Construction of Employee Engagement Survey Component

Martin Hofhanzl

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Abstract

Youmanage HR Ltd. is an SME company based in Stirling Scotland that specializes in providing online human resource management software. Their product is a web-based tool that is designed to help HR professionals and people managers to simplify and automate their administrative tasks associated with their employees. One capability they would like to have in the Youmanage application is an ability for clients to create surveys to collect feedback from their employees. Employee surveys help employers to measure and understand their employees' attitude, feedback, motivation, and level of satisfaction. Satisfied and motivated employees will be more productive and result in a higher customer satisfaction and in turn positively influence a company's growth, result and profit.

The objective of the project was to develop a new component of the Youmanage HR system from the ground up that would accommodate all aspects of survey management such as creating, editing, sharing, and analysing and to integrate it seamlessly into the Youmanage application. Due to the on-going Youmanage rebranding the objective was also to seamlessly integrate the survey component into the new version.

The development itself was done using the Agile approach divided into two phases to ensure all necessary parts were going to be implemented. The first phase was about working towards a basic functional prototype, whereas the second phase focused on further improvements and extensions. During the development, the special emphasis was on keeping the user interface as simple as possible for users since there was not any design phase prior to the development.

The output of this dissertation is the survey component that has an ability to create, edit, preview, share, analyse, delete, and clone a survey. A survey can have unlimited questions with unlimited answers and can be made up of five different question types.

A fully functional survey component was designed and developed with regards to the new version of Youmanage HR software as a result of the project. It has been successfully tested by the professional team of Youmanage. The new survey component fully satisfied client´s expectations. Additionally, the entire survey component is mobile responsive and it was constructed in an object-oriented manner (implementing the Model-View-Controller pattern) and it was designed to be open for a potential future development.

Feedback from the client has been extremely positive throughout the whole development process. The survey component will be included in the release of the new Youmanage version as a part of the Core HR module.

Attestation

I understand the nature of plagiarism, and I am aware of the University's policy on this.

I certify that this dissertation reports original work by me during my University project except for the following:

- The motivation in Section 1.2 was written by the CEO of Youmanage, Nick Pye.
- The Youmanage Server Architecture (Figure 4) was taken from the internal Youmanage documentation.

Signature **Date**

Acknowledgements

I would like to give special thanks to my supervisor, Dr. Mario Kolberg. His guidance and support has been invaluable as well as his suggestions made throughout the entire dissertation period which I am very grateful for.

Now, I would like to thank to the Youmanage HR Ltd organisation as a whole. I would also like to emphasise each of the team members individually and give special thanks to Nick, Maurice, Jason, Paul, and Katie as without them this project would not have been possible. Maurice and Jason deserve to be given thanks again as without their technical advice while developing this project it would have never been possible to have got the project to the phase where it is.

Finally, I would like to thank my parents for their patience, care, enthusiasm and support they were giving me while I have been far away from home because simply without them and their financial support throughout the whole year, studying in the UK would have never been possible.

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1 Introduction

1.1 Background and Context

Youmanage is an HR company based in Stirling that provides a unique, web-based HR management application. The Youmanage HR software helps people managers and HR professionals automate and simplify many of their daily administrative tasks [1].

Many current clients who started using the Youmanage software did not use any HR software before. All HR related procedures were paper-based or in spreadsheets which becomes more difficult to manage when a number of employees working in the company increases. The actual strength of using a specialised HR software especially pays off in a long-term horizon.

The Youmanage HR software consists of a suite of six modules as follows: Core HR, Absence & Holidays, Self Service, Disciplinary & Grievance, Performance & Development, and Recruitment & Interviewing. Each of these modules offers comprehensive workflow tools.

The Core HR module comprises an employee database where data is recorded against employee records. The Absence & Holidays module lets line managers easily manage staff resources, and plan holidays and leave. The Self Service module is used by employees, it lets employees manage their absence, holidays as well as personal development. The Disciplinary & Grievance module helps managers to manage disciplinary and grievance processes. The module ensures that the process is handled professionally and stays compliant at every stage. The Performance & Development module is designed to make the performance, development and appraisal process engaging for employees and efficient for managers. Lastly, the Recruitment & Interviewing module makes managing the interview and selection process simpler, more robust and more cost-effective. Further information about all modules can be found in section 2.1.1.1 The Overview.

The reason that the Youmanage software is divided into six separate modules is that each client can choose the modules they wish to adopt and then the annual subscription for the software is calculated based on the selected modules and the number of employees.

This dissertation focuses on a development of the survey component that is seamlessly integrated into the broader Youmanage system. The following section explains why there is a need for having a survey functionality in the Youmanage HR software.

1.2 Motivation

Employee surveys help employers to measure and understand their employees' attitude, feedback, motivation, and satisfaction. Businesses need to concentrate on employee engagement to

develop workers who can drive innovation and propel their organisations forward. Research shows that satisfied, motivated employees will create higher customer satisfaction and in turn positively influence organisational performance, and regular checks of employee satisfaction and engagement are critical in both improving performance and in retaining employees [2].

