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# Implementation Phase during Software Development Life Cycle

## Interpreting Tools and Methods

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The purpose of the project was to describe the methods used during the implementation phase of a piece of software. The main idea of the project was to introduce a package of information about the technologies and frameworks such as CakePHP, JavaScript and Bootstrap that help building a software application.

During this project, a search engine application was developed from a previous version by the Bookndo company. A pre-analysis of the old version was made in order to understand more about the main technologies. The goal of the project was to ameliorate the application by manual testing and make manipulating code easier.

As an outcome, designs were updated and new ideas were discussed to improve the software. The thesis presents the technologies used and the final results.

In conclusion, code reusability and testing are the main fundamental elements to improve the software. The technologies that were utilized to improve the software, such as CakePHP and JQuery, are still in use nowadays, although other software exist too.

| Keywords | environment setup, Vagrant, VirtualBox, Meister Task, client side development, frameworks |

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**Abbreviations and Terms**

| | |
|---|---|
| Ajax | Asynchronous JavaScript and XML. Ajax is the art of exchanging data with a server, and updating parts of a web page - without reloading the whole page. |
| CakePHP | An open-source web framework. It uses the model-view-controller approach. It has different features such as flexible licensing, code generation and localization. |
| CSS3 | The latest version of the Cascading Style Sheets language. It describes how HTML elements are to be displayed on screen. |
| GitHub | A version control system designed for software development and other version control tasks. |
| Git Bash | It is comprised of two parts: Git, which is a version control, and Bash. It is a shell that runs command lines. |
| HTML | Hypertext Markup Language for creating web sites. It describes the structure of webpages and it contains different elements such as heading, table, and paragraph. |
| JavaScript | An object-oriented programming language commonly used to create effects within web browsers. |
| JQuery | A JavaScript library that simplifies HTML document traversing, animating, event handling and Ajax interactions for rapid web development. |
| Linux | An open source software operating system for computers. |
| MeisterTask | An online task management tool that runs inside a standard web browser. It is used to manage projects of all types and sizes. |
| MVC | Model View Controller. |
| OneSkyApp | A translation management system that help to translate strings that are extracted from an original website. Once the translation is done, a new file can be downloaded and added to the project. |
| PostgreSQL | an object -relational database management system. It has a strong reputation for reliability, data integrity, and correctness. |
| Sass | An extension of CSS that adds power and elegance to CSS. It allows using nested rules, mixings, variables, and inline imports. |
| SDLC | Software Development Life Cycle. |
| Slack | A messaging application for teams. It brings all communication into one place, and it is available on both mobile devices and desktop computers. It |

contains different features such as uploading and sharing files between team members, creating channels and direct messages.

SQL         Structured Query Language.

Vagrant     Open-source software for building and maintaining portable virtual development environments. It lowers development setup time, and increases production parity.

WinSCP      A free tool and open source for Microsoft Windows. It is used to transfer or update files between local and remote control.

XML         eXtensible Markup Language which is designed to store and transport data.
            .

# 1   Introduction

Nowadays, the use of web applications has grown rapidly because of user needs. This thesis intends to introduce a list of web technologies, which were utilized to build an application that would meet certain goals.

The project took place at a company called Bookndo. It is a private start-up company which operates in the field of health, fitness and sports. It was founded in 2013 in Helsinki. Bookndo provides a search engine application which allows different types of users (individuals and service providers) to search for and book sports activities in Finland.

This project aimed to present an overview of how the coding phase during a software development life cycle is handled. The thesis describes how software is implemented and what tools were used while working on the project.

At Metropolia University of Applied Sciences, Finland, there was a good amount of curiosity among students who need to do an internship at an IT company about the tools used to build an application in a real working company. Furthermore, the students were also confused about the technologies used during an internship. Therefore, this thesis tries to clarify the confusion and problems faced during the work.

The work carried out during this project was to fix bugs, add new features and test the previous tasks to make sure they were implemented correctly. The software is expected to be used by customers that are located in different countries. Matters such as languages, communication and prices had to be taken into consideration.

Additionally, the purpose of this thesis is to describe different steps to go through during the coding phase of software. In practice, various types of testing was executed to ensure the quality of the built software.

## 2   Theoretical Background

Creating software from scratch is a highly challenging task. It usually requires a lot of work to make a decision on how an application should be built out. Many software exist which use a long list of requirements and details. Questions such as "Which technologies are applicable for the software?" and "How to make code reusable in other applications?" are usually challenging questions to answer. However, a good starting point is needed to define the application and its possibility to attain a good outcome in sports and fitness market.

As a frontend developer, there is more focus on the client-side of the application. There are also a few decisions to be made. First, it is important to decide which frameworks or libraries are suitable for the system requirements, and how to improve the application with minimum changes in the future.

There are different frameworks available such as JQuery, Angular, Backbone[1] and React. Each framework has its own characteristics and features. However, since the Bookndo application was built based on JQuery, adding any new features or improvements will be based on that.

The architecture of the application has been already made by previous developers, and a list of instructions including designs and tools were also given to new trainees. For the server-side scripting, CakePHP was the developer's choice for its features and advantages.

### 2.1   Client Side Development

### 2.1.1   Hypertext Markup Language

Hypertext markup language (HTML) is the core language for building web sites. It is universally used in web development and responsible for marking up and structuring the content of all pages. Matters such as color, positioning of elements, and decoration are

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[1] http://backbonejs.org/

the job of the Cascading Style Sheet (CSS), which is briefly discussed in the next section. [1, 3-4.]

The latest revision used in the Bookndo application is HTML5. It has different features that allow developers to build web pages that are smarter and faster than the old version of HTML. [2, 1-2.]. For better understanding, listing 1 shows an example of HTML5 elements that are used for making good structure of a web page.

```html
<!DOCTYPE html>
<html>
      <head>
            <meta charset="utf-8">
            <title>Title of the document</title>
      </head>
      <body>
            <header>    </header>
            <article>  </article>
            <section>  </section>
            <footer>   </footer>
      </body>
</html>
```
Listing 1. HTML document example

As shown in listing 1, the first line contains a small piece of code, which indicates to the browser that it is compliant with HTML5. The browser examines the DOCTYPE to load the right grammar to speed up parsing and rendering the content of the page correctly.

The most interesting new HTML5 elements are semantic attributes, graphics and multimedia. HTML5 is also using a new application programming interface such as geolocation, drag and drop, local storage and application cache. [2, 1-2.]

It is important to know at least the basics of HTML5, because knowledge of HTML5 was required to be able to build the search engine application for Bookndo that was done in the project documented in this thesis.

2.1.2   Cascading Style Sheet

Cascading Style Sheet is a language used to describe the style of an HTML document and how the content should be displayed. It is utilized to control the visual aspect of a

web page, including colors, background colors, element positioning, fonts, images, and other design aspects. [3, 6]

```css
section {
        font-size: 16px;
        color: #CC0000;
}
```
Listing 2.  An example of CSS code

Listing 2 is an illustration of CSS that defines the font size of all content within an HTML element called `<section>`, using 16 pixels with the red color. The HTML tag `<section>` is used for selecting the element that the style must be applied to; the code inside curly braces describes the style.

The application uses different CSS files for different purposes. Based on the designs and decisions made for choosing colors, background colors, and the layout, creating these files was a must to meet the project goals and fulfill its requirements.

### 2.1.3   JavaScript

JavaScript is the web programming language used to build interactive and dynamic websites. Developers can use it to change stylish appearance when it is loaded into the user's browser. It is useful for listening to events and mouse clicks. [4, 1-2.]

JavaScript uses different key terms such as variables, objects, functions, and events. Understanding the basics of JavaScript was a must to meet the needs of the customer in the project documented in this thesis. There are two options for adding JavaScript, it can either be inside an HTML file, or linked to external JavaScript files. The example in listing 3 shows an inline script.

```html
<script>
        window.onload = function() {
                document.write("Welcome");
        };
</script>
```
Listing 3. An example of inline scripts

As shown in listing 3, an inline script was added to an HTML file. This script uses an event called `onload`. When a page finishes loading, it will display the text "Welcome.

Since the application is based on the JQuery library, it will be a good chance for new trainees to practice and get to know how to use it in different situations. More about JQuery and its features will be presented in section 2.2.1.

2.2   Frameworks

In this section, some frameworks are introduced which are used to implement the application for booking and searching for sports activities. Since the prerequisites were already chosen before I joined the client company, it is necessary to list them out to give a brief idea of what the software was built over.

A framework is a collection of libraries or codes that allow an application to use prewritten functionalities. It is the base that developers can build over to support the development of web applications. Each framework provides features and functions which are already tested and proved to be functioning. It means that the code is reliable and can be reused in different applications. There are different open sources which allow anyone to use web frameworks for free. [5, 34.]

There are different advantages for choosing a specific framework, for example, pre-written functions which are composed, tested and developed by engineers. The codes are reusable which means speeding up the development process of the project. Therefore, frameworks allow developers to give attention to developing the software requirement rather than preparing tools and the environment of application development. Moreover, each framework follows its own design pattern. Thus, using a specific framework includes following their particular coding. Additionally, they promote a design pattern which makes it easier for developers to understand the code faster.

Most frameworks are open sourced which means free access to their functionalities and features. Developers are not obligated to start from scratch and worry about features while developing the application. [5, 35; 6.]

Frameworks have advantage aspects but also disadvantages. Here are a few:

- In some cases, it will take time to get used to a new development methodology when working with application frameworks. Sometimes, comprehending the development methodology could be a challenge.
- Each application framework uses specific syntax for many functionalities that they expose. It may take time to get the exact documentation when needed.
- Most frameworks are providing a single templating system, already defined to be used. However, this might be a limitation for some applications. This is considered as a small disadvantage because some developers might prefer to choose individual components for building their applications.
- In order to benefit from the tools offered by a specific framework, the developers are required to spend more time in improving their skills. Sometimes moving from one framework to another might cause time loss.
- Some frameworks do not offer flexibility and tend to be stricter in development. In case developers use the wrong framework, they will end up doing extra work to solve certain challenges. Therefore, choosing the right framework is an essentia point.

[5, 35-36.]

In the following section, a brief definition is given of some frameworks that were used to implement the desired software.

