set as the query target. This technique is used for task comparison (comparison of time moments when different characteristics took place in the same location or in a different location). The tasks in this group can be compared using an interactive time series graph. The time series graph allows for the representation of the moments that an object’s value was at a high or low level and when was a high or low level value attained. This graph is not suitable so as to answer questions in relation to many attributes as it focuses on the representation of one attribute. This graph is suitable for individual objects or locations (Andrienko, Andrienko and Gatalsky, 2003).

There are two approaches in order to represent data in a geographic information system (GIS):
- object-based is based on the arrangement of information (spatial and non spatial information) as attributes or features of geographic objects.
- and location-based where information is stored in specific locations.
(Andrienko and Andrienko, 2006)

The object-based approach corresponds to vector data and the location-based approach to raster data. (Andrienko and Andrienko, 2006)
Geographic data can be organized and stored using vector or raster data. Vector data refer to points which are connected in the form of lines or areas. Raster
data refer to grid of cells that each cell has a specific value or values (Krygier and Wood, 2011). Vector data represent discrete phenomena and raster data continuous phenomena. The object-based and location-based approaches have been extended in order to include temporal data. In the discrete phenomena, the basis of the representation is entities like roads or lakes. The temporal and spatial extents are indicated as attributes which are attached to these entities. In the continuous phenomena, the representation basis is space and/or time and individual objects are indicated as attributes which are attached to a specific location in space and time (Andrienko and Andrienko, 2006).

Figure 8: Vector data.

Vector data representation.[image] Available at: ByMcmillin24[CCBY-SA3.0(http://creativecommons.org/licenses/by-sa/3.0)], viaWikimediaCommons [Accessed 26 May 2016].

Figure 8 depicts an example of vector data. Vector data are represented using geometry which consists of one or more vertices which are interconnected (Sutton, Dassau and Sutton, 2009). Vector data consist of points, lines and areas (Krygier and Wood, 2011). If there is one vertex then it is called a point (Sutton, Dassau and Sutton, 2009). The lines consist of many points connected together and the areas are polygons which refer to closed and connected series of points (Krygier and Wood, 2011). If there are two or more vertices where the first and the last vertex are not equal then this is called a polyline. Polylines are used in order to present linear features like roads, rivers or footpaths. If there are three or more vertices and the first and the last vertex are equal, then a polygon is created. Polygons are used in order to present enclosed areas such as islands, a country’s boundaries or dams. (Sutton, Dassau and Sutton, 2009). Points, lines and areas can have their corresponding attribute information which can be stored in a database. Also, points, lines and areas can have their own design characteristics. Sources that vector data can be collected from, are the following: GPS devices, public and private sources of data which are on a map format such as KML/KMZ, USGS, Census TIGER as well as GIS software. Furthermore in graphic design software such as Adobe Illustrator or Corel Draw make use of vector data (Krygier and Wood, 2011).
Figure 9: Raster data representation [image] Available at: [https://upload.wikimedia.org/wikipedia/commons/3/3a/Carpathians-satellite.jpg](https://upload.wikimedia.org/wikipedia/commons/3/3a/Carpathians-satellite.jpg) By Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC [Public domain], via Wikimedia Commons

Figure 9 shows how raster data are represented. Raster data refer to grid of cells that each cell has been assigned with a value or values. Raster data can be collected from satellite and aerial imagery which can be found from private and public sources. Raster data consist of points (one cell), lines (adjacent cells) and areas (closed or adjacent cells) (Krygier and Wood, 2011). A difference between vector and raster data is that when zooming in raster data the image’s pixels are shown (Sutton, Dassau and Sutton, 2009).

GIS software allows for the use of vector and raster data simultaneously. Moreover, software such as Photoshop, GIMP, GRASS make use of raster data (Krygier and Wood, 2011).

Maps and databases

A database allows the computer to deposit, store and retrieve data. There are two types of databases which are: the relational databases and spatial databases. The relational databases are based on connections among data items. The relational databases have tables which have certain attributes. The data in the relational database are in the form of rows or tuples and they have values. One value is associated with each attribute. In order to perform different actions on a database, the SQL or else Structured Query Language is needed. SQL allows for the insertion, modification and retrieval of data from the database (Worboys and Duckham, 2004). Spatial databases are used in more complex cases of structures. Spatial databases can be used in order to manage spatial and geographic data. These databases focus on a large collection of objects. Moreover, there are specific spatial data types to be used such as point, line, region and also their relationships are being depicted (Gütting, 1994).

5.1.4 Usability issues of Geographic Information Systems

A usability issue of a GIS system is that it requires its users to have prior technical knowledge in order to operate the system. The geographic information systems are based on knowledge derived from many fields like geography, computer programming, cartography, statistics and database management. The
term field can denote different meanings in databases, in geography, therefore it may be an obstacle for a novice user who is not familiar with its different meanings (Haklay and Jones, 2008). Moreover, due to the complicated user interfaces, the users need to be trained thus making it more difficult to them to perform simple tasks quickly (Komarkova, Jakoubek and Hub, 2009). Another issue relates to desktop GIS which have as the main way of representation and manipulation of information the maps. Therefore, the graphical application is used for the interaction of the user with the data (Haklay and Jones, 2008). Moreover, GIS are complex systems that the users need assistance in order to choose tools which will be appropriate for them. Due to the complexity of the GIS and the plethora of tools available to the users, the usability of the system can be decreased (Komarkova, Jakoubek and Hub, 2009).

A solution to the usability issues, is the adaptation of usability engineering methods for GIS. Usability engineering methods for GIS consist of tools and methods that focus on the representation and manipulation of information and provide assistance in the design of user interaction. If characteristics of GIS such as the map size or the representation of information are taken into account, then the appropriate techniques and guidelines can be used. Moreover, it is important to have a distinction among the users of GIS and geospatial technologies as techniques that are relevant to web mapping websites are not suitable for desktop GIS users (Haklay and Jones, 2008). In addition, web-based solutions can provide assistance to the users in accessing spatial information by providing the most appropriate tools; thus the users will not get overloaded with information from tools that may not be relevant to them (Komarkova, Jakoubek and Hub, 2009).

5.1.5 Results of the literature review on accessibility

People with disabilities use assistive devices in order to be able to use computers. The W3C (World Wide Web Consortium) has provided a set of guidelines in order for a website to conform in order to be processed accordingly by the assistive devices. Even though designers and authors follow a set of accessibility guidelines, the websites still have accessibility issues causing difficulty so as to be accessed by users of assistive devices (Harper and Yesilada, 2008).