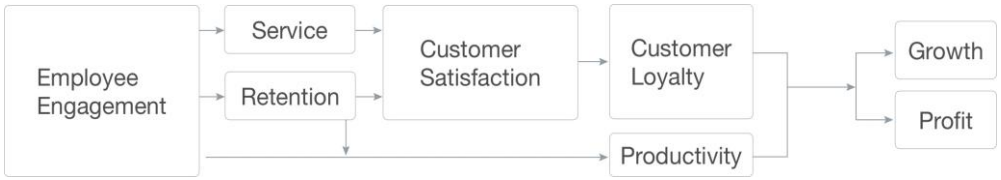

Figure 1. Employee Engagement Diagram

There are two ways of looking at surveys especially how to provide a survey functionality to Youmanage clients. The first way is to get clients to use any of third-party survey tools that are already available on the market. One of the biggest problems of using a third-party survey tool is getting employee data from the Youmanage and uploading it into a third-party software. Whenever employee data changes, it needs to be uploaded into a third-party survey tool again. The second way is to develop a survey right into the Youmanage software and makes use of employee data without having to transfer them elsewhere. Of course, there are also disadvantages coming with this approach and probably one of the biggest ones is that developing a survey tool as a part of the broader Youmanage HR software is never going to be as complex and it will most probably never provide as much features and functionality as other third-party tools which specialise only in delivering one-purpose applications.

1.3 Scope and Objectives

The scope of this project is to develop a survey functionality (a new module into the existing Youmanage application) that will be capable of creating, editing, sharing, and analysing surveys. Based on existing user roles in the Youmanage application (Admin, HR employee, Manager, Employee), HR employees and managers must have access to all functionality, whereas employees must be restricted to only have access to fill out surveys. Selecting employees as a target group for surveys must use the existing hierarchy dictionary (companies, divisions, locations, departments, and job levels) and employee information has to be taken from the existing database. All surveys should be accessible only from within the Youmanage application meaning all employees must be logged in. Employees should get notified by tasks that are implemented within the Youmanage application and by emails whenever a survey is created for them. Lastly, the survey module has to be mobile responsive and integrated into the existing Youmanage application from the design perspective.

The objective of the external company is to address a particular area of the existing system to the student to be created or improved. The external company tends to give the student a real project that at the end of the dissertation period might end up being integrated into the existing system which helps the student to feel the importance of the project as well as the ability to see in the end that the effort was worth it. The objective of the University is to establish a strong relationship with local businesses to provide an invaluable opportunity for students to be able to get to know a professional software development environment in order to gain work experience whilst working on a dissertation. The student's objective is to create a piece of software in a methodical and professional manner that will result in client's satisfaction and a creation of high level academic assessment.

In regard to this project, the objectives are to:

- *List all surveys* – a part of the component that should list all surveys and show basic information for each survey. There should be a functionality to create a survey as well.
- *Create surveys* – a part of the component that should provide a form for creating a survey. After the survey has been created it will redirect to the edit page where all questions with answers will be created.
- *Edit surveys* – a part of the particular survey that will be used to edit surveys. This should be dynamic page with the capability of adding questions and answers.
- *Preview surveys* – a part of each survey that will be used to preview the survey in the same way as it will be displayed from employee perspective.
- *Share surveys* – a part of each survey that is supposed to display the hierarchy dictionary to select all employees or particular group of employees.
- *Analyse surveys* – a part of each survey that should be used to analyse collected responses in an interesting way using charts.
- *Fill out surveys* – a part of the component that employees are supposed to use to fill out surveys.
- *Make the component mobile responsive* – the component has to be accessible from a various of devices including mobile phones, tablets, laptops, and desktop computers.

Of course, due to the time constraint of three-month period it was important to prioritise and well estimate the client's needs. The main objectives of the project were to create a survey component and to ensure the design is in keeping with the new version of the Youmanage ap-

plication. Since the beginning the client expressed intent to include the output of this project into the next release of the Youmanage application if all goes well.

1.4 Achievements

A fully functional survey component designed and developed with regards to the new version of Youmanage HR software is realised as a result of the project. The survey component fully meets a client's expectations. The entire survey component is constructed in an object-oriented manner using the MVC pattern and it is designed to be open for a potential future development. On top of that, the entire component is mobile responsive. In the three-month period the survey component was successfully developed along with a fairly good set of features. The survey component was developed whilst the development team Youmanage was working on the entire new version of the Youmanage. Despite the undergoing rebranding the development of the survey functionality was very smooth and in the end, thankfully it did not end up with any user interface inconsistencies.