2.2.1   JQuery Library

JQuery[2] is a rich and small JavaScript library. It helps in making HTML documents traversal, manipulated with animation and event handled. It provides a simpler way for selecting page elements. It uses the same syntax as CSS, because it refers to IDs and classes. It is a collection of code that can be reusable, which means there is only a little code. Moreover, some libraries address issues such as browser compatibility and other browsers are used to develop interactive gadgets for the pages. [7, 1.]

The benefits of using JQuery are for example functions for updating the content of elements and properties as well as manipulating CSS styling. It contains different functions that serve for adding effects such as animations and fades to the web pages. As shown

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[2] https://jquery.com/

in listing 4, JQuery code can be added to the `head` tag, but it can be also added to the body section. [8, 4-5.]

```html
<!DOCTYPE html>
<html>
    <head>
        <script src="https://cdnjs.cloud flare.com/ajax/libs/
            jquery/3.2.1/jquery.min.js">
        </script>
        <script type="text/javascript">
                $(document).ready(function(){
                        $("button").click(function(){
                                $("p").hide();
                        });
                });
        </script>
    </head>
    <body>
         <p>This is a paragraph</p>
        <p>This is another paragraph</p>
        <button>Click to hide paragraph</button>
    </body>
</html>
```
Listing 4. JQuery Hide method

JQuery is a very powerful library. Listing 4 shows simple code to hide all paragraphs which are found on the page. When the user clicks the button, a JQuery method will be executed and all paragraphs will disappear. There are many functions, which are very useful to build responsive web applications using selectors, events, and effects.

It is seen as an advantage if all trainees know how to use JQuery, for example, by participating in school projects or by building their own applications. Additionally, in web development, most developers are expected to understand the basics of jQuery, as it helps to build highly interactive applications.

### 2.2.2   Bootstrap

Twitter Bootstrap[3] is a popular stylesheet cascading framework. It provides crafted user interface elements, JQuery plugins and layouts. It is an open source for developing responsive, mobile projects on the web. It makes front-end development faster and easier.

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[3] http://getbootstrap.com/

It comes with ready-made styles for navigation, typography, forms, tables, buttons and more. [9, 23.]

As any other framework, Bootstrap has its own properties. The following points highlight the advantages of using Bootstrap:

- It works mostly on all browsers and devices. The latest versions of browsers and platforms are supported. In addition, all the latest desktop and mobile browsers can display the content in a better way.
- Bootstrap is easy to customize. It means that parts which are not needed can be deleted and only grids can be kept.
- It provides useful jQuery plugins that come handy when needed.
- Using media queries, applications become responsive on small devices. This means the grids start floating and adapting with the screen size.

There are other advantages of using the Bootstrap framework which are not discussed in this thesis such as a wide range of jQuery plugins and the dynamic stylesheet language LESS, which gives flexibility and advantage to use it in order to write different styles. [10, 23.]

### 2.2.3   Cakephp Web Framework

Learning a new framework such as CakePHP[4] can be a challenge and exciting at the same time. However, the documentation of CakePHP could help understand better when, how and where to use it.

CakePHP is a rapid and new framework for PHP. It makes building applications faster and simpler, while writing less code. It provides an extensible architecture for developing, maintaining and deploying web applications. Figure 1 shows different layers when page is requested. [11, 20.]

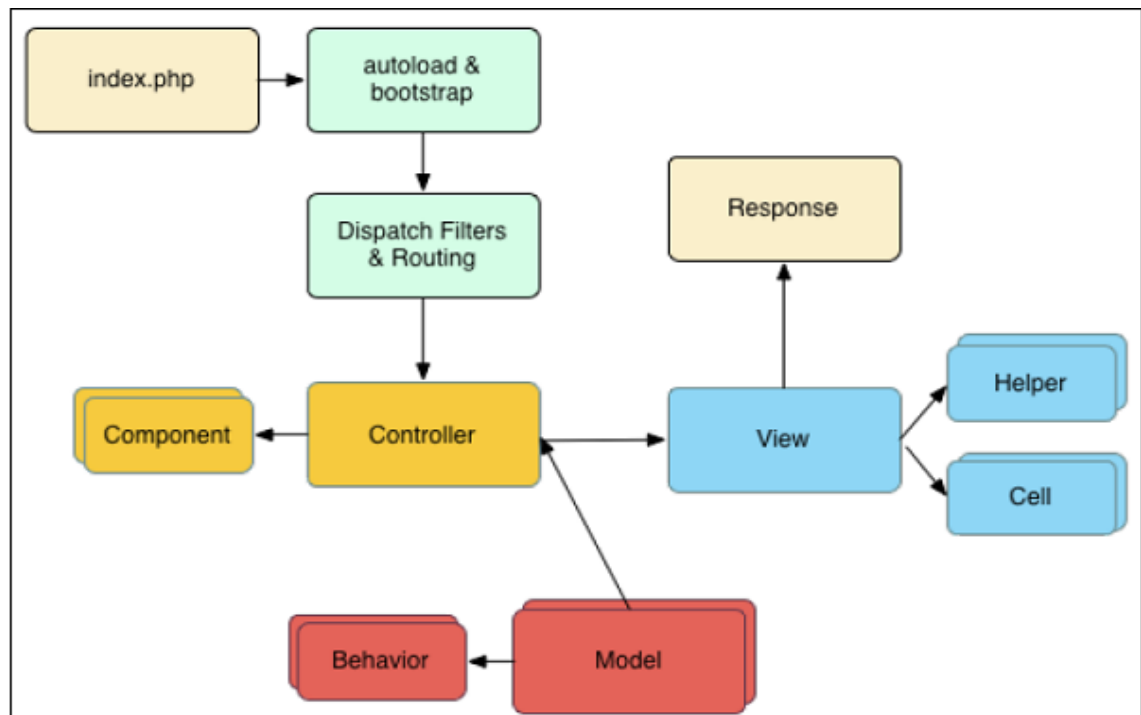---

[4] https://cakephp.org/

Figure 1.  A request cycle in CakePHP.  Copied from CakePHP Cookbook (2017) [12]

The model CakePHP request cycle begins with a user requesting a page in an application. As shown in figure 1, each request goes through different steps. First, the application is bound and loaded to an HttpServer, then the Middleware is initialized. If no response is found, a controller and action is to be selected. When the controller's action is called, it interacts with the models and components. The response is delegated via the controller to the view in order to generate the output from the model. Each view uses helpers to output the response headers and body. Finally, a response will be sent back through the middleware, and the HttpServer forwards it to the web server.

There are different benefits and advantages for choosing the CakePHP framework. It uses the Model View Controller Pattern (MVC). The model supports data handling by inserting, updating, deleting or reading the data from the database. The view supports the display of data on the screen. The controller responds to different events (based on the user's action) and modifies data before interacting with the model. Therefore, it is easy to separate the logic functions from the view. Moreover, it is an object relational mapping technique for converting data between different systems. It means that every class represents a table. In these classes, it is possible to define relations between tables. Once the relation definitions are properly defined, there will be no need to write structured query language (SQL). [13, 5.]

In addition to what has been mentioned earlier, CakePHP has other features. For example, no configuration is required, which means that the developers are not required to configure the framework. All libraries are auto-detected; however, the only thing to worry about is the database connection settings. CakePHP has built-in validation, which means it is possible to attach multiple validation rules to a single field. Furthermore, this framework is declared as an excellent and authorized tool. There are many built-in tools such as SQL injection prevention and input validation for preventing attacks and unwanted actions. Besides, it is possible to create test cases to ensure that all functionalities of the application work properly. Some parts of the application are critical; therefore, it is highly recommended to check the performance of the application carefully. [13, 5.]

Choosing CakePHP as a framework to build the Bookndo application is based on long research, taking into consideration the skills gained by developers during their studies.

In summary, this chapter has included a discussion on how important it is to have the basic skills in web development, especially in HTML5, CSS3 and JavaScript. Additionally, a general idea was presented about the advantages of using frameworks such as Bootstrap and CakePHP.

2.3   Software Development Life Cycle

The software development life cycle (SDLC) is a framework used in project management. It helps to define tasks that must be handled during the development process of each phase. Figure 2 describes various software development phases. However, the focus in this final year project was on the development and testing phases. The SDLC is used in software development, within a software company. The process illustrates a methodology for making better software quality as well as the general development process. It is highly recommended to follow the SDLC phases in order to meet customer expectations. As seen in section 4.2, Bookndo is following the V model architecture, where executions happen sub-sequentially. The model is well-known as verification and validation.
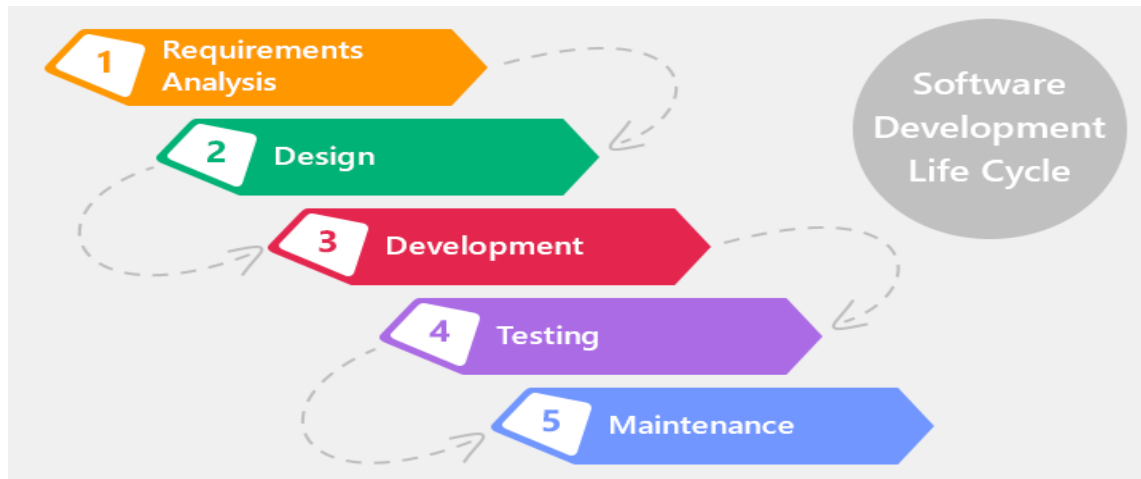
Figure 2. Software development life cycle phases. Copied from Gordiyenko (2017) [14]

As shown in figure 2, there are different phases in a software development life cycle. The first phase is requirement analysis. It is also called requirement engineering. In this phase, gathering software requirements from the client, description of features, and functionalities of the target application is necessary to develop a sophisticated document which contains a system requirement specification. Additionally, requirement analysis includes the interaction between the users and a certain product. The requirement engineering process includes different steps to go through. A feasibility study is done to analyze all details about the desired system and its functionalities to make sure it is feasible to build. It is highly recommended to focus on the organization to find out whether an application can be practically developed. The result of this step should be a feasibility report that contains comments and recommendations. The next phase is to start gathering requirements from the user. Engineers communicate with the client or end users about what the application should provide and what kind of features the application should include. It is always accompanied with documents such as user interface requirements, technical requirements, design requirements and development requirements. [15, 63.]