Assistive technology

Many assistive devices accept binary input or on/off whereas there are others like a screen reader which is used in conjunction with a browser. The screen readers are used by people who have visual impairments but can also be used by people who have dyslexia or literacy issues (Connor, 2012)

The screen reader's purpose is to identify what is on the screen and to output data in the form of speech. The screen reader basically reads a page's contents or the user can choose specific items that they would like to focus on. Examples of screen readers are: JAWS, Window-Eyes, NVDA and many others (Connor, 2012). The way that the screen readers work has changed over time and nowadays, they check the DOM in order to know what will be displayed by the browser (Thatcher, 2006). DOM refers to document object model and provides an interface to XML documents and can be used in order to read or edit information and add new nodes (Jacobs, 2006). For websites as well as ap-
plications, the screen readers do not read the screen anymore but they use DOM in order to provide speech to all data of a web page. The screen reader needs to present a two-dimensional web page to a user and an one-dimensional stream of characters to a speech synthesizer. The conversion of a two dimensional page to an one-dimensional text string is called linearizing. An example of linearizing is by showing the content of the html code without the code elements. Another linearizing approach is by reading the page from left to right and also from top to bottom. People with visual impairments rarely listen to the content of a web page in full but they navigate on specific parts of the page (Thatcher, 2006).

**Accessibility evaluation**

There are validation, evaluation and repair tools which focus on accessibility of a website and a designer can test the website's pages in order to see if any accessibility issue exists. Those kind of tools, focus on accessibility guidelines and they analyse the pages in relation to those guidelines (Harper and Yesilada, 2008).

These tools even though they focus on accessibility guidelines, they are not an accurate solution as they cover a 50% of accessibility issues. Therefore, an expert review is also a solution in order to test whether a website is conformed with the accessibility standards. There is a strong reliance to online evaluation tools in relation to accessibility from companies due to the lack of expert evaluators. An expert evaluator takes into account the accessibility guidelines and decides whether the pages have conformed to them or if there are any accessibility issues. An online tool on the other hand, shows only negative or positive results without a proper interpretation of the guidelines and their importance (Vigo, Brown and Conway, 2013).

Accessibility evaluation takes place either at the end of the project or on a website that has already been launched. This form of evaluation is called summative evaluation and it can be conducted by experts or by using online tools by the combination of experts and online tools (Vigo, Brown and Conway, 2013).

**Web accessibility guidelines**

The web content accessibility guidelines (WCAG) provide a set of guidelines in order for websites to adapt accessibility. These guidelines are organized in principles. There are four principles (Connor, 2012):

1) Principle 1: Perceivable: This principle focuses on all of the contents as well as multimedia, audio and video:
   - To provide text in content that does not have text,
   - To provide alternative ways of synchronization for multimedia (for example audio descriptors, captions on a video),
   - To separate information and structure from presentation,
   - The background and foreground must be distinguished.
   (Connor, 2012)

2) Principle 2: Operable: The elements of the interface must be operable:
   - All the tasks can be performed using keyboard,
- To control limits on reading or interaction,
- To be able to avoid content that causes health issues,
- To provide appropriate mechanisms in order for the user to easily orientate themselves on the website and perform their tasks,
- To avoid mistakes and if a mistake occurs, to allow the users to correct them. (Connor, 2012)

3) Principle 3: Understandable: The website’s content needs to be understandable:
- The content needs to be understandable and readable,
- The content’s placement and functionality need to be predictable. (Connor, 2012)

4) Principle 4: Robustness: The content needs to be robust in order for it to work with existing and future technologies:
- To support compatibility of existing and future technologies,
- To ensure that the content is accessible or to provide any accessible alternatives. (Connor, 2012)

Moreover, other aspects to be taken into account when designing for people with disabilities are the following:

Audio captions: The captions show the words that are heard once a audio or video file is being played. They are helpful for people who have a hearing disability as well as when someone is in a noisy environment and has a difficulty hearing the audio (Thatcher, 2006).

Device independence: It refers to the design of websites without having the solely support of a mouse device. Thus, the user can rely on different keyboard shortcuts in order to perform their tasks on the website. This is helpful for people who have different injuries such as RSI which stands for Repetitive Stress Injury (Thatcher, 2006).

The navigation and design to be clear and consistent: A clear and consistent design is important as the user will be able to find their way on the website. Every user (with disabilities or not) needs a clear and consistent design and navigation in order to be able to perform their tasks as it is also a usability matter. People with disabilities such as cognitive disabilities encounter a difficulty in processing visual information, especially if there is a problem with the website’s navigation. If the navigation is clear and consistent the users will be able to distinguish it and also even if various supportive devices are used, then the users will not encounter any problems (Thatcher, 2006).

Easy and accessible controls: The website’s buttons should be adjusted so that they will not be too small or too close (Oestreicher, 2011).

Enough time: The users may need time so as to be able to read the website’s content therefore it is not good to have a specific time limit. If there is a need for presentation it would be better if it would be provided the option to skip the presentation (Oestreicher, 2011).
Seizure problems: Various animations can cause seizures to a user visiting the website. Therefore, it is suggested not to include animation such as moving images or flashing lights unless it is necessary on the page. If it is necessary to include them, it should be better if there is an option to turn them off (Oestreicher, 2011).

Compatibility: It would be good if the website is compatible with current as well as future technology. It is not easy to be able to know what the future technology will be but what is important is to be able to adapt the website easily (Oestreicher, 2011).

5.2 Implementation of the design of a prototype

5.2.1 Layout of the website

The layout adapts a responsive type of layout for the purpose of the completion of the project’s website. The layout is based on bootstrap and its name is Capture. The master thesis website’s structure is the same for desktop and mobile versions. The navigation is located at the top of the page in both of these versions but with the mobile version having the navigation menu under a button titled Menu.

5.2.2 Presentation of the website’s pages

In this subsection, images of the mobile version of the master thesis website will be presented and relevant description text will be added below them.

![Navigation menu of the website.](image)

Figure 10: Navigation menu of the website.

The figure 10 shows the navigation menu of the mobile version of the website. The menu can be found at the header when clicking the Menu button. The
choice of a menu depicted under the Menu icon was because it will be easier to the user to identify the menu. Another reason is that the menu is grouped in a better format without causing any problem when font is adjusted. The navigation approach that was used was the select approach or hamburger menu. This navigation menu approach was used because it is a common approach nowadays and people are familiar with it and also because the main focus of the website is on the search option rather than the navigation among pages. Moreover, this minimalist menu is consistent with the accessibility guidelines so as to have a simple menu that will provide clear information to the user in order to perform their tasks.

![Home page of the website.](image)

Figure 11: Home page of the website.