In order to achieve all the objectives, it was necessary to analyse the existing survey tools to find out what features might be implemented when developing this project. All the objectives were achieved by implementing all the defined requirements (See 4 Requirements). All the achievements are further described below:

- The Survey Manager page was implemented to list all surveys. All surveys are displayed in minimal, readable table where each row represents one survey. Each row shows a survey title with a date when the survey was created and with a state the survey is currently in. Additionally, each row shows a set of buttons that are used to access different phases of the survey lifecycle (Edit, Preview, Analysis). The page is also equipped with a navigation bar for filtering surveys.
- The Build page was created to facilitate the process of creating surveys. The page allows to add unlimited questions with unlimited answers. A user can choose from five types of questions (Single Text Field, Multiple Choice with Single Answer, Multiple Choice with Multiple Answers, Star Rating, and Essay Text). Additionally, every question can be set if it is required or not. All data (questions, answers) get saved in the database as the survey is gradually being created.
- The Preview page was included to give HR employees and managers the ability to see a neater version of the survey to check for possible mistakes that may have been overlooked when creating.
- The Share page was created to select a target group for the survey based on the hierarchy dictionary consisting of companies, divisions, locations, departments, and

job levels. HR employees and managers are able to select all employees or particular group of employees. On top of that, they get to see a real-time number indicating how many employees they are targeting as they select the target group.

- The Analysis page was implemented to analyse all collected responses from surveys. It shows two columns and gives the ability to compare two set of responses by narrowing down responses by selecting particular groups of employees based on the hierarchy dictionary. The page displays all responses using charts and HR employees and managers get to choose from four modes (pie chart, bar chart, line chart, table) how each question can be displayed.
- The Fill page was created to display the survey to employees. This page is similar to the Preview page. It is equipped with the client-side and the server-side validation to get the correct and consistent responses. Once an employee has submitted the survey, that survey cannot be accessed again.
- The entire component is mobile responsive and it has been tested across a number of devices, platforms, and web browsers to ensure implemented functionality works everywhere.

The survey component has been successfully tested by the professional team at Youmanage. The feedback from the client was very positive and there is full intent to include the survey component in a future release of the Youmanage version 4 which is expected to happen in late 2017.

From a personal perspective, the project has been a truly unforgettable experience. Due to the architecture of the Youmanage software, it was necessary to learn a new programming language, C#, and some other technologies that come along with it such as ASP.NET MVC and the Entity Framework within the three-month period. The first two weeks were quite overwhelming in terms of amount of information to get to know. However, the overall experience of the dissertation was more than satisfying. Working in a real company as a part of the development team was hugely beneficial whilst working towards finishing up the Master degree. In addition, working within professional environment provided invaluable experience and has resulted in a smoother transition between the university life and the work life.

1.5 Overview of Dissertation

The structure of this dissertation is as follows: *Chapter 1* provides a brief introduction to this dissertation by setting the background, it introduces the client followed by the motivation, it then sets the scope and objectives and finally it states the achievements of the project. *Chapter 2* further introduces the existing Youmanage software by dividing it into user and technical

perspective. Furthermore, the analysis of competitor products is included followed by the section about used technologies with specifying reasons why they have to be used or what features might be used and exploring alternative solutions concludes this chapter. *Chapter 3* discusses two different approaches to software development and adds a section about which approach is used at Youmanage. *Chapter 4* is a chapter that covers requirements for the survey component and it is divided into functional and non-functional requirements. *Chapter 5* explains aspects of the Youmanage rebranding, wireframes, design of user interfaces along with the design of the project structure, and the database design. *Chapter 6* explains how the survey component works, what parts it consists of, and what functionality was implemented nicely broken up into smaller logical sections. *Chapter 7* discusses the testing methods. Finally, *Chapter 8* summarises the whole project by providing the evaluation, the future work, and the summary.

2 State-of-The-Art

2.1 Existing Youmanage System

It is necessary to gain some knowledge of the Youmanage HR software to get to know the system. For the sake of simplicity, the Youmanage HR software can be divided into two perspectives – a user perspective and a technical perspective. The user perspective is about everything what users can find on the Youmanage website, basically everything what potential clients might want to know before they decide to adopt the Youmanage as an HR system, whereas the technical perspective is the exact opposite particularly focusing on information users are not interested in seeing which is for example what goes on in the background or in other words what makes the Youmanage HR system work.

Figure 2. Landing Page

2.1.1 Youmanage: User Perspective

2.1.1.1 The Overview

The Youmanage system offers a number of modules that could be adopted which allows them to target small businesses (10 employees) as well as larger companies (1500 employees). Modules can be switched on and off on the fly whilst using the system. Youmanage has dynamic pricing that is calculated based on the modules and a number of employees in the company [1].

Modules within Youmanage are:

- *Core HR* – a module that is used for effective management of employee information. Data in Youmanage are managed by a range of user, not just the HR department. Key features of this module are employee database, corporate branding (option to upload company's own logo and choose own colour scheme), pre-configured HR best practice workflows, payroll data exchange, organisational charts, outlook/google calendar synchronization, integration with other systems.