The software design is a process to convert client requirements into a suitable prototype, which helps software developers to implement the application. The design must take into account all specifications of the software, algorithms, and architecture design. There are things to consider in this phase of the software development life cycle such as compatibility, maintainability, modularity, performance, and scalability. The design documents might include architecture design, data design, interface design and procedures. [15, 231.]

## 3 Methods and Materials

Bookndo has two types of clients, individual users and service providers. The architecture for each client will be introduced in the following subsections. The output of the design process is design detailed logic diagrams, including functional and non-functional requirements. It is very important to verify the results before going further to the next phase.

### 3.1 Bookndo Architecture

### 3.1.1 Individual User Module

Individual users can create their own profile and participate in different activities. It depends on which city the user is from or in which location he/she is interested. Individual users are the participants. A user can be one person or more. Sometimes, a small team might be interested in doing just one activity. Therefore, this aspect must be taken into consideration while developing the desired application.
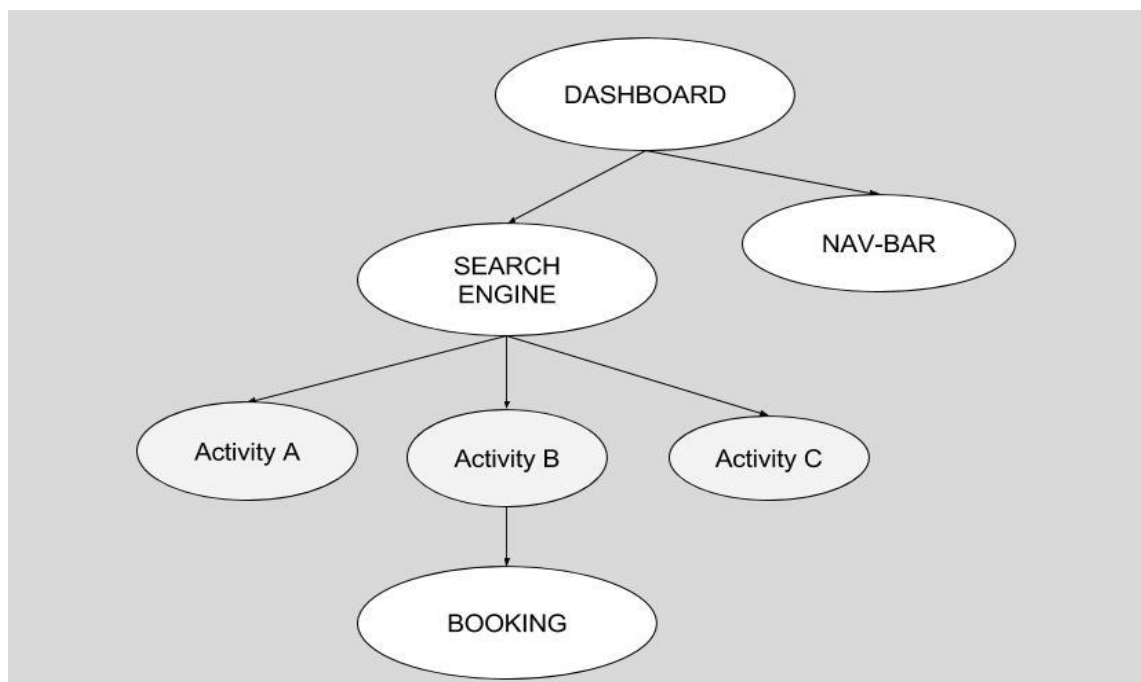


Figure 3. Individual user architecture

As shown in figure 3, all users will be able to create their own account. After a successful login, users can make a quick search for available activities based on the number of the

participant and the location. If an activity is found, it will be displayed and the user can select anything he/she is interested in. Furthermore, information such as description, date, time, and the price of the selected activity will be previewed before reaching the payment phase. It is possible also to change an activity with another. Additionally, a booking form and payment information is the final step before attending an activity.

The navigation bar provides users with extra options, such as switching from one language to another. The application is translated into six languages which are Finnish, Estonian, Russian, Italian, German and English. Additionally, users have the possibility to update their profile information. Moreover, a booking history page where users can access their previous bookings. Furthermore, the application can be used by different types of individual users, even by those who come to Finland as tourists.

### 3.1.2 Service Provider Module

Service providers are the second type of customer that is targeted through the Bookndo application. The company is providing a platform which allows them to create and advertise their own events. Figure 4 shows the architecture of the service provider, including the main components of the Bookndo interface.
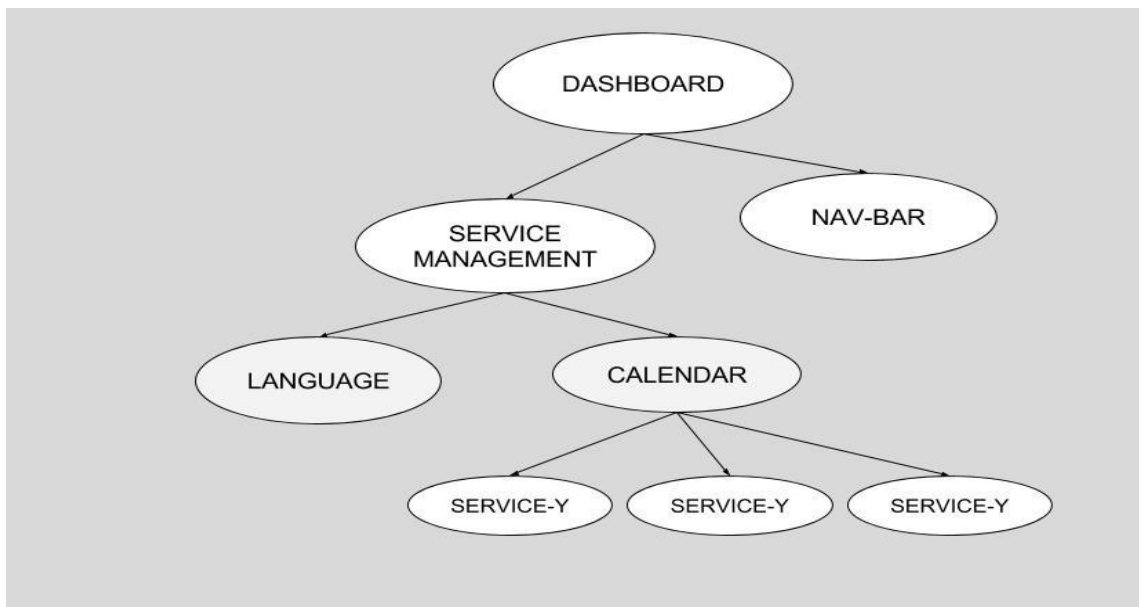


Figure 4. Service provider architecture

As shown in figure 4, service providers have the possibility to create different service "events". These services will be used to invite individuals to participate in various activities. When a service is created, it will be added to the calendar based on the language selected by the user. These services are managed by service providers who are able to see the list of participants.

The calendar contains a list of events or activities that were created by service providers, with information about the number of participants, date and time. Moreover, when a service is created, it can be translated into other languages. A service provider has the possibility to duplicate services if needed, because there are participants who can take part in an activity more than once.

The project started in 2013. The first three phases of the software development life cycle were already implemented by previous teams; however, my mission as a new trainee was to update the old functions and to add new features to the Bookndo application. Therefore, the focus of the final year project was on the implementation phase of the built application.

## 3.2    Setting up the Development Environment

In order to start working on the target application, all trainees needed to set up the environment. This is the first step when a team reaches the coding phase. There are different tools to be used and a few dependencies to be installed. In the following sections, a list of the tools is given need to be installed before starting solving tasks.

### 3.2.1    Vagrant

Vagrant[5] is a tool for managing and building virtual machines. Most startup companies use it for its advantages. Vagrant increases production, lowers development environment setup time and gives the opportunity to focus more on automation. It is easy to configure; it has portable work environments and it is reproducible. It is controlled by a single workflow for more productivity and flexibility of the team. [16, 21.]

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[5] https://www.vagrantup.com/

Other tools such as browsers, editors, and debuggers will not be affected. When a member of the team creates a single Vagrant file, they need to `vagrant up` to install and configure everything. This means that other members can setup their development environments using the same configuration. Therefore, all the teams can run code in the same environment even if they are using different operating systems. There are other tools to manage development environments and virtual machines. Each tool has its own properties. It is highly recommended to use the Vagrant documentation to understand how to use it for small projects as well as large ones.

Vagrant can be installed on the Windows, Linux, and Macintosh operating system. It requires another tool for virtualization such as VirtualBox. To get Vagrant running on machines, VirtualBox should be installed.

3.2.2   VituralBox

VirtualBox[6] is a powerful virtualization product developed by Sun Microsystems as Sun VirtualBox. Later on, it became an Oracle product. It is efficient, cross-platform, robust and high performance in nature. VirtualBox has many features, which make it the first choice for many companies. It can run on different operating systems, which means a virtual machine created on one host can be run on other hosts. Additionally, it enables the user to manage virtual machines collectively as well as individually and helps access any guest virtual machine. [17, 24-27.]

VirtualBox creates a special environment for different operating systems. In other words, there is a possibility to run a guest operating system in a virtual machine. In general, a virtual machine will be displayed as a window on a computer's desktop, but it depends on the various frontends of Virtualbox which are used. Most startup companies use Virtualbox, as it helps solve many issues and improve development. [18, 13.]