The figure 11 shows the home page of the website. There is a search option that the user can write a specific keyword such as country, book title, author and see the corresponding results. The homepage was developed in order to provide a minimalist design and allow the users to focus on the most important information which was the search of books. Furthermore, as mentioned previously, due to the lack of screen size of mobile devices it is important to present the most important level of information rather than have redundant information on the page and disorient the users. Therefore, the main focus is on the search option. In addition, accessibility guidelines were adapted to the page and specifically on the search option indicating that it is a search bar. Furthermore, relevant html code adjustment took place so as to conform to the
accessibility guidelines. For example, there is a distinctive footer on the page, the book logo provides an alternative text in case the image is not shown and the page shows a heading in order to distinguish the page that the user is located.

Figure 12: Search results

Figure 12 depicts the results while searching in the database for the keyword Germany. There are two ways that results are represented on the website and are: the map format and the table format. When a user is searching for a book it is important to be able to see the books in a map format so as to allow them to identify easier the book locations. Besides the map format there is also a table format which includes additional information for the users to see. Also via the table representation of the results, the users can access the book’s history (if there is any book history). Moreover, accessibility guidelines were taken into account in relation to the table format. The table follows the guidelines’ structure in relation to how a table is designed.

<table>
<thead>
<tr>
<th>Book Id</th>
<th>Title</th>
<th>Author</th>
<th>Country</th>
<th>User's username</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>The Woman in Black</td>
<td>Susan Hill</td>
<td>Germany</td>
<td>kate_wh</td>
<td>Book history</td>
</tr>
<tr>
<td>6</td>
<td>White is for Witching</td>
<td>Helen Oyeyemi</td>
<td>Germany</td>
<td>kate_wh</td>
<td>Book history</td>
</tr>
<tr>
<td>9</td>
<td>Noonshade</td>
<td>James Barclay</td>
<td>Germany</td>
<td>kate_wh</td>
<td>Book history</td>
</tr>
<tr>
<td>16</td>
<td>Lost World</td>
<td>Sir Doyle</td>
<td>Germany</td>
<td>kate_wh</td>
<td>Book history</td>
</tr>
</tbody>
</table>
The figure 13 shows the book history page of a specific book. The Google map depicts the locations that the book has traveled and links the locations using polylines. The table below the map shows in a greater detail information relating to the book such as timestamp (date and time the book was found), country, title and author. The technique that was used for the book history representation is the polylines. The polylines in this figure are depicted by lines forming a triangle. The book history representation can vary depending on the various locations that a book has been found. Therefore, it will not always be a triangle but another way of representation as for example a single line. Instead of having markers scattered around various countries without showing any kind of connection, the polylines achieve the book connection by linking those locations. The book history representation with the use of polylines is being achieved.
when the book has already a history but if there is no book history there will be no representation on the map. Besides the map representation, there is also a table format which shows in a detail manner information related to the book. Moreover, data depicted on the table format follows the structure of the backdrop (Andrienko and Andrienko, 2006) that refers to data that have three aspects: time, space and population. The time on the website refers to the timestamp, the space is the location that the books are found and the population refers to the users who found the book.

The figure 14 shows the pages that the user can add and edit a book. The user clicks on a location of their choice on the map and then an information window appears. This window allows the user to add information (left figure) in relation to the book title, author, country and so on. The edit book page allows the user to click on the map and edit the book’s location, country and the user’s username. The edit page (right figure) can be found either on the member’s page with the option of editing a book or if the member searches for a particular keyword in the database then there will be an option (if there are relevant results) in the table format in order to edit the book. The edit book option is secure for the users as it focuses on editing a book that has already been left on a public place (that means that a user uses the add a book when they leave it on a public place and another user uses the edit a book option when they find it).
5.2.3 Database Model

Figure 15: This image shows an entity relationship diagram of the database.

The figure 15 depicts an entity-relationship diagram of the thesis database. There are three tables which are the following: book, user, and history. The book contains information of the book’s title, author, country, id, username of the user, latitude, and longitude. The book_id and user_username are both primary keys in this table. The table user contains information of the user’s username, password, and e-mail. The user’s username is a primary key and is linked to the table book and history. In addition, the e-mail is used in the registration page in order to retrieve the user’s password. The table history is similar to the book table as it allows a user to be able to edit the book’s new country. The only difference between the table book and history is that there is a timestamp option (in history), which shows the date and time that the book was added in the database. The table’s synthesis has been developed in this way because each of these tables focus on different aspects. The table book focuses on information in relation to the book’s title, id, author, country as well as the username of the member who has the book. The user table focuses on information in relation to the user and the history table focuses on information of the book and the user but with additional information of the date and time the book was found (it shows the history of a specific book, history of locations and members). All of these tables are linked to each other.
5.3 Usability evaluation of the design

This section focuses on the results and is divided in two parts. In both of these parts, the websites that were tested were the bookcrossing website and the master thesis’s mobile version website. The first part is based on a set of tasks that the participants had to perform as well as a questionnaire to complete. The number of participants who participated were 24. The second part of this section focuses on observations while the participants performing a set of tasks on the websites as well as interviews commencing after the observations. The number of participants in the second part was four (4).

5.3.1 Questionnaire results

This part of the section shows the results of the questionnaires. As mentioned in the methods section, 24 people participated in questionnaires. The participants were given a set of tasks to perform from bookcrossing website and the master thesis website.

Bookcrossing website questionnaire results

This subsection focuses on the results of the questions related to the bookcrossing website.

The questions in the questionnaire related to various sections of the website such as: the registration page, FAQ page, member’s profile, search option, forum, language change as well as its layout and navigation menu. Besides the use of close-ended questions, an open-ended question was used and allowed the participants to share their thoughts in relation to the tasks they performed and their overall impression of the website.
The results of the close-ended questions of the bookcrossing website questionnaire, showed various usability issues. On a Likert scale the numbers 1, 2, 3 of the questionnaire’s close-ended questions indicated usability issues whereas numbers 4 and 5 were considered acceptable from a usability point of view. The following usability issues are being defined:

- Language change: 33% of the participants found the language change to be usable but the rest of 67% encountered usability issues. The variation of results on this task related to problems arising when switching languages. Some participants mentioned that there was either not the language that they wanted to choose in the system or that the language change option did not translate all the page’s content.

- FAQ page: Another page that usability issues were encountered was the FAQ page. 45% of the participants found the FAQ page to be easy to use but the highest number of participants (55%) encountered usability issues on that page. The result variation occurred due to the structure of the page. All of the participants agreed that the structure of the page was confusing as the questions were not in a correct order.