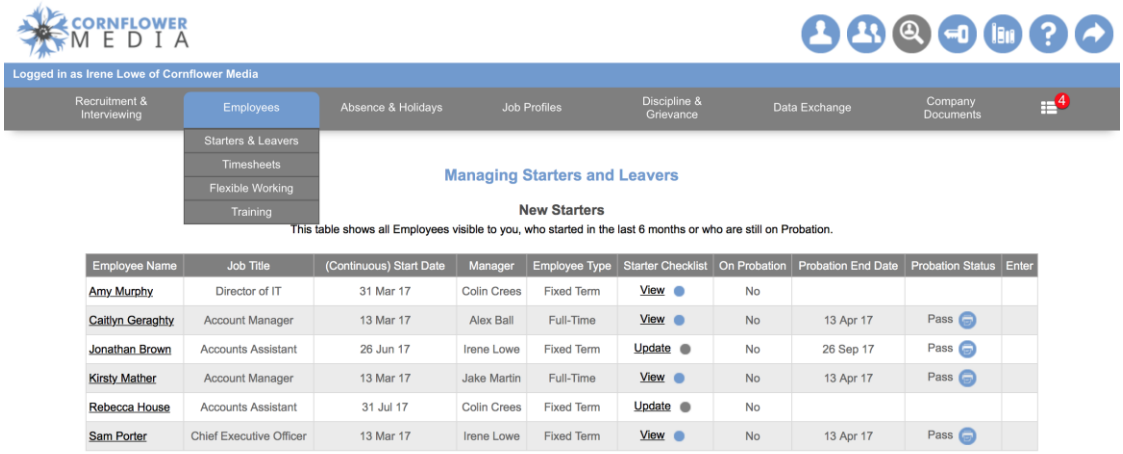

Figure 3. Youmanage Employees: Starters and Leavers

- *Absence & Holidays* – a module that oversees managing absence and holidays. It lets managers and HR professionals manage staff resources, and plan holidays and leave using built-in simple, visual interface.
- *Self Service* – a module that helps employees feel engaged and be part of the HR management process. Youmanage provides simple self-service interface for employees to help them with personal development and appraisal process. Additionally, employees can feel involved in their performance as well as their contribution to the success of an organization.
- *Disciplinary & Grievance* – a module that empowers managers to manage disciplinary and grievance processes. Disciplinary and grievance impacts employees at all levels and this module handles the process professionally and stays compliant at every stage in the process by keeping all parties well informed and providing clear guidance at each step.
- *Performance & Development* – a module that helps all employees within an organisation focus on meeting their goals and reach their full potential. Managers can focus on helping employees to reach their full potential, and foster an organisational culture of excellence.

- *Recruitment & Interviewing* – a module that covers the entire process of recruiting and interviewing potential candidates and keeps information in one place. This module makes managing the interview and the selection process simpler, more robust, and more cost-effective.
- *Reporting & Analytics* – a module that can generate dashboards, custom reports, and automated report schedules.

2.1.1.2 User Roles

Youmanage divides users into four different groups in a way how they interact with the system. Four groups of users are Administrators, Managers, HR employees, and Employees. Each group has a different user role within the system. Each user role has permissions set up that allow them to access limited parts of the application as well as the data they can access to. Generally, administrators can alter certain information and make the application suit company's rules. They can add specific options for dropdown lists which specific for the company or they can restrict which groups of users can access which parts of the system. Whatever an administrator sets the system will be adjusted based on those changes.

2.1.2 Youmanage: Technical Perspective

This chapter covers the other side of the Youmanage system, the side that clients do not get to see, the side that was even more crucial to know about because when a new component is developed into an existing system it is important to get to know the project structure and develop the new component with the same structure and convention that are used in the existing project. Especially, this gets even more important when the project is maintained by many developers as each developer might be working on something that other developers might make use of (it could be libraries, classes, and so on).

2.1.2.1 Programming Language

The primary programming languages that the current version of the Youmanage software are written in are WebForms.NET and VB.NET. However, at the point of the time this project was developed, the Youmanage software was moving from version 3 to version 4 (See 2.1.3 Youmanage: Rebranding). The significant change that the process of the rebranding led to was moving away from WebForms.NET and VB.NET to C# and ASP.NET MVC.

2.1.2.2 Architectural Pattern

The Youmanage application implements a multi-tier architectural pattern, where the application is divided into three maintainable units: the presentation layer, the business layer, and the database layer as displayed in Figure 4.

- *Presentation Layer* – is the top level of the application which comprises all of the mark-ups. In other words, it displays data that is given. This layer is not dependent on the business layer nor the database layer. In ASP.NET this layer usually contains Razor pages with cshtml extension. Razor pages are classic HTML pages enriched by a Razor syntax.
- *Business Layer* – is the place where all business logic related to the application is defined. The business layer is the right place for any calculations and retrieving data when the database is needed. In the Youmanage application, the business layer is the place where all queries are defined regardless of how many tables a query needs to use.
- *Database Layer* – is an abstraction layer for communication between the application and the database management system (DBMS) that is used. Having the database layer means it is loosely coupled with all business logic which means if there is a reason for a DBMS to be changed the only that needs to be updated is the database layers and in most cases without having to change the business layer.