It was important during the implementation of the Bookndo application to make sure that all necessary tools and dependencies are installed. As mentioned before, the installation

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[6] https://www.virtualbox.org/

of Vagrant and Virtualbox were considered as the first task which all developers must do in order to participate in the development of the Bookndo application.

3.3   Task Management and Communication Tool

While developing new software as discussed in chapter 2, it is highly recommended to go through the software development phases of the company in question. After gathering the requirements and making a design, it is time to start coding and implementing the application.

In order to begin solving problems and given tasks, it is necessary to mention that each company uses its own task management and communication tool. There are many tools in the market. However, the focus is going to be on the tool used by the Bookndo company.

3.3.1   Meister Task

Meister Task[7] is a task management tool. It has flexible project boards. It is easy to adapt with the team workflow ensuring that everyone is progressing and finishing their tasks. After accessing Meister Task, there will be a list of pending tasks which are assigned to each team member individually. Meister Task is easy to use and a few companies consider it as Kanban based.

As seen in figure 6, when a task is created by a lead developer or trainer, it is assigned to a specific member of the team in order to be solved within a specific amount of time. This means every task has its own deadline.

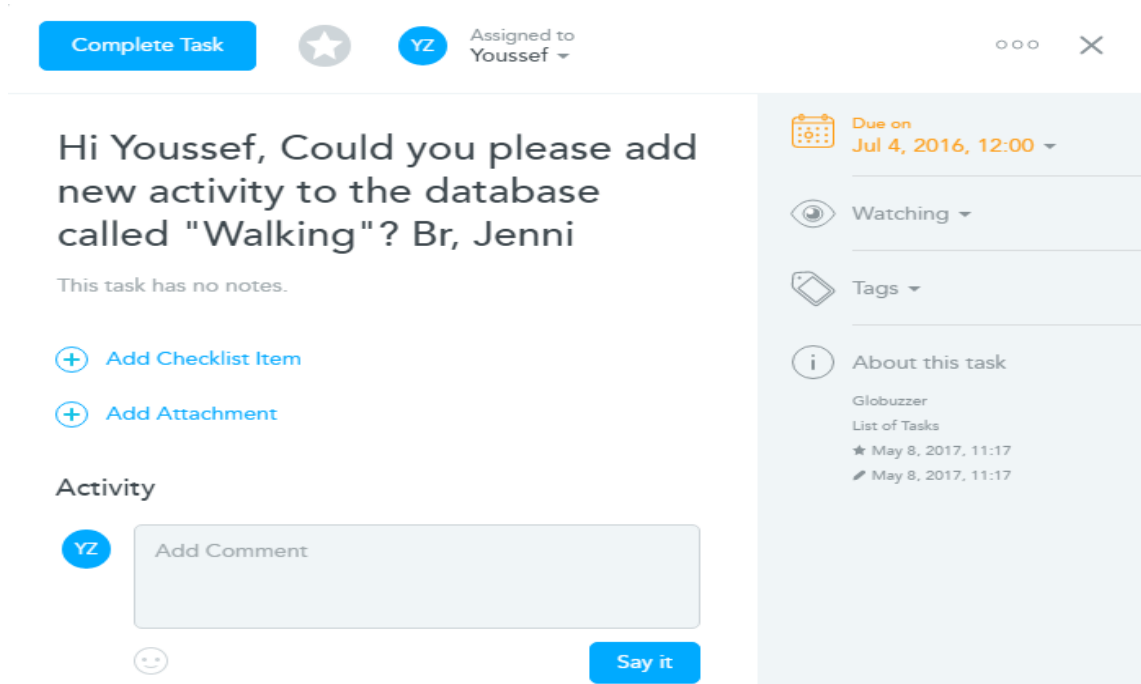---

[7] https://www.meistertask.com/

Figure 6. A task about adding a new activity to the sports activities database. Copied from Meister Task [19.]

As figure 6 shows, a task was created by a team leader asking one the team members to add new activity to the sports activities database. A deadline has been chosen beforehand. A trainee must first look at the assignment and read it carefully before starting to work on it. There is a text-area which can be used to discuss the details of the task. The text-area means that the team can communicate by asking further questions or clarifications.

In practice, when a task is checked, it will be moved to the "in progress" board for implementation. As soon as the task is completed, it must be moved to another board called "Testing" for testing. A software tester is going to test it to make sure that it is solved successfully. When a task is solved as it is supposed to, feedback from the tester is to be reported to the trainee or a comment is to be added to the task in order to clarify what went wrong and how the task should be implemented. Additionally, one of the most important features of using a task management tool as Meister Task is that it is easy to follow the team and to check the progress of each member separately.

There are other task management tools; however, Bookndo is using Meister Task because of its characteristics. It is necessary to understand how to use the task management tool in order to solve tasks in time and also to communicate with the others when needed.

3.3.2   Slack

Slack[8] is a team collaboration tool. It is used for communication purposes. Whenever trying to reach other team members, or willing to have a discussion about any topic, Slack offers the possibility to communicate and to create channels. Many companies are using Slack, because it is possible to create channels for different purposes. For example, all developers can have their own channel to communicate about technical challenges, ideas and issues.  [20.]

Slack has many advantages which are listed below:
- The whole team can communicate one channel.
- There is integration with other services such as GitHub and Meister Task.
- Any content or message can be found by using the search box.
- A possibility to share files and documents with the entire team exists.
- It is possible to share and test code snippets.
- Exchanging messages privately is possible between team members.
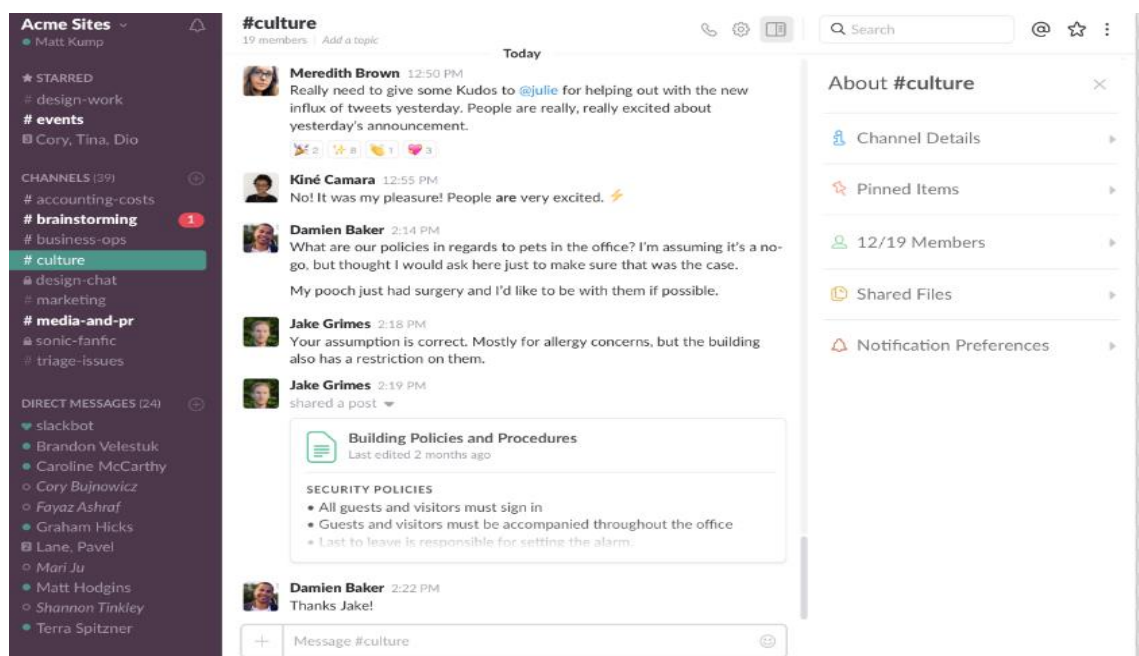- It is accessible anywhere, because it has a mobile application too.



Figure 7.  Slack interface (Channels and users). Copied from Slack [20]

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[8] https://slack.com/

As shown in figure 7, this tool can be used for school projects. It makes the communication faster and easier. It is good for sharing ideas and suggesting solutions. In the final year project, there were tools which were used during the implementation of the Bookndo application such as Skype and Facebook. As mentioned previously and as seen in figure 7, there is a possibility to create different channels for different purposes. Figure 7 shows a list of team members, who can be contacted individually and also invited to join new channels.

### 3.3.3 Git

Git[9] is a tool for managing and tracking different versions of software. It was created by Linus Torvalds to support the development of the Linux kernel. It is a powerful and flexible tool that makes collaborative development easy. [21, 1.]

Bookndo uses GitHub[10] for web-hosting, because of its features such as code review which is used to ensure the quality of code. It is also considered as a project management tool, because it offers the opportunity to track and update the work of each team member in one place. Additionally, it has hundreds of integrations to choose from.

When a task is solved in the local environment, all changes must be saved and merged to GitHub. There are a few command lines to execute, in order to update the repository with the new changes.

```
git checkout -b task_name
```
This command line is used to create a new branch, which means giving a name to the solved task.

```
git status
```
This command is used to display the changes made by a developer. The command displays a list of the updated in red.

---

[9] https://git-scm.com/
[10] https://github.com/

```
git add file_which_was_updated
git commit -m "Describe the reason of the commit"
```

These command lines are used for adding changes to a commit. Additionally, they help in understanding the solved problem by adding description to the solved task.

```
git push Remote task_name
```

This is the last command line which is used to send all the changes to the repository.

It is highly recommended to remember the command lines described above. They will be repeated each time a task is solved. Additionally, there is documentation[11] that contains other command lines which are not listed above, but which are very important to use while working on a project.

In this section, a review was presented of the most important tools that were used while developing the desired application. Meister Task and Slack were the most significant tools that were used in this project. It is an advantage for new trainees to be familiar with these tools because they play a key role in their internship. Furthermore, being familiar with the tools allows them to focus more on improving the Bookndo application.

## 3.4   Examples

The implementation phase is also referred to as the coding or constructing step, which is based on the design phase. It is essential to keep in mind how to build good software, taking into account the user's background. During the implementation of the Bookndo application, there were several tasks related to frontend and backend. There were new features to be added based on the user's feedback too.