- Navigation: Another usability issue is depicted on navigation. Even though that 70% of the participants found the navigation easy to use, the rest 30% encountered usability issues. The navigation menu has a top navigation approach with all the navigation links residing at the header. The navigation menu has an excessive use of links thus overloading the user with excess information.

- Member’s page: Another usability issue, is the location of the member’s page. Even though 66% of the participants could easily locate the member’s page, a 34% encountered usability issues.

Finally, the participants suggested the following set of improvements for the bookcrossing website:
- The profile page design to change and contain a minimum set of information,
- The language page option to provide the right functionality,
- The interface design to be modified as well as the FAQ page structure.

**Master’s thesis website’s questionnaire results**

This subsection shows the usability issues encountered from the questionnaire’s results in relation to the master’s thesis website’s mobile version.

The main focus of the questions related to the mobile version of the master’s thesis website was in relation to the use of Google Maps. Tasks in relation to the use of Google Maps focused on answering whether the participants thought that the use of maps (so as to perform certain tasks) was usable to them or not. Furthermore, the questions aimed to answer the research question of whether the participants encountered any usability issues and how usable the website was to them.

The results of the close-ended questions of the questionnaire showed that the participants did not encounter any problem performing the website tasks that were provided to them. High scores were represented in questions related to the use of Google Maps for the representation of results as well as adding and editing of books.
The results of the questionnaire showed different usability issues. On a Likert scale the numbers 1, 2, 3 of the questionnaire’s close-ended questions indicated usability issues whereas numbers 4 and 5 were considered acceptable from a usability point of view. The following usability issues are being defined:

- **Font resize**: A usability issue encountered by the questionnaire’s results was the font resize option that can be found at the About page. 80% of the participants found the font resize option to be usable whereas a 20% encountered usability issues while performing this task.

- **Lack of escape options**: Another usability issue encountered is the lack of options in order to undo or re-do a step in case of a mistake.

- **Password recovery**: Another usability issue encountered was on the password recovery page. Two of the participants mentioned that the development of the password recovery page may not yield the appropriate security protection.

- **Web mapping**: A last usability issue is the use of Google Maps in order to represent data. 80% of the participants found the use of Google Maps easy in order to perform their tasks whereas a 20% of participants encountered usability issues.

The participants suggested the following set of improvements to the mobile version of the website:

- To provide undo/redo buttons in order to avoid or correct any possible mistakes,
- To create a simple member profile page,
- To change the colour scheme of the website,
- To add documentation on how to add or edit books,
- To provide the option of editing a book’s title, author in case of a mistake,
- To create a forum so that the members of the website can communicate with each other or that various inquiries can be answered.
- To provide better security options to the forgotten password page.

**Mobile website comparing to bookcrossing**

The mobile version of the website comparing to bookcrossing has a minimalist layout. There is a simple menu with no sub-menus as the main focus is on the search of books and not on the navigation in between pages. Therefore, comparing to the bookcrossing’s results in relation to navigation and layout, the mobile website did not encounter any usability issue.

**5.3.2 Observations and Interviews**

Due to the reason that the questionnaire results did not show all the usability problems, observations and interviews were conducted. Therefore, this section is based on the findings of the observations and interviews as well as the modifications that took place in the website. The observations and interviews were conducted on both of the websites (bookcrossing and the mobile version of the master’s thesis website).
Observations and Interviews of bookcrossing website

Observations
All tasks were completed successfully by the participants. Their response time varied depending on their use of smartphone or computer (for example if they are Android/iOs users or Apple/Windows users). All of the participants did not encounter any problem in order to log in and navigate themselves around the website’s pages. While performing the task of searching a book, all of the participants chose the search option that was in plain view whereas one participant did not see this search option and clicked on the search option under the menu (it performed the same task but it was not obviously located as the one in plain view). The tasks of registering and releasing a book were performed successfully. The participants needed a little time in order to locate the register option and afterwards to release the book. The release option needed the participants to remember information that was given in the register option and this forced them to move in between pages because the copy/paste option did not prove to work as it used to. On the FAQ page, two (2) of the participants chose to find the Question 1 by using the ctrl+f shortcut. The other two (2) participants scrolled up and down the page in order to find the Question 1 which was located at the bottom of the page. The last task was to change the language of the website. The participants performed this task successfully though all of them encountered a problem with the language change as it changed only on specific parts of the page and not on the whole page.

Interviews
The participants suggested alterations on the bookcrossing page. The modifications that they suggested were the following:
- Difficulty of understanding the purpose of the book map option which was located below the navigation menu. This option provides a difficulty as it did not allow the users to perform any task and the countries depicted on the map changed very quickly without giving further information.
- The menu needs to have a refurbish and have more specific buttons (limited information).
- The FAQ page structure needs to be improved
- On the register/release page was not obvious on how to register or release a book therefore an improvement of those pages was suggested.
All the interviews can be found under the Appendix section.

Observations and Interview results of the mobile version of the master’s thesis website

Observations
All tasks were completed successfully by the participants. Here again their response time varied due to their use and knowledge of technology in their daily lives. All of the participants did not encounter any problem while navigating themselves around the website’s pages and searching for a book. It was suggested to search for a book using any keyword that they wanted in order to see if this book exists in the database and if it exists whether it has any book history. The tasks of registering and logging in were performed without any problem.
One participant encountered a problem entering his credentials in order to log in but he quickly overcame this problem. Another task that the participants had to perform was to add a book in the database. This task was performed successfully though one of them was not sure in the beginning of what he would have to do so as to add a book. He started adding markers on the map and did not read the notification above the map indicating how to add a book. When he understood how to add a book, he performed this task successfully. The other participants did not encounter any problem adding a book as they had read the note at the top of the page. The edit book task was performed successfully as the participants had familiarized themselves with the process of adding a book. Therefore, they performed the edit task a little quicker. The last task was to use the resize option of the About page. All of the participants did not encounter any problem so as to perform this task and they were familiar with this resize font tool.

**Interviews**

The participants made suggestions on modifications of the website. The suggestions that were received by the participants were the following ones:

- To include screenshots or further documentation in some tasks of the page so as to show how to perform certain tasks. This suggestion was due to the reason that it was not obvious how some tasks could be performed such as to add/edit a book.
- To be able to zoom in the pages in order to see the book results depicted on a table format.
- To delete the username and location from the add/edit information window and set information to minimum. It was suggested to delete these options because there was no need of using the name of the user as the user has already logged in and also for the location option was mentioned that it was difficult to remember the exact location of the marker on the map.
- To improve the search option results. It was mentioned by one participant to improve the search page results as he searched the database for a specific keyword and he found no results.