Figure 4. Youmanage Architecture

2.1.2.3 Server Architecture

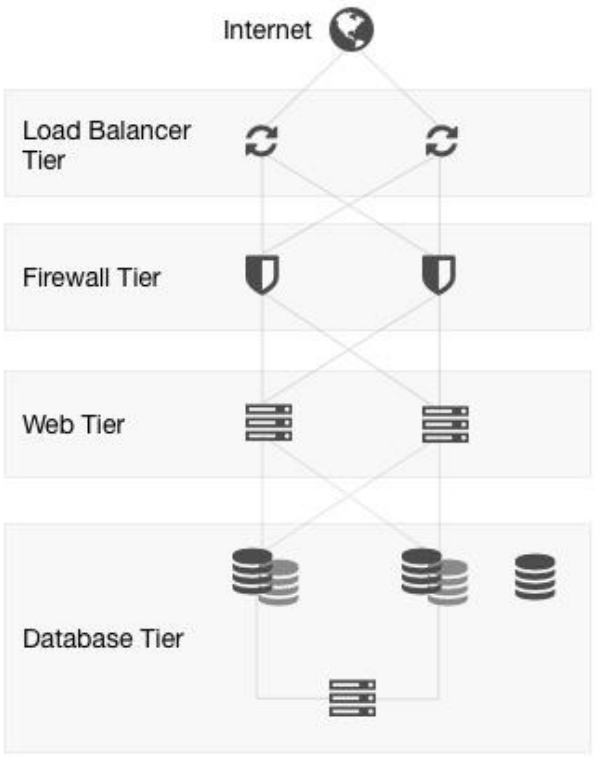

Figure 5. Youmanage Server Architecture

The Youmanage application is hosted on a remote server located in Reading, England maintained by a company called Pulsant. Pulsant is a UK service who specialiase in Cloud solutions. Each server is configured to run Windows SQL Server 2012, IIS 10, ASP.NET MVC 5.

The server architecture (Figure 5) is logically divided into four parts. At the very top, there is a load balancer tier which distributes incoming requests to avoid server overload.

The load balancer tier is followed by a firewall tier that acts as a security boundary to the Web tier.

It implements high-availability firewalls that are responsible for monitoring incoming and outgoing requests.

The web tier contains two mirrored servers that host the presentation and the business layers of the application (See Figure 4). Mirroring the servers allows load balancing to ensure there is no single point of failure.

The database tier sits at the very bottom of the architecture. It comprises of six mirrored virtual servers. One of them acts as a witness for two set of servers (See Figure 5). Each of the

servers contains all the databases that host client data. Each Youmanage client is allocated a separate SQL database to maintain their data. Additionally, there is a master database containing basic client information and global system configuration settings.

2.1.3 Youmanage: Rebranding

While this project was developed the Youmanage system has been undergoing rebranding from version 3 to version 4. The Youmanage version 3 was released in mid-2014 and a few things have changed since then in terms of trends on the internet. One of the things that has changed over the past few years is that a lot of people do not just use desktops to browse the internet but they also do use mobile phones to browse the internet. Some people even no longer use PC the way they used to before. They tend to use smaller and portable devices more and more and it makes web development process longer as there is a need to target those devices and to think about how a website is going to be displayed on mobile phones and tablets. That is the main difference between the Youmanage version 3 and the Youmanage version 4. The Youmanage version 4 is built entirely using mobile-first approach which allows the website to be nicely readable on smaller devices as well as on desktops. Two screenshots (See Figure 6 and Figure 7) show the visual difference between the Youmanage version 3 and version 4.

Figure 6. Youmanage 3 - Dashboard

Figure 7. Youmanage 4 – Dashboard

The emphasis is not only on making the website mobile responsive it is also on making data display in more natural way that HR employees and managers can immediately see what is going on in the company for example who is on holiday and other useful information that they might be interested in seeing. The first difference in between the screenshots above is using different colour schemes, although it is noticeable it is something that each client can change for themselves within the system so the whole interface may change visually for each client based on the colour they have chosen for themselves. The second feature that is visible from the version 4 comes with the usability to make the page look more interesting using charts. People like looking at charts as it is easier way to show or interpret a set of data as opposed to seeing just numbers in the table.

2.2 Competitor Products

A key part of each project and a good starting point is to conduct a research to see what competitors are already on the market, what features of their products are, and how they differentiate themselves.

To get as much information about existing survey platforms on the market as possible the research includes a comparison of five survey tools that can be used to create surveys for free. In addition to free versions, most of the survey tools do offer paid versions as well. The difference between free and paid versions is usually in a number of questions that a survey can have and a number of respondents a survey can be sent out to. However, this research focuses only on capabilities of free versions of these tools.

All survey tools that are listed in the comparison below are taken from an article[1] from the internet. This recent article from March 2017 compares seven best survey tools on the market. Of course, there is a lot more survey tools available on the market to compare but choosing five survey tools was adequate to get reasonably good idea to be able to put together desired set of requirements.

The output of this chapter is used as the input to the requirements chapter (See 4. Requirements) where the gained observations are used to create a set of requirements which were followed while developing this project.

2.2.1 Survey Monkey

Survey Monkey is probably one of the most popular survey platforms on the market. It is well-designed and quite easy to use. A free version of Survey Monkey offers unlimited number of surveys, max ten questions per survey and max hundred responses per survey. Additionally, 24/7 customer support via email is also included. Surveys can be created via a website as well a mobile app which supports users who want to create surveys on mobile phones or tablets as the website is not mobile responsive [3].