This section gives a description of the steps needed to be followed in order to solve a task.
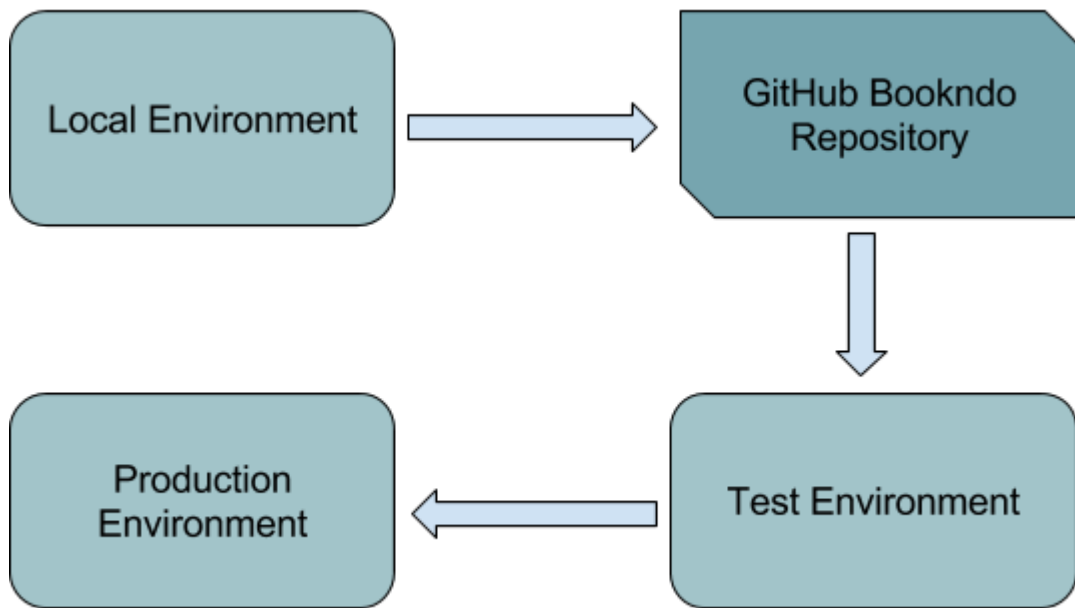
---

[11] https://git-scm.com/documentation

Figure 8. Flow of different environments

As shown in figure 8, the Bookndo environment was divided into three parts; local environment, test environment and production environment. In general, all new trainees mostly used their local environment to get familiar with the project files and to understand how to solve tasks. Before looking at a few examples, understanding the role of these environments is important as it gives a clear idea about the process of solving a task before it is published and available for customers.

The local environment is the first part to work with. This means that all tasks should be solved first within a local computer (localhost). When a task is solved and tested, it must be moved to the test environment. Therefore, when a task is completed, it will be pushed to the project repository (GitHub repository) using the GitBash tool. It is very important to learn how to use UNIX commands as they are required in many companies.

The test environment is used to test and check the tasks that have been implemented by developers in order to make sure that they solve the problem as expected. This is the role of a software tester; however, most developers can both solve tasks and at the same time test them manually. All developers and trainees have access to the GitHub repository. This means they are able to review each other's tasks. Therefore, if a task is tested without any issues and contradictions, it will be merged into the test environment. Additionally, all edited files have to be updated to the server.

The production environment is the final step where all solved tasks are published. All files in the server must be updated. Therefore, after an update, all new features or solved issues are visible on the Bookndo website.

Next two examples are reviewed to understand how a task must be solved. The first example is a task about adding a new activity called "Walking" to the database. Figure 6 shows a task that has been assigned to one of the team members. First, the developer must understand the task to avoid any misunderstanding, he/she should ask additional questions to clarify what is expected from him/her or her to do. The second step in solving a task is to identify which file to work with. This is a sensitive case as sometimes new trainees might mistake one file for another. Therefore, it is very important to ask for assistance in order to find which file to work with.

```
<changeSet id="43" author="youssef">
        <insert tableName="sports_activities">
            <column name="name" value="Walking"/>
            <column name="icon" value="sports/summer_2.png"/>
        </insert>
        <rollback>
            <delete tableName="sports_activities">
                <where>name in ('Walking')</where>
            </delete>
        </rollback>
</changeSet>
```
Listing 5.   Adding new activity to the database.

The code in listing 5 illustrates a method for adding a new sport activity called "`Walking`" with a photo icon to the "`sport_activities`" table. The code shows the name of the person who is adding the activity to the database. In this case, it is "`youssef`". There are two tags, `<insert>` and `<rollback>`. By using the `<insert>` and `<column>` tags, the data will be added to a table called "`sports_activities`". This table is composed of two rows, name and icon, where the data will be stored.

Furthermore, a new tag called `<rollback>` is used to ensure it is not added more than once to the database. This means that the activity is not duplicated. In case the activity exists already, it will be overwritten by deleting the old one and inserting the new one. Therefore, a new activity is added to the database. Finally, it will be displayed within the list of all activities in the database and found by users while searching for an activity on

the Bookndo website. When this operation is done successfully, there will be only final step to go through, which is the GitBash command lines as discussed in section 3.3.3.

```
1)    After that, open Terminal or GitBash
2)    Enter ssh@produc-bookndo.cloudapp.net
3)    Enter password
4)    Enter cd /
5)    Enter cd /var/www/bookndo2/db/
Enter ./liquibase update
```

Figure 9.  Updating the database in the server.

All necessary steps for updating the database in the server are described in figure 9. It is considered as a final phase before displaying the new activity in the table. In order to make sure that the new sports activity was added successfully, it is important to check the list of sports activities by accessing Bookndo tools as an administrator. As a result, the new activity is inserted in the database and displayed as shown in figure 12.

The following example is a bug that has been reported by the users of the Bookndo application. The Bookndo company has received many emails and calls from service providers and individual users informing that the footer section is covering the content of some pages, which makes it difficult for them to update their profiles and display information about the list of sports activities.
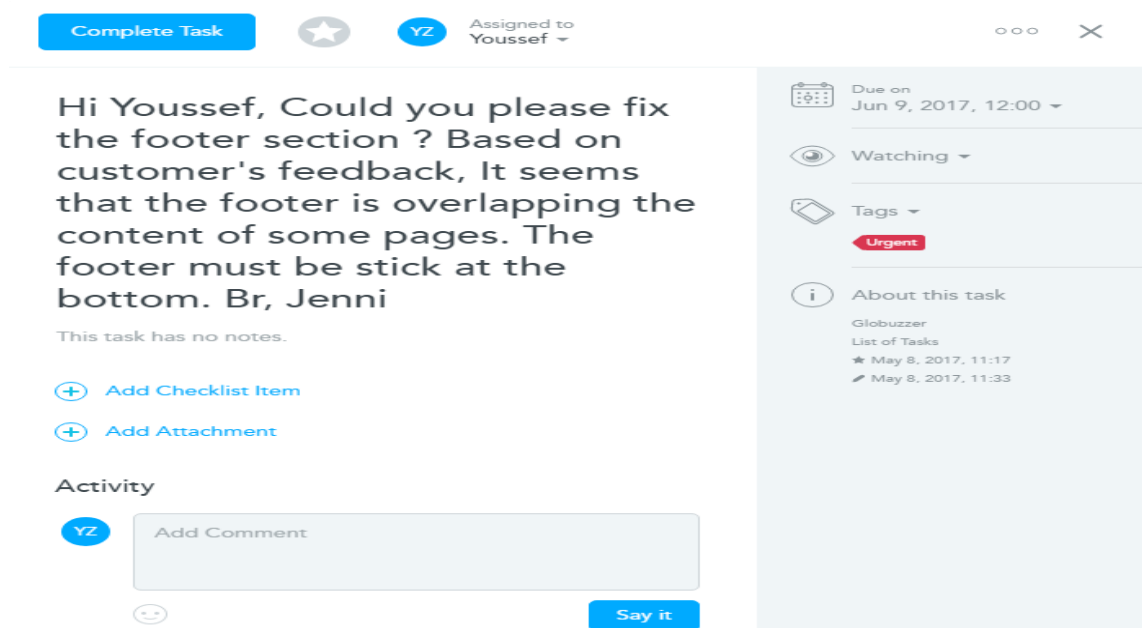


Figure 10.  A task review. Copied from Meister Task [19.]