All the interviews of the thesis website can be found at the Appendix section.

**5.3.3 Comments on the websites from the observations and interviews**

From the observations and interviews of both of the websites were identified problems and possible modifications. The participants liked that, in both of the websites, you can search for a book and add a book to the system. Both of the websites featured a different format on how to add and edit a book or register and release a book therefore the difficulty performing those tasks varied. Concerning the master’s thesis website, some participants suggested that the add and edit page should have less input information in the information window so that the user will not have to remember additional information. For example it was suggested that the username should be deleted from the information window because the user who has already logged in will be the one who will add or edit the book. Moreover, it was suggested to delete the book’s location because the users may not be aware that they had to look at the location’s
name while clicking on the map. The main issue identified on the project was the add and edit page. One participant also mentioned that he had trouble identifying whether the search results returned any results or not. The observation and interview sessions focused on answering questions in relation to whether the use of Google Maps so as to depict the history of the books and the search result representation provided a usable outcome. Furthermore, usability issues could be identified by observing the participants performing certain tasks as well as interviewing them.

5.3.4 Expert review on accessibility

An expert review was conducted in order to evaluate the master’s thesis website’s accessibility. The results of the expert review, of the mobile version of the master’s thesis website, were overall positive. Various sections on the code were distinguished so that users of assistive devices could distinguish the page’s content. The header element contained a navigation option and a logo. The navigation was distinguished using the `nav` element. The navigation of the website followed a minimalist approach containing the most important information. This approach is consistent with the guidelines of accessibility as the navigation menu’s purpose is clear and the users can perform their tasks. Moreover, the mobile website’s tables followed accessibility guidelines in relation to the presentation of information. A relevant table header, on each of the tables on the mobile version of the website, was shown in order to distinguish the content of the respective table.

A page footer was added to the website enclosed in relevant tags in order to distinguish that it is a footer. Also, the only image of the website is the book logo and has relevant in-code text describing its purpose and is enclosed within the `alt` element. In addition, the search option included relevant labels indicating that there is a search option on the website. All the text that appeared on the website was enclosed in relevant paragraph brackets. Moreover, every page had a distinctive heading representing the page that the user is currently located. Furthermore, the links were described accordingly and no click here text was used. Also, the font size was in em points and not in pixels in order for the users of assistive devices to be able to adjust accordingly the page’s text. Moreover, the search option of the website as well as the forms had relevant label elements in order for the input to be identified. The label elements were used on each of the text-fields.

An evaluation using web evaluation tools was conducted. The tools that were used were AChecker, WAVE and SortSite. The results on these tools varied. AChecker and WAVE had mostly positive results. Positive results could be identified on the forms, the navigation, header, footer and search option. Minor alerts could be identified on the book logo (at the header section) because it has a link to the home page and was identified as redundant. It was identified as redundant due to the reason that there is also a navigation menu link to the home page. The web evaluation tool SortSite provided a list of evaluation results on the website but the results on some pages did not provide additional information on how to overcome a problem. In addition, SortSite showed some compatibility problems using Internet Explorer whereas while using other browsers like Opera, no compatibility issues were identified.
5.4 Summary and analysis of the usability evaluation

The questionnaires and observations and interviews showed various usability issues on both of the websites (bookcrossing website and the master’s thesis website). The most common usability issues of the bookcrossing website were: problems in the structure of the FAQ page, too much information on the navigation menu, language change problems and problems while registering and releasing a book. The participants in both of the testing sessions (questionnaires and observations and interviews) proposed grounds of improvement in those areas.

The most common usability issues of the master’s thesis website related to: the excessive information of the add and edit information windows, the addition of corresponding documentation in order to add and edit a book, to provide undo/redo buttons in case of a mistake and to provide security at the password recovery page.

5.5 Redesign

Due to the comments from the observations, interviews as well as the questionnaires various redesign options were taken into account. A redesign example is that of the add and edit pages in which a relevant modification took place. The parts that were modified were the information windows of those pages. The information windows contain minimum information comparing to the previous version. The previous database entry location and country have been deleted due to the comments of the participants as well as the username does not appear on the information window. Below can be seen the modifications that can be identified in those pages (add and edit) as well as the new database prototype.

![Figure 17: New add information window](image)

The figure 17 shows the new add a book option with the information window containing information of the book’s title and author. The modification of
the add page’s information window took place due to the comments of the participants (during the interview sessions) in relation to excess information. The participants suggested that it would be better to keep the amount of information to a minimum eliminating the username, country and location options.

Figure 18: New edit information window

The figure 18 shows the new edit information window. The options of the edit information window have been decreased and only one option is left which is a button so as to store the new country. The modification of the information window took place due to the comments of the participants in the interview sessions in order to include limited information.
Figure 19: Database model

The figure 19 shows the database prototype that contains all the data that were presented in the previous prototype but with the elimination of the location. The location was eliminated due to comments of the participants as it was difficult to them to remember the location that they placed a marker on the map.
6 Conclusion and Discussion

This section focuses on the conclusion in relation to the overall steps taken so as to complete this master’s thesis. The master’s thesis focused on the concept of the bookcrossing website. The bookcrossing website is a type of an online community. An online community allows people to connect in order to exchange resources or information, to share common interests, to socialize, to explore their creativity (Faraj, Jarvenpaa and Majchrzak, 2011). The bookcrossing website allows the users to add a book that they own for other users to be able to find it on a public place. This website did not allow the users to be able to see the history of a book or use Google Maps so as to add and edit a book therefore this option was implemented in the master thesis project. Moreover, the master’s thesis website focuses on responsive web design therefore a respective layout was used so that the users could access the website via their smartphone or tablet without having any problem. The layout that was used was a bootstrap made layout where changes were made in order to have a better flow of information.

Additionally, the polylines technique that is found in Geographic Information Systems was used. This technique is used in order to provide to the users a better experience in the representation of the book history on the Google Maps and allow the users to see easier the book history locations. If a book has many locations in its history then all of the locations will be linked with representative lines so as to show their connection. If the book has no history then there will be no markers shown on the map. The book history is an important aspect of the master’s thesis website therefore its appropriate representation will yield a better experience to the end user. According to Esri, the term polylines is defined as “a shape defined by one or more paths, in which a path is a series of connected segments. If a polyline has more than one path (a multipart polyline), the paths may either branch or be discontinuous” (Esri, 2016).