The free version can be reasonably good solution for small businesses who want to engage with their employees whose headcount does not exceed over a hundred. For larger companies, it is necessary to choose one of the paid versions which do offer additional features which they might find quite useful.

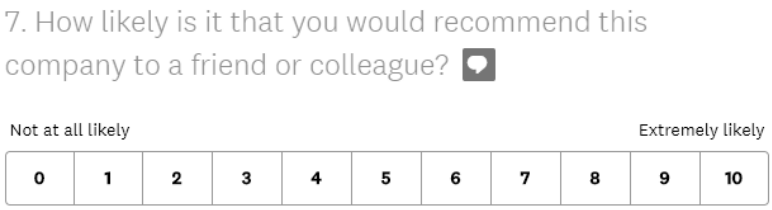

Figure 8. Survey Monkey's Sample Question

2.2.2 TypeForm

TypeForm is a type of the survey tool that tries to target people who are looking for creative surveys. Typeform's interface is elegant and attractive and company' s motto "Asking questions should be easy, human, and beautiful" reflects its overall design of the tool. One of the

[1] „7 Best Survey Tools: Create Awesome Surveys For Free!" [http://www.wordstream.com/blog/ws/2014/11/10/best-online-survey-tools]

benefits of their free version (nicknamed CORE plan) is unlimited questions and unlimited answers. On top of these benefits, the free version also consists of data export, custom design themes, and basic reporting [3].

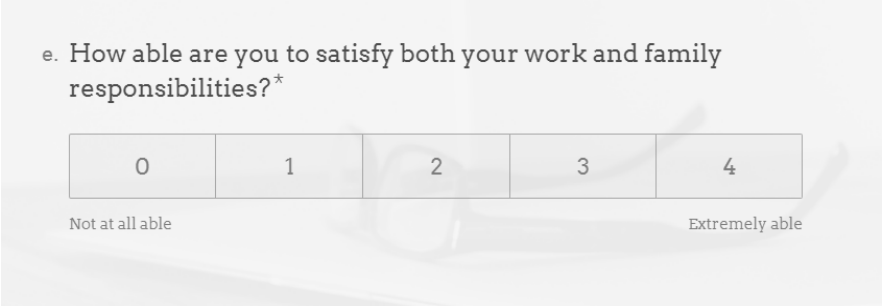

Figure 9. TypeForm - Sample Question

2.2.3 Google Forms

Google Forms are well known as it is a completely free survey tool created by Google. The user interface is very simple, easy, and intuitive. Features of Google Forms are unlimited surveys and respondents, lots of theme options, option to add a custom logo, images or videos and much more. The feature that Google Forms provides for free and none of other survey tools provide for free is skip logic and page branching which means additional questions can be shown based on selected answers. Another important feature is that survey answers and data are automatically collected in Google Spreadsheets. Generally, it is a part of Google ecosystem which means responses can be easily uploaded on to Google Drive. To sum up, due to its free pricing category Google Forms will most likely be the first pick for most people looking for surveys [3].

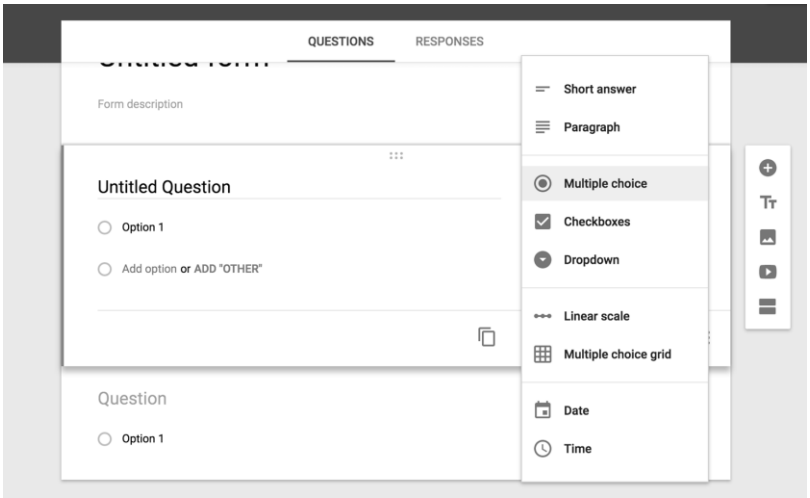

Figure 10. Google Forms – Survey Builder [4]

2.2.4 Zoho Survey

Zoho Survey is another decent survey tool available in three pricing categories. The free version offers unlimited surveys, up to fifteen survey questions, and up to a hundred and fifty responses [3].