Figure 10 describes a task which is considered urgent. This challenge was assigned to a member of the frontend team. It seems that the footer section is overlapping the content of a few pages and does not appear at the bottom as it should. After understanding the objective of the task, the developer has to review the application to see the issue in action as depicted in figure 11.
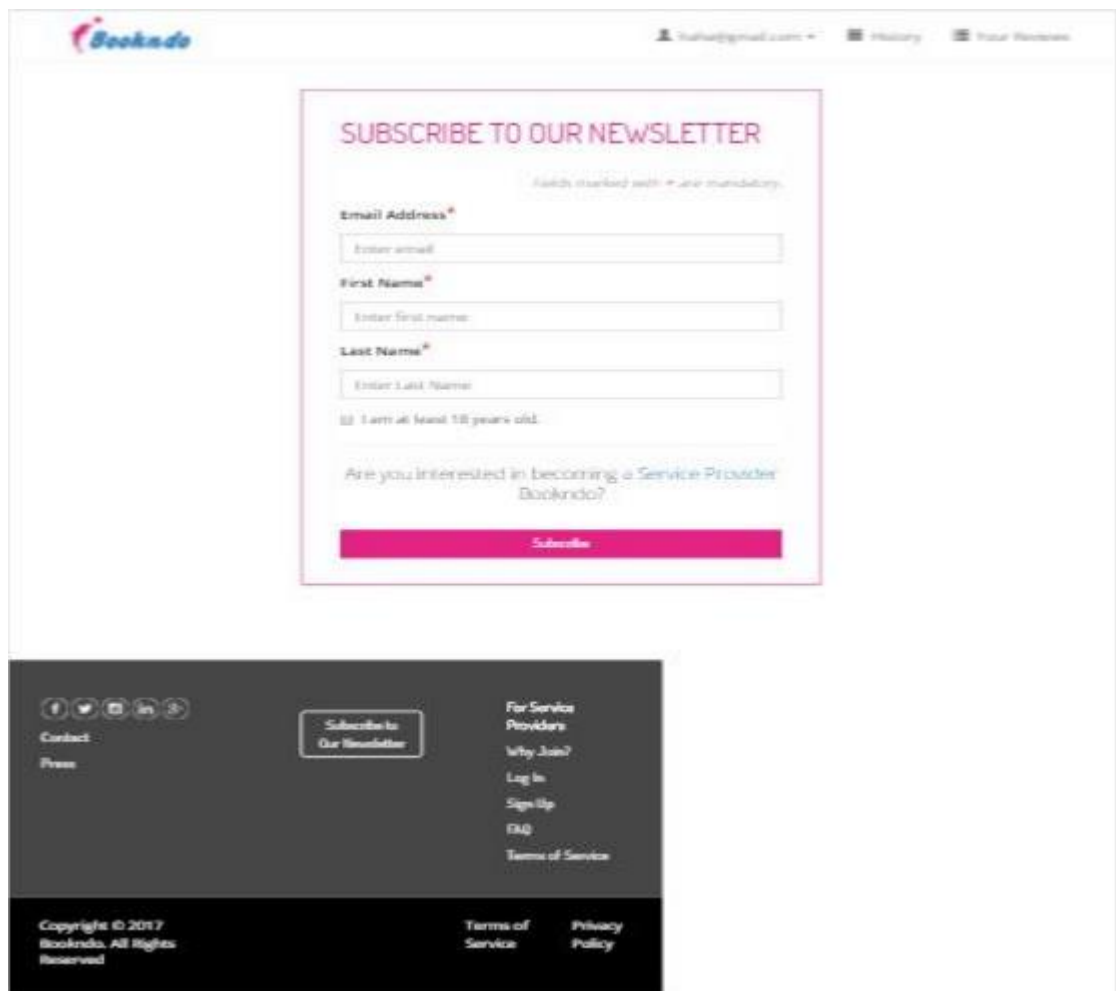


Figure 11. Bug with footer section. Copied from Bookndo [20]

As shown in figure 11, there was a problem with the footer section. It is overlapping the contents of the pages when the user moves from one page to another. In addition, the page was not responsive. This challenge took time to be solved because there were other bugs to be fixed in parallel.

After reviewing the right file which contains the cascading style sheet, it could be seen that some properties were missing such as "`position`" and "`width`". Therefore, the

solution was to keep the footer at the bottom of every page and to make sure it is responsive in all browsers.

```css
/* align footer to bottom of page */
.align-footer {
        position: absolute;
        bottom: 0;
        width: 100%;
        height: 20px;
}
```
Listing 6. The CSS footer

As shown in listing 6, CSS code was added to keep the footer section at the bottom of the page and make it responsive on all the pages of the application. The footer section used a class named "`align-footer`". This class a used few properties such as `position`, `width`, `height` and `bottom`. Therefore, after updating the code by adding the property `position` to be `absolute` and `width` to be `100%`, the footer was appearing at the bottom and not overlapping the content anymore as seen in chapter 4.

Sometimes, it might be difficult to fix a bug as discussed in the second example; however, for an IT student, this should not be a problem because they can always read project documentation or watch tutorials on YouTube. In the final year project, there were tasks which required time and team collaboration between the frontend and the backend team to be solved.

In this chapter, a list of tools and methods were introduced because of their main role in the implemented application. Additionally, the chapter reviewed the steps needed to be followed before solving a task, for example, setting up the development environment and understanding the use of task management and communication tools.

## 4    Results

In this chapter, the results of the previous examples are analyzed in detail. Moreover, the chapter includes a review of the methods used to test the Bookndo application.

### 4.1    Outcome of Tasks

As discussed in section 3.4, two tasks were solved. The first one is about adding a new sports activity to the database. The second one is about fixing the footer section of the built application. This section describes the results of the solved tasks.

As mentioned before, there was a task about adding a new activity called "Walking" to the database. Based on the given instructions (documentation), the activity was added successfully. By logging in as an administrator[12] to the Bookndo website, the new activity was inserted to the database as shown in figure 12.
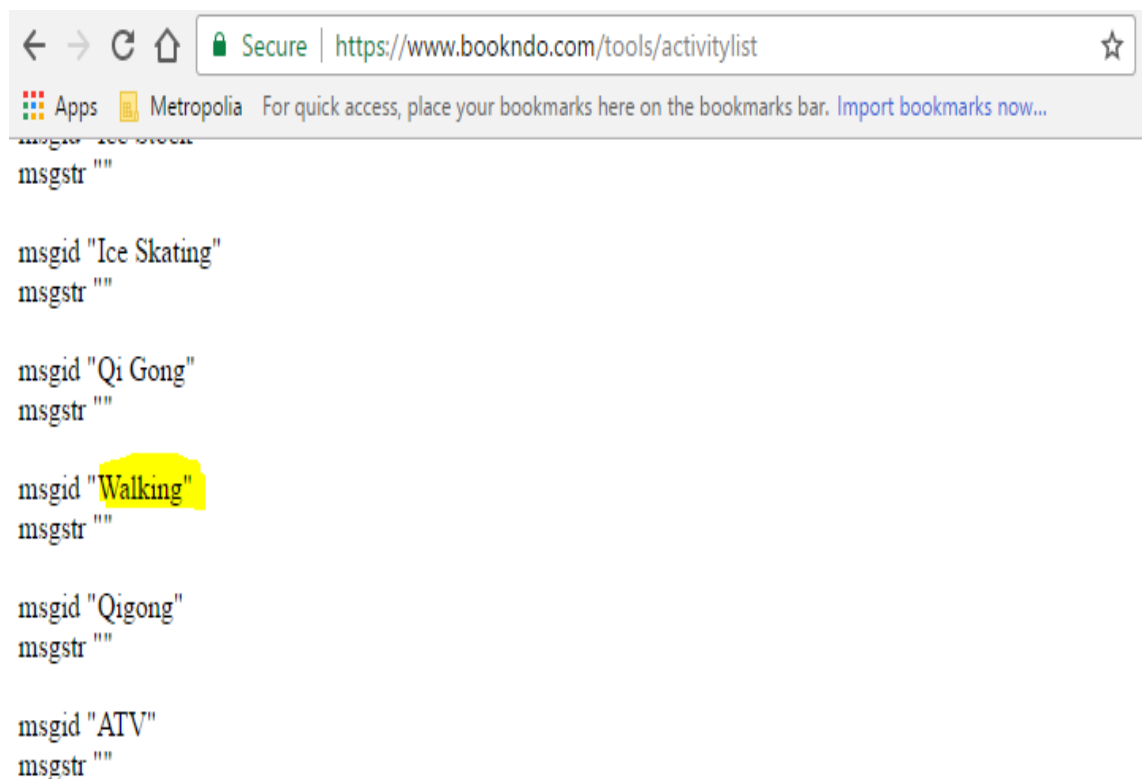


Figure 12. List of sports activities. Copied from Bookndo [21]

---

Figure 12 presents a list of sports activities that were stored in the Bookndo database. After accessing the Bookndo tools as an administrator, it was possible to review the list of sports activities and to check whether the new activity is added to the list. As a result, the new sport activity "Walking" is inserted and it will be displayed to customers who are interested in a sports event.

The second task was related to the footer section. It was overlapping the content of some pages; however, after updating the CSS file which contains the code of the targeted component, the footer appears at the bottom of the page and responsive in all devices as shown in figure 13. Additionally, the customer can display the content, update their profile, and search for activities.



Figure 13. An overview of the footer section after a code update. Copied from Bookndo [22.]

As shown in figure 13, the task was solved by the frontend team. After updating the CSS file with the correct code, a request was sent to the test environment using the GitHub version control. When the software tester checked the outcome of the task, the CSS file was updated in the server which was in this case the production environment. Therefore, the new bug was fixed and the task had to be moved to the last board in Meister Task called "Done".

## 4.2 Testing Methodology

The purpose of testing the components of any application is to determine whether the application is working as expected. Each task requires a test before solving the next step. Whether a person is a frontend or backend developer, it is necessary to test the results of each task separately before merging to GitHub.

During this project, two models were used, validation and verification. These models are also called the V model. The V model is an updated version of the waterfall method which is balanced on the verification of the previous phases before proceeding further.

The V model was proposed by Barry Boehm in 1979. Boehm tried to link each design to a test activity. The duration between the design and the test is the period when the test of the phase in question can be developed. In general, the tests are created to validate what has been defined during the design phase. [23, 45-46.]
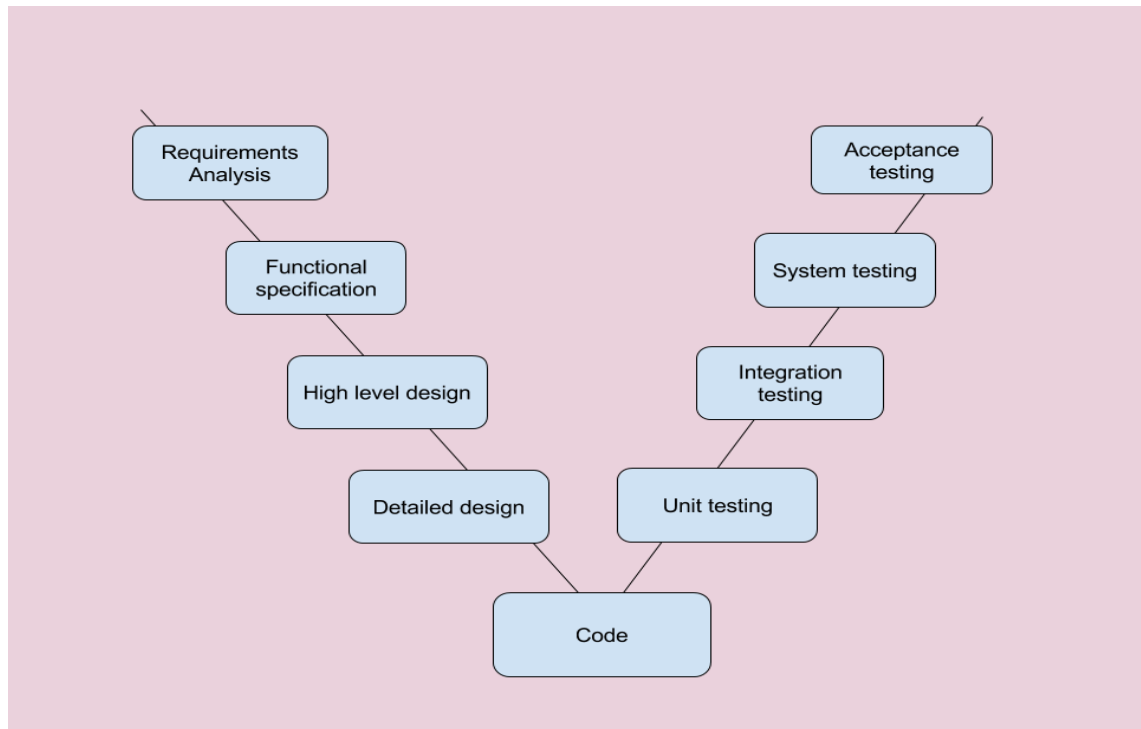
Figure 14. The different phases of the V Model. Adapted from [24]

As shown in figure 14, the V Model is based on two essentials parts, the verification and validation phases. The verification phases are the stages for building software; however, the validation phases are needed to ensure that each phase in verification is built correctly.