Moreover, the evaluation of the mobile version of the website was important. Therefore, a usability evaluation and an expert review in relation to accessibility took place. The usability evaluation focused on the comparison of bookcrossing website and the master’s thesis website. The usability evaluation was divided in two parts: i) evaluation using questionnaires and ii) evaluation with observations and interviews. These two different approaches took place in order to gather respective data in relation to usability issues. Both of these methods showed a number of usability issues to both of the websites and also possible ground for improvement. At the end of the usability evaluation, a redesign of the mobile version of the website took place following some of the participants’ comments in relation to improving the website. The pages that were redesigned were the add and edit pages. The main focus on these pages is to present minimum amount of information on the information window.

The evaluation following an expert review was conducted in order to identify any accessibility issues on the mobile version of the website. The website was consistent with some of the accessibility guidelines. For example, there was a code distinction among the various parts of a page so that if any assistive device could be used then each of the parts will be distinguished. Moreover, the navigation menu was simple and clear to its purpose so that the users could easily navigate themselves on the website. In addition, the tables of the website adapted some of the accessibility guidelines and also each table had a title which
described its purpose.

In conclusion, the goals of the master’s thesis project were: to adapt responsive web design, to evaluate the mobile version of the website in order to identify usability issues and to provide accessibility for the visual impaired users. The master’s thesis website achieved the goals that were set. Furthermore, the mobile version of the website followed the accessibility guidelines and from the results was indicated that it was usable though some minor usability issues were encountered. Also, by taking into account some of these usability issues, a redesign of some pages of the website took place in order to improve the usability in those pages.

7 Future Work

As a future work the current master’s thesis website could be improved in various sections. An improvement could take place on the layout of the website so that it would have a change of colors as well as a change of the simple layout that is now used. Additionally, from the participants’ comments it was noted that a forum is a positive section to be included on the website therefore it would be good to be used in future versions. Moreover, the profile of the user could receive a refurbishment to allow the user to upload an image and serve as a user profile page of an online community. Furthermore, the process of adding and editing a book could be improved and provide other functionalities and additional options to add/edit a book. In addition, a mobile application could be designed that could provide all the information that the user would need in order to access their profile, search for a book and add/edit books.
References


Appendices

In the Appendices can be found the interviews, the questionnaire and the user manual.

Appendix 1: Interviews

Participant 1

Questions on Bookcrossing.com

1. Have you visited the website bookcrossing.com before?
   No
2. What do you think that is the purpose of this website?
   Yes. You find books in different places worldwide.
3. What do you think of the difficulty of the tasks that you had to perform?
   Was there anything difficult to you?
   No, everything was easy.
4. What do you think of the navigation menu?
   It was very good.
5. What do you think of the user’s profile page?
   It was usable and very simple.
6. What do you think of the options registering and releasing a book?
   It was very simple. I had only a problem on the release of a book because there was the option of wild release and controlled release and I couldn’t distinguish them.
7. Did you encounter any problem using this website?
   No, there was no special problem or something that I couldn’t perform.
8. What do you think of the language change of this website?
   There is no language change in this website. The only language is English. All the other languages exist simply as options.
9. What do you think of the structure of the FAQ page and the FAQ page in general?
   I didn’t like the structure. I think the content was very mixed up and I think it would be better if it was numerically ordered.
10. If you could change something from this website what would you do?
    I would add a new language. I would add the same menu but to a new language. Probably on French or German language.
11. Would you use this website in the future? If yes, why? If no, why?
    Yes, if it could help me so as to find books

Questions on the Thesis website

1. What do you think that is the purpose of this website?
   The website had to do with the search of books in different locations.
2. What do you think of the difficulty of the tasks that you had to perform?
   Was there anything difficult to you?
   No, there was not any problem to mention.
3. What do you think of the navigation menu?
   I didn’t like the search option because I couldn’t search for a keyword of a book
title or an author and the only way was when searching for a specific country
and you are obliged to see the books of these countries. This isn’t very helpful
while searching for a book. You could add the name “Umberto Eco” and there
could be results of it showing in which countries the books exist.

4. Could it be also the option that the book has not be added to the system
? Yes, this is a probable option.

5. What do you think of the use of Google Maps so as to perform certain
tasks in the website?
The use of Google Maps was a good option.

6. What do you think with the representation of the results? (Map view
and table view)?
There was no problem, the use of the maps was good.

7. What is your opinion towards the mobile version of the website?
I didn’t have any problem using the mobile version. It wasn’t difficult.

8. What do you think of the options of adding/editing books?
It was a little confusing because you can add many markers on the map and
you cannot eliminate them.

9. Did you understand from the beginning that you had to click on the map
to perform those tasks?
No

10. Did you encounter any problem using this website?
No, the only problem was the one I mentioned before in relation to the search
books option.

11. What is your opinion towards the font resize button that is located in
the About page?
The three options were good. The text could be readable.

12. If you could change something from this website what would you do?
I would modify the search option.

13. Would you use this website in the future? If yes, why? If no, why?
Yes, if it would assist me so as to find books.
Participant 2
Questions on Bookcrossing.com

1. Have you visited the website bookcrossing.com before?
   No

2. What do you think that is the purpose of this website?
   Book exchange

3. What do you think of the difficulty of the tasks that you had to perform?
   Was there anything difficult to you?
   No, I don’t think so.

4. What do you think of the navigation menu?
   It needs some modifications in relation to what is represented on each button. I think that it was not very understandable.

5. What do you think of the user’s profile page?
   It was simple.

6. What do you think of the options registering and releasing a book?
   It was confusing. It wasn’t very obvious of what’s going on

7. Did you encounter any problem using this website?
   No, I didn’t have any problem

8. What do you think of the language change of this website?
   Most of the times it didn’t work and also when you loaded the website the default language was different than the one that was presented. I mean even though English was the default language, Greek was presented. I had to press again the English option so that I can see everything in English.

9. What do you think of the structure of the FAQ page and the FAQ page in general?
   It was not structured. It wasn’t in a correct order.

10. If you could change something from this website what would you do?
    I would change the appearance of the website

11. Would you use this website in the future? If yes, why? If no, why?
    Yes if I need to find a specific book

Questions on the Thesis website

12. What do you think that is the purpose of this website?
    Book exchange.

13. What do you think of the difficulty of the tasks that you had to perform?
    Was there anything difficult to you?
    It wasn’t very obvious of what to do in some tasks and on the map. Maybe if further information was added or a screenshot that could show with appropriate signs what you need to do.

14. What do you think of the navigation menu?
    It was simple.

15. What do you think of the use of Google Maps so as to perform certain tasks in the website?
    It was good. It was a smart choice.

16. What do you think with the representation of the results? (Map view and table view)
    It is as it should be presented. I would like to have the ability to zoom in even if I had to scroll a lot left and right on the page. It is good that the results
were presented on a table view so as to see all the results in a separate row and column.