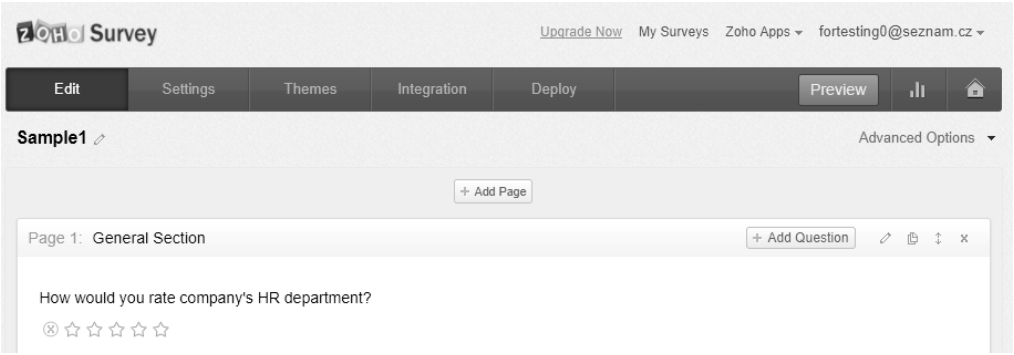

Figure 11. Zoho Survey – Survey Builder

2.2.5 Survey Gizmo

Survey Gizmo divides its survey tool into five pricing categories. The free version offers unlimited surveys and questions, up to 50 respondents, several basic question types, free templates, basic reporting, and an option to export to CSV. The free version is limited up to 50 respondents which may be insufficient for some companies and those companies have to either pick some of the paid versions or choose any other survey tool [3].

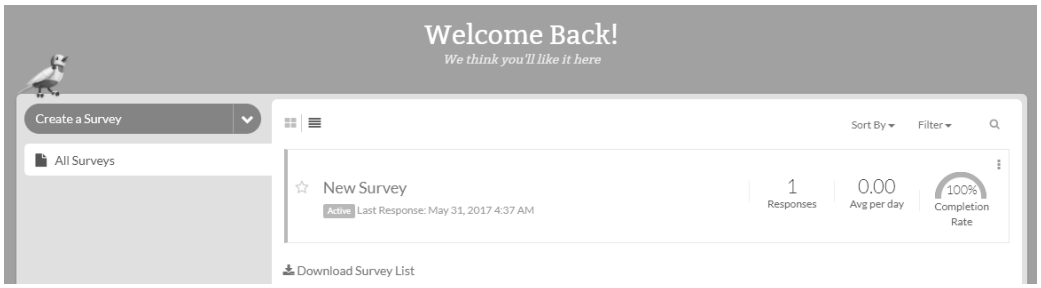

Figure 12. Survey Gizmo – All surveys

2.2.6 Summary Analysis

All of the survey tools presented above share similar phases of the survey lifecycle as follows: create, edit, send out, and analyse. However, each survey tool is unique in the sense of implementing these phases, the user interface, and pricing plans.

In regard to this project, it is important to mention what might be taken as inspiration for this project from each of these survey tools, how each phase of the survey lifecycle is structured, and which interesting features they offer.

In my opinion, Survey Monkey provides an easy-to-use, easy-to-understand user interface. Its general layout is neat, more importantly it stays consistent throughout the entire application. On the other hand, Google Forms takes this a step further by providing even simpler and minimal-looking user interface. Zoho Survey has the user interface that looks a bit out-dated, however surveys are displayed in well-arranged way without graphical elements that might be irritating to users. Survey Gizmo shows all surveys in a table where each row represents one survey along with other information (some of them are when a survey was created, how many responses were collected and a few more). After all, creating an account and trying out each of the survey tools listed here was greatly beneficial and it helped to form thoughts how the survey component might be created and what features might be implemented.

The main objective of the analysis was to gather the specifics about a few existing survey tools which was necessary for successful completion of this project. The output of the analysis was used to form a set of requirements for this project (See 4. Requirements).

2.3 Used Technologies

This chapter explains technologies that were used when developing the survey component. Some of the technologies listed below are vital and must be used every time when any website is created, whereas some of them had to be used to fit the component into existing Youmanage system. Essentially, this chapter is supposed to give readers a good introduction to technologies that were involved in the project. This chapter is further divided into several sections where each section describes one technology used in this project.

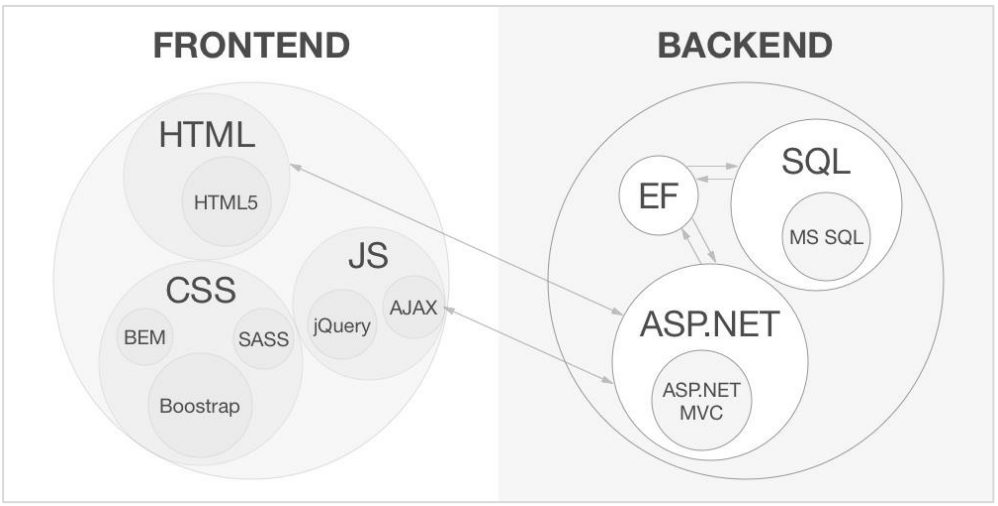

Figure 13. Used Technologies Diagram

Figure 13. shows all technologies that the existing Youmanage project makes use of. When developing this project, it was necessary to use those technologies to fit it into the existing Youmanage structure.