The benefits of using the V model are many such as the test strategy or approach, which defines how to perform testing throughout the software development life cycle. The tests can be run at any stage of the lifecycle. This means that there is a need to find faults as soon as possible because it will help reinforce the documentation regarding the requirements and functional specification. The V model provides the idea of gathering all necessary test requirements and what the expected results are. Additionally, each test has to have a description of what and how to run a test. In most companies, there is always concern about the quality of the code written by developers. All test cases would have to be run successfully before the application is released for other testing.
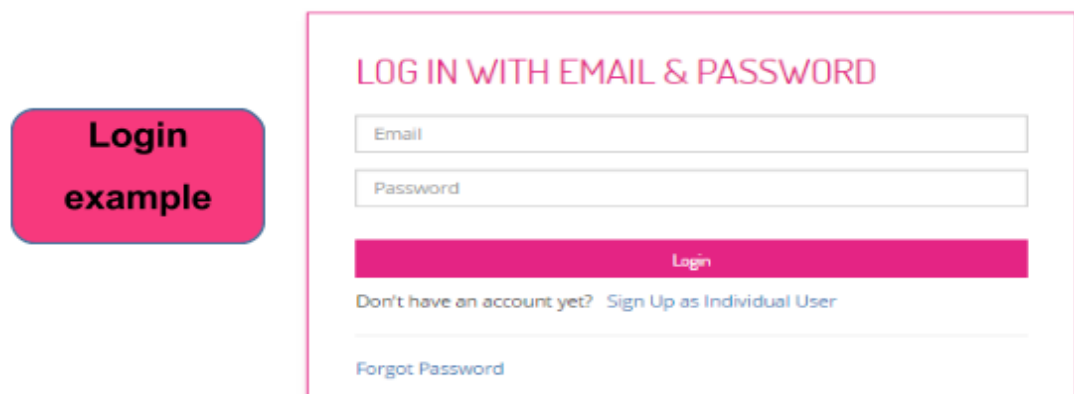
During the development process, the place of testing is critical. However, there are suggestions about executing all tests to find faults as early as possible. Furthermore, new trainees joined the project too late to do well. Although all findings concerning usability and reliability had to be reported to the team leader. [25.]

There are different approaches and strategies to test a particular application. One way to ensure the application works as it should; is to run different tests. As shown in figure 14, software testing methodologies include different methods such as unit testing, integration testing, system testing, and user acceptance testing.

## 4.2.1 Unit Testing

Unit testing is also called component testing. It is performed on a standalone module to check whether it is developed correctly. Unit testing is done by developers, but in practice developers are either reluctant to test their own code or do not have time to unit test. If there are a guidelines on how to test, the testing responsibility remains with the developers. Unit testing focuses on evaluating individual modules against specifications. In the final year project, specifications were generated as a part of the design phase during the software development life cycle. [25, 33.]

As shown in figure 15, when a login form is built, there will be typical unit test cases to define whether the login module is developed correctly or not.



Figure 15.  A login form developed by Frontend developers.

At the beginning, it is necessary to check the user's inputs for a valid email and password. Secondly, it is essential to check the result for entering an invalid login and password. Additionally, it is necessary to evaluate the outcome when the input fields are empty and the login button is pressed.

All different tests are executed to make sure that the login form component is working properly. Therefore, unit testing is mostly conducted by developers to evaluate the results of a completed task. [23, 32-33.]

In general, unit testing is highly needed while developing an application, because it will help in understanding and figuring out whether any piece of code is working correctly or not.

4.2.2   Integration Testing

Integration testing is a phase when individual modules (or unit tests) are combined and tested as a group. It ensures the data transfer between the modules is tested thoroughly. Usually, an integration test is not done by developers. All components which are developed by developers are integrated and checked. However, there are some cases where developers are responsible for the test by assuring interoperability.
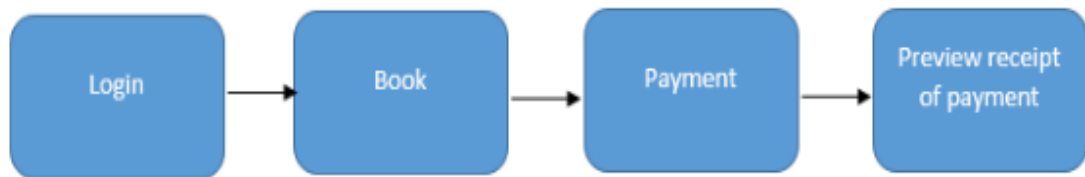


Figure 16. A group of unit test cases using the top down approach (links integration).

As shown in figure 16, the integration test case is mainly focused on the flow of data between modules and interfaces. The application has four modules, which are login, booking, payment, and receipt of payment. Each module is integrated logically. The priority is given to the links between the modules. [23, 32-33.]

As shown in figure 16, when users sign up successfully, they can search for and book any sport activity. The booking page contains information and details about the selected activity. If the users accept the terms and conditions, the next step will be payment. In order to make sure that the integration test is successful, all components must interact logically among themselves. The data should flow consistently based on the user's interaction. [26.]

### 4.2.3 System Testing

System testing is concerned with behavior of the system as a whole. It checks complete end-to-end scenarios; in the same way, a customer would use the system. The system testing is a service to the development team. The goal of system testing is to find and find as many faults as possible are prior to acceptance testing (all faults must show up at system testing rather than acceptance testing). As soon as the software architecture is drawn, a planning for system testing can start. [23, 39-40.]
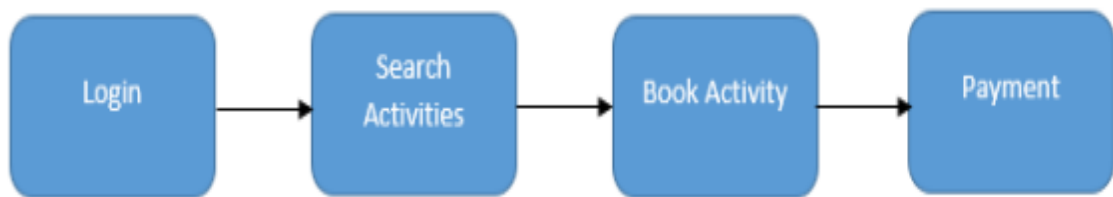


Figure 17. A test case for functional and non-functional requirements.

The purpose of system testing as shown in figure 17 is to make sure that the software is working properly before it is introduced to the sports market. This type of testing is done by professional testers, since it is the pre-stage before the acceptance testing. [23, 32-33.]

### 4.2.4 Acceptance Testing

Acceptance testing is usually done at a client location by the client. Once all the defects are found in the system, the testing phase must be fixed. The goal of acceptance testing is to demonstrate that the software is functioning according to its specifications. This means that the focusing of acceptance testing is not to find defects, but to check whether the system the meets customer's requirements. [23, 39-40.]

The acceptance testing can be done in two ways:

- Alpha Testing: It is performed at the time of acceptance testing when developers or an independent testing team test the product to check whether it meets the client requirements or not.

- Beta Testing: It is conducted and carried out by a small set of users in a real-time environment. The main role of beta testing is to allow users to try the application in order to find out any issues or flaws. [23, 32-33.]

Based on the built application, all necessary tests were executed such as unit testing, integration testing, and system testing by the end users. The results of these tests are described below:

- Users are able to display a list of sports activities based on their location.
- Users are capable of adding sports activities to their own calendar.
- The Bookndo company sends a generated email to remind users about the selected sports activity two days before the event starts.
- Bookndo can return the money in case the customer decided to not attend a sports event.

Acceptance testing is the final phase before introducing the application to the public. It is a very sensitive step as it will be available for everyone. If the application contains errors, or it does not meet the requirements, reliability will be at stake.

In this chapter, the results of some tasks have been discussed. The tasks were solved during the implementation of the Bookndo application. Additionally, different test methodologies were used to evaluate the outcome of the Bookndo application. The project reached its goal as all tasks were resolved successfully.

# 5    Discussion

As discussed previously, solving tasks while working on a project could be a big chal-
lenge. It is not easy, especially when working with new tools and trying to get familiar
with them. This chapter includes a discussion about the benefits as well as the difficulties
that I, as a new trainee, faced during an internship at the Bookndo company.

## 5.1    Benefits and Limitations of Used Tools

Being a member of the Bookndo team gave me a chance to gain new skills and utilize
different tools. As mentioned earlier in chapter 3, different tools were used to build the
Bookndo application.

Using Meister Task for task management was necessary for the success of the Bookndo
project. It was used for its advantages and features. It is efficient as it combines collab-
oration and tasks into one platform. It has many boards which are visible to all team
members. It is possible to display the tasks of each member and ensure that everyone
finishes their own tasks. It was not difficult to follow the progress of all members.