17. What is your opinion towards the mobile version of the website? I think that because some tasks needed a greater detail such as to move around and click on the map, then it would be better to use it in a desktop version so that you can use a cursor.

18. What do you think of the options of adding/editing books? Maybe if there was a separate pop up outside of the map

19. Did you encounter any problem using this website? When you tried to add a book on the information window suddenly the window disappeared and you had to move around the map and make everything fit in a way so as to see it.

20. What is your opinion towards the font resize button that is located in the About page? It was a good option but it didn’t cause big changes to the text. It changed the text a little.

21. If you could change something from this website what would you do? The forms that you have to fill in. Also because you have logged in it is not needed to ask you all the time to add your username in the forms.

22. Would you use this website in the future? If yes, why? If no, why? Yes probably if I want to find a specific book
**Participant 3**  
Questions on Bookcrossing.com

1. Have you visited the website bookcrossing.com before?  
No  
2. What do you think that is the purpose of this website?  
Book search and registration.  
3. What do you think of the difficulty of the tasks that you had to perform?  
Was there anything difficult to you?  
It wasn’t difficult  
4. What do you think of the navigation menu?  
It was understandable.  
5. What do you think of the user’s profile page?  
It was understandable and simple.  
6. What do you think of the options registering and releasing a book?  
They were easy to perform. I didn’t encounter any difficulty.  
7. Did you encounter any problem using this website?  
No  
8. What do you think of the language change of this website?  
Only a part of the page changed language and not the whole page.  
9. What do you think of the structure of the FAQ page and the FAQ page in general?  
It didn’t have a structure  
10. If you could change something from this website what would you do?  
I would add more language options. The menu to be able to show more languages.  
11. Would you use this website in the future? If yes, why? If no, why?  
Yes if I was looking for a specific book  

Questions on the Thesis website

12. What do you think that is the purpose of this website?  
A database of books around the world.  
13. What do you think of the difficulty of the tasks that you had to perform?  
Was there anything difficult to you? It was understandable. It wasn’t difficult.  
14. What do you think of the navigation menu?  
It was good, understandable. 15. What do you think of the use of Google Maps so as to perform certain tasks in the website?  
It was good  
16. What do you think with the representation of the results? (Map view and table view)  
It was specific, it didn’t have any difficulty. It was understandable  
17. What is your opinion towards the mobile version of the website?  
It was good as a mobile version.  
18. What do you think of the options of adding/editing books?  
The tasks were specific and I had no problem of performing them. I think the less options on these pages will be more usable to the user.  
19. Did you encounter any problem using this website?  
No  
20. What is your opinion towards the font resize button that is located in the About page?
With the myopic problem that I have I would definitely use it (laughs)

21. If you could change something from this website what would you do?
I don’t think that I would change anything

22. Would you use this website in the future? If yes, why? If no, why?
Yes, if I was looking for a specific book.

**Participant 4**

Questions on Bookcrossing.com

1. Have you visited the website bookcrossing.com before?
   No I haven’t.

2. What do you think that is the purpose of this website?
   To search for a book worldwide and register your books.

3. What do you think of the difficulty of the tasks that you had to perform?
   There wasn’t any problem on the tasks. They were understandable.

4. What do you think of the navigation menu?
   It was ok. It had though many options that made it a little confusing with all the information.

5. What do you think of the user’s profile page?
   It was good and simple.

6. What do you think of the options registering and releasing a book?
   They should be placed on a more clear place on the member’s page because I had to check the menu to find them. Also the release book should be easier because I had to go back to the register page to see the book number.

7. Did you encounter any problem using this website?
   Yes. I didn’t understand the purpose of the book map. It changed so quickly locations and I was not sure of what to do. I started clicking on the map but it moved to another location. Also, I was confused with the my bookplates page as in the beginning it was full of information and then everything disappeared.

8. What do you think of the language change of this website?
   It didn’t work. The main language was English. Any other option was shown on the menu and on the rest of the page the English language was default.

9. What do you think of the structure of the FAQ page and the FAQ page in general?
   I didn’t like it. It should be in order. I had to scroll up and down to find the number 1.

10. If you could change something from this website what would you do?
    The language, the FAQ page’s structure and the release book ( to be easier)

11. Would you use this website in the future? If yes, why? If no, why?
    Probably yes if I wanted to add a book and communicate with other users

Questions on the Thesis

12. What do you think that is the purpose of this website?
    Search for books and add your books and edit them.

13. What do you think of the difficulty of the tasks that you had to perform?
    I didn’t have any problem with the tasks.

14. What do you think of the navigation menu?
    It was simple with no irrelevant information.
15. What do you think of the use of Google Maps so as to perform certain tasks in the website?
It was nice. I liked it. It provided a more playful part of the page. It was dynamic.

16. What do you think with the representation of the results? (Map view and table view)
I liked that I could see in detail the book results on a table besides the map view.

17. What is your opinion towards the mobile version of the website?
It was good and simple.

18. What do you think of the options of adding/editing books?
Some fields I think did not need to exist in those forms like the username or the location. I couldn’t remember the location because sometimes I added a map marker and I hadn’t zoom in that country to see the exact location.

19. Did you encounter any problem using this website?
No I didn’t have any problem.

20. What is your opinion towards the font resize button that is located in the About page?
It was good. I liked it.

21. If you could change something from this website what would you do?
The add and edit pages information windows. Information should be kept to minimum.

22. Would you use this website in the future? If yes, why? If no, why?
Yes I would to search or add a book.
Appendix 2: Questionnaire

Note: All the questions have this * sign which means that is required for you to answer all of them
* Required

Name: *
Gender *
- Female
- Male

Age *
- 15-19
- 20-25
- 26-30
- 31-35
- 36-40
- 41-45
- 46-50
- 51-55
- 56-60
- 61-65
- 66-70
- 70+

Bookcrossing website questions
(The following set of questions will be based on the bookcrossing.com website)
1. Was the navigation menu usable for you? *
   1 2 3 4 5
   Strongly disagree Strongly agree
2. Was the registration page usable for you? *
   1 2 3 4 5
   Strongly disagree Strongly agree
3. Did the layout of the website seem simple for you? *
   1 2 3 4 5
   Strongly disagree Strongly agree
4. Is the member’s page easy to be used? *
   1 2 3 4 5
   Strongly disagree Strongly agree
5. Could you locate easily the member’s page in the website? *
   1 2 3 4 5
   Strongly disagree Strongly agree
6. Did the search option provide you the information you were looking for? *
   1 2 3 4 5
   Strongly disagree Strongly agree
7. Is the forum option important to be included in the website? *
   1 2 3 4 5
   Strongly disagree Strongly agree
8. Was the FAQ option usable so as to look for a specific question/answer? *
   1 2 3 4 5
   Strongly disagree Strongly agree
9. Did the language change (from English to another language) assist you so as to perform your tasks efficiently? *
   1 2 3 4 5
   Strongly disagree Strongly agree