It is possible to configure the dashboard to display pending and completed tasks. The
customized dashboard can be adjusted to suit the team's needs in order to make every
member more productive. In addition, Meister Task integrates with other applications
that are designed to improve cooperation, communication, and file sharing. It is compat-
ible with Slack, Google Drive[13], Dropbox[14] and GitHub. It integrates with MindMeister[15],
an effective mapping tool that allows team members to brainstorm with each other in real
time.

I had a chance to work as a team leader and could access Meister Task as an adminis-
trator. This opportunity allowed me to test different features of the application such as
creating tasks, adding new members and assigning tasks to other team members. Addi-

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[13] https://www.google.com/drive/
[14] https://www.dropbox.com/
[15] https://www.mindmeister.com/

tionally, a weekly report was sent to the team leader by the MeiserTask platform. It contains the number of tasks that were solved, with the progress of each member individually.

Personally, I found that Meister Task has no limitations except when it comes to what category a customer belongs to. A basic customer can have free access to some features; however, in order to benefit from all of its features, a user has to be a Pro customer and pay a monthly fee of €7.50. It is cheap; however, for some startup companies such as Bookndo, it was expensive because the company did not make any income.

Meister Task had an impact on new trainees. They started taking responsibility for their own tasks, because they were given deadlines and instructions which had to be followed carefully. All team members were tracked while working on their challenges and received feedback from the lead developers.

Utilizing the Slack tool for real-time messaging and communication was beneficial for the team and the success of this project. The team can now join one channel to discuss further the development of the Bookndo application. The advantages of using Slack are for example, creating many channels for different purposes, storing conversations to make them available and accessible at any moment, flexible notifications and integration with other applications. Slack solved many problems. By default, everyone can see and read what is going on public channels. In the Bookndo case, a channel was created for technical support, where we tried to assist each other and suggest solutions for some tasks. Slack can be also used to organize meetings and contact each member individually. The option of using the Slack application on the phone was a must, because team members could reach each other anytime and anywhere.

Regarding the mobile devices, Slack has some limitations related to content sharing, such as inability to send photos or share files through the phone. Therefore, the desktop version had to be used to benefit from Slack's features. Moreover, working for the Bookndo company required communication and collaboration. Therefore, it could not be successful without using Slack and Meister Task. These tools helped a lot in building the desired application.

5.2    Outcome and Limitations of Project

Participating in this final year project had many advantages. All new trainees started understanding how to work on large applications. It was a good opportunity to practice technologies such as HTML5, CSS3 and JavaScript in a growing and professional manner. Additionally, learning new technology such as the CakePHP framework was a challenge, but also beneficial.

As discussed in chapter 2, the framework selected to build the application was CakePHP. When new trainees started working with CakePHP, they did not know that much about practical development. CakePHP was chosen over other frameworks, because it has many features as mentioned in chapter 2 such as MVC architecture, data handling, object relational mapping and security with zero configuration. It has other advantages such as compatibility with other versions of PHP, built-in validation and view helpers for JavaScript and HTML forms.

For new trainees, it was not hard to go through the tutorials, because they are PHP based. The quality of the documentation is good. Regardless of my status as a trainee, I can say that CakePHP is one of the best PHP frameworks. Less code needs to be written to get the same result that other team members get. This means more time to work on other tasks and the possibility to test the results. There are other interesting PHP frameworks such as Symfony[16] and Laravel[17]; however, CakePHP means less coding time, fast core updates, and useful plugins.

As discussed in chapter 2, it is an advantage to know how to use Bootstrap as it reduces the time on styling pages. However, it was not an issue for new trainees, because there are many tutorials and online courses which could help to understand the basics or even reach an intermediate level of using the framework. Using Bootstrap was very useful. However, it has some disadvantages too such as:

- It does not follow best practices. This is seen as one of the major problems, as a web page ends up with a lot of document object model (DOM) elements. It makes reusability, scalability and maintenance much more of a challenge.

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[16] https://symfony.com/
[17] https://laravel.com/

- Bootstrap is heavy because it contains CSS and JavaScript files and for sure not all functionalities will be used. Therefore, many companies try to build their own CSS and scripts.
- Some developers argue that Bootstrap's jQuery plugins are not the best practice framework because they are hard to customize.
- Many Bootstrap websites look the same; however, in order to avoid this, developers must use a custom theme or even create their own theme.

[10, 24.]

Based on the results discussed in chapter 4, the project met its goals. First, new features and improvements were added successfully. Second, the methods used to build the desired application were useful for the trainees. They can be reused in the future too while working on different projects.

During the participation in this project, depending on the experience gained, new trainees faced many difficulties. First, no training program was provided to the team members. The documentation which helps setup the environment and installations dependencies was very poor. Another point to add here is about the lead developers. Most of them were working remotely and were not always available to help. Furthermore, there was a time when backend developers were missing. Only frontend developers were doing tasks. Another problem was related to the working space. At the beginning of this project, there was no office. However, Slack was used to communicate and reach others. In fact, Slack was effective and compensated this problem.

We did not receive any salary during our internship. This was a major problem, especially for us who had to pay for transportation, food and sometimes even to buy equipment (the company does not provide laptops). Therefore, most of our team members preferred to work remotely, because they could not cover all their expenses.

In addition to what has been mentioned before, the time to solve tasks was too short. Sometimes, while solving a task, we were asked to work on something else. This issue caused a delay in finishing previous tasks. Furthermore, regular meetings were organized once in two or three weeks. It was hard to keep track of the work progress. The team members could not share each other's developments. Moreover, it is important to discuss and brainstorm about the development of the project. During a meeting, crucial

and urgent matters must be discussed. However, Skype and Slack were mostly used for such situations and sometimes phone calls too.

Unfortunately, not all startup companies provide all necessary materials for their trainees, which would help the project to be successful. This may cause less enthusiasm and sometimes even less focus while working on solving tasks. Nevertheless, other trainees might consider it as a challenge and always try to rely on themselves.

5.3    Recommendations and Suggestions

As discussed in chapter 2, the front-end was developed using predefined technologies such as HTML5, CSS3, JavaScript and jQuery. Therefore, it is necessary to understand what and how each language was used for building an application. I recommend to check new technologies such as the Angular[18] and React[19] frameworks, because both have good architecture patterns and a strong community around them. Choosing between these options is not an easy task. Besides the features of each framework, there are reasons why they are chosen by many companies. For example, both frameworks provide excellent documentation and promote a solid architecture. They are supported by almost all browsers. Many professional developers are using React and Angular to build web applications. They have huge communities and big corporations working on developing and supporting them for a longer period by their sponsors. Moreover, they promote component-based development. The design of each component is an implementation of the module pattern. Furthermore, in case of bugs, it will be easy to identify the component which causes the error for further investigation and maintenance.

In fact, React does not belong to the Model View Controller category. React is more well known as more because of its view of the Model View Controller structure. Many applications are using React such as Facebook, Netflix, Instagram and BBC. [27, 5-6.]

In order to start building applications using React or Angular, it is recommended to know JavaScript in advance. Knowing the base language can help in learning a new framework faster and allow taking advantage of its features. Therefore, for front-end development, it is important to focus on learning JavaScript. This programming language should be

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[18] https://angularjs.org/
[19] https://facebook.github.io/react/

chosen over others, because the code functions can be run immediately in the user's web browsers.

In chapter 3, a description is given of the methods and materials that were used while building the Bookndo search engine application. Moreover, a list of tools is given that were utilized to succeed in building the Bookndo application. However, there are discussions about other tools which are used nowadays by many companies such as Asana[20]. Asana is also a task management tool, which is powerful enough to track work across the company. This tool can be used by different teams in different fields such as marketing, human-resources and recruiting, managers and executives. It can be also used by students to track all the activities and homework.

In this chapter, the benefits of participating in a real project were discussed. Moreover, the chapter included discussion on how important it is to take advantage of the knowledge already gained during studies or while working in a project to develop one's technical skills. Additionally, the difficulties and limitations that might appear during an internship were mentioned. Furthermore, in this study new technologies were suggested to build similar applications.

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[20] https://asana.com/

# 6    Conclusions

The goal of this project was to describe the implementation phase of a software development life cycle. The project aimed to introduce the methods and materials that help in building the desired application.

There are many challenges to go through when joining a company as a trainee. The study shows that learning a new framework such as CakePHP and Bootstrap can be an advantage to the trainee as the trainee acquires new skills.

Practical guidelines and recommendations were compiled in the project to make it easier for trainees to adapt to the working environment of any IT company. Therefore, the project reached its goals.  A search engine for sport activities was built successfully for Bookndo. Bugs were fixed, and the application is more responsive than before. Therefore, Bookndo can now be distributed to the sports market.

The tools that were used during the implementation of this project such as Meister Task, Slack and GitHub helped the frontend and backend teams to succeed and develop the Bookndo application. It is recommended that they will be continued to be used in different projects. The findings are based on the technologies used when carried out the project. It is still possible to use the same technologies and tools to implement new software.

However, based on the limitations, lack of documentation and slowness of the CakePHP framework, I would recommend to further study the React and Angular frameworks to see they are better suited for a project like this. Therefore, it is highly recommended for new trainees to learn these technologies to build large web applications.

## References

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## **Interview with an IT student**

P1: Hi, my name is Youssef. I'm 4th year student at Helsinki Metropolia UAS.

P2: Hello

P1: In the near future, I'm willing to start writing my thesis. Would you mind if I ask you few questions?

P2: sure.

P1: Have you done your internship already?

P2: No, not yet. However, I'm looking for one at the moment.

P1: Good. Do you have any idea what kind of technologies, methods and tools can be used if you have a chance to join a company?

P2: Honestly speaking, I have heard few things, but still unclear for me.

P1: Great. If you have a chance to read a piece of information, which gives you a clear idea what is expected from you as an intern? And what are the tools used Inside the company? What are the methods used to participate in the building of a software, will you be interested?

P2: That will be great. At least I will know in advance what I'm expected to deal with during an internship.

P1: Perfect. The topic of my thesis will answer those questions in details, while participating in the implementation of a search engine application.

P2: I cannot wait to read your thesis. Could you please send me a copy of your thesis when it is ready?

P1: With pleasure. What is your email?

P2: murad.tanmoy@metropolia.fi

P1: Good. I'll be in touch with you. It was nice to meet you. Have a nice day!

P2: Nice to meet you too. See you.

P1: Goodbye