10. Please, write here any comments that you have in relation to the bookcrossing.com website (if you liked something, you had encountered any problem, anything you would like to share). *

Thesis website questions
(The following set of questions will be based on the website designed for the needs of the master thesis)

11. Was the navigation menu usable for you? *
   1 2 3 4 5
   Strongly disagree Strongly agree

12. Could you become a member of the website easily? *
   1 2 3 4 5
   Strongly disagree Strongly agree

13. Was the web mapping option (the use of Google Maps in most of the pages) usable to you? *
   1 2 3 4 5
   Strongly disagree Strongly agree

   1 2 3 4 5
   Strongly disagree Strongly agree

15. Could you edit a book easily? *
   1 2 3 4 5
   Strongly disagree Strongly agree

16. Was the font size button in the About page usable to you so as to adjust the font size accordingly? *
   1 2 3 4 5
   Strongly disagree Strongly agree

17. Would you use the website so as to add and edit books? *
   1 2 3 4 5
   Strongly disagree Strongly agree

18. Would you be interested in using a website in a mobile version? *
   1 2 3 4 5
   Strongly disagree Strongly agree

19. What do you think of the mobile version that this website is based on? *
   1 2 3 4 5
   Strongly disagree Strongly agree

20. Would you be interested to use a website in a desktop version? *
   1 2 3 4 5
   Strongly disagree Strongly agree

21. Please write here any comments/suggestions you have in relation to the thesis website (any comments/suggestions are welcome) *

Thank you!
Questionnaire

**Bookcrossing questions**

1. Was the menu usable for you?

![Bar chart](image1)

2. Was the registration page usable for you?

![Bar chart](image2)

3. Did the layout of the website seem simple for you?

![Bar chart](image3)
4. Is the member’s page easy to be used?

5. Could you locate easily the member’s page on the website?

6. Did the search option, provide you the information you were looking for?
7. Is the forum option important to be included on the website?

8. Was the FAQ option usable so as to look for a specific question/answer?

9. Did the language change (from English to another language) assist you so as to perform your tasks efficiently?
Master thesis website questionnaire’s results

11. Was the navigation menu usable for you?

12. Could you become a member of the website easily?
13. Was the web mapping option (the use of Google Maps in most of the pages) usable for you?

14. Could you add a book easily?
15. Could you edit a book easily?

16. Was the font size button in the About page usable for you so as to adjust the font size accordingly?
17. Would you use the website so as to add and edit books?

18. Would you be interested in using a website in a mobile version?
19. Would you be interested to use a website in a desktop version?
Appendix 3: Tasks

Bookcrossing
1. Task description: Check the Registration page and log in.
Scenario: Check the registration page and then log in using the following credentials:: Username/e-mail : booktest16@gmail.com password : booktest
Successful completion criteria: The task is completed successfully when the participant has logged in the website.
2. Task description: Navigate on the homepage.
Scenario: Use the navigation panel so as to navigate yourself in the website. Do you encounter any problem during this process?
Scenario: In this task you need to search for a book in the website’s database by using the book’s title.
Successful completion criteria: The task is completed successfully when the participant enters a keyword in the search option and the relevant results are shown. 4. Task description: Register a book in the database
Scenario: In this task you need to add a book in the website’s database by using the Register a book option under the navigation menu.
Successful completion criteria: The task is completed successfully when the participant has registered a book.
Scenario: In this task you need to release a book by using the Release book option under the navigation menu.
Successful completion criteria: The task is completed successfully when the participant has released a book.
6. Task description: Check the FAQ page
Scenario: Go to the FAQ page and search for the question with the number 1. What do you think of the FAQ page structure?
7. Task description: Change the language
Scenario: In this task you need to change the language of the page by clicking on the language option
Successful completion criteria: The task is completed successfully when the participant has registered a book.

Thesis
1. Task description: Navigate on the homepage.
Scenario: Log in to the mobile version of books worldwide website via your mobile or tablet device and try to use the navigation panel so as to navigate yourself in the website. Do you encounter any problem during this process?
Scenario: In this task you need to search for a book in the website’s database by using any keyword that you wish such as: country, book’s title, book’s author. Successful completion criteria: The task is completed successfully when the participant enters a keyword in the search option and the relevant results are shown.
3. Task description: Check the history of a book.
Scenario: Search for the book Nemesis and check its book history. Successful completion criteria: The task is completed successfully once the par-
4. Task description: Become a member.
Scenario: Register in this website.
Successful completion criteria: The task is completed successfully when the participant has registered in the website.
5. Task description: Forget your credentials
Scenario: Go to the log in page and use the option forgotten your password. When you see your credentials try to log in.
Successful completion criteria: The task will be completed successfully when the user has logged in.
6. Task description: Add a book in the database
Scenario: While in your member’s page, add a couple of books of your choice.
Successful completion criteria: The task will be completed successfully when the participant has added a few books in the database.
Scenario: Edit one of the books that you previously added.
Successful completion criteria: The task will be completed successfully once the participant has edited his/her books
8. Task description: Check your book list.
Scenario: While in your member’s page, check your book list.
Scenario: While in your member’s page, search for a book in the database. You can try to use a keyword such as the name of a country, book’s title, book’s author. Once you see relevant results, check the book history and try to edit the book’s location.
Successful completion criteria: The task will be completed successfully when the participant has edited another user’s book.
10. Task description: Resize text
Scenario: Navigate yourself to the About page and resize the text. What do you think of the resize button option?
Appendix 4: User manual

1. Download and install WampServer. The download of the WampServer can be from here: http://www.wampserver.com/en/
2. Create a folder within the WampServer’s www folder which is located in the program files of your computer.
3. Once the WampServer has been installed then click the WampServer icon to open it.
4. Go to http://127.0.0.1 and click the phpmyadmin option.
5. Click from the menu tab the Databases and write the database name mydb.sql (that can be located in the project folder so as to run the project correctly) and click create.
6. When the database is created at the left side the database’s name can be found. Click the database’s name and from there click the Import from that menu and then press the first choice so as to locate the .sql file from your folder (the thesis folder).
7. When the .sql file is located then the button Execute will be pressed which can be found at the bottom of the page and all the tables of the database will be created.
8. In order to run the project what is needed is to go to the WampServer folder then to www and locate the project’s files and click the homepage.