The frontend contains three main technologies (HTML, CSS, JS). HTML (HyperText Markup Language) defines the structure of the web. CSS (Cascading Style Sheets) describe the style of HTML documents. JS (Javascript) adds interactivity, animations, and visual effects to HTML documents. Furthermore, CSS has three more parts (BEM, SASS, Bootstrap). BEM (Block, Element, Modifier) is a convention how to structure CSS stylesheets. SASS (Syntactically Awesome Style Sheets) is an CSS extension. Bootstrap is CSS and JS library of predefined components. jQuery and AJAX are parts of Javascript. jQuery is a javascript library, whereas AJAX (Asynchronous Javascript and XML) is a mix of technologies communication with the web server without reloading the page.

The backend contains three main technologies (ASP.NET, SQL, EF). ASP.NET (Active Server Pages) is a Microsoft's web framework for building web applications. ASP.NET MVC is the framework with the MVC (Model-View-Controller) architectural pattern. SQL (Structured Query Language) is a standard query language and MS SQL (Microsoft SQL) is a Microsoft's solution to relational databases. EF (Entity Framework) is an object-relational mapping for MS SQL. ASP.NET communicates with the database using an abstract layer that Entity Framework creates and Entity Framework then communicates with an actual database.

The connection between the frontend and the backend is between ASP.NET and HTML as well as between ASP.NET and AJAX. ASP.NET processes scripts on the server and returns HTML documents back to the browser. AJAX does the same thing without reloading the page. All these technologies that were involved in this project are further described in this section.

The only thing that the Youmanage system does not adopt is the BEM methodology for CSS and it was chosen by the developer. However, BEM is just a naming convention which could be used without any problem as it does not interfere with the existing structure in any way.

2.3.1 HTML

HTML ("Hyper Text Markup Language") is the standard markup language for creating websites. It is the most basic building block of the web. HTML describes the structure of websites using markup. It uses elements to describe the structure of the website. Elements are represented by tags. HTML tags normally come in pairs.

2.3.1.1 HTML 5

HTML 5 is currently the newest version of HTML. It does bring not only the new elements but also new attributes of form elements. The most interesting of HTML 5 are new semantic elements (<header>, <footer>, <article>, <section>), new attributes of form elements (number,

date, time and range), new graphic elements (<svg>, <canvas>) and new multimedia elements (<audio> and <video>) [5].

It is always desired to use the newest version if possible especially when it is well supported in older browsers. Some new elements are most likely not be used such as svg, audio or video. However, the canvas element might be used to render charts on analysis page and elements like header, footer, and section will help to better mark different parts of the website. HTML/HTML5 will be used in the project to define the content of websites that will be created throughout the development.

2.3.2 CSS

CSS ("Cascading Style Sheets") is a language that describes the style of an HTML document. In other words, CSS is responsible for how a website looks like in browsers. For example, CSS can be used to make a text larger or to make it italic or to change a background colour or to define how elements on a website should be laid out. CSS has many advantages it saves a lot of work when it comes to controlling of layout of multiple pages as one CSS style can be used to style multiple pages all at once. CSS styles can be defined either within HTML <style> element or using a better approach to keep a style in external CSS files with css extension. The advantage of keeping a style separate from HTML document is being able to take advantage of using one CSS style in multiple HTML documents [6].

As outlined in 2.1.3 Youmanage: Rebranding, one of the objectives of the Youmanage version 4 is to make the whole HR software mobile responsive. CSS has a feature called media queries which are used to create specific stylesheets for mobile phones, tablets, and desktop computers. To put it more simply, CSS media queries help to determine which device a website is viewed on and it serves appropriate CSS stylesheets according to that device. Consequently, CSS media queries are already used in the Youmanage application and will be used in this project too to make the survey component mobile responsive.

There is no other way how to style a website without CSS. CSS must be used in the project to make the website look more aesthetically pleasing. Without CSS, the website would display just plain text without any colours, borders, animations, button hover states and so on.

The current version of CSS is CSS 3. CSS 3 has been split into modules. It is mostly backwards-compatible with previous versions of CSS. It adds several new modules such as background and border, text effects, 2D/3D transformations, animations and multiple column layout [7].

Unfortunately, some of the new modules of CSS3 are not well supported in older versions of web browsers which basically means they cannot be used in this project as some Youman-

age clients still use quite old versions of browsers. As a result of that, the development team at Youmanage can only use technologies that are well supported in older versions of web browsers. On the other hand, if there was no browser limitation and CSS3 could be used, for example using a multiple column layout would help to simplify creating a complex layout a lot on a survey manager and on a build page.

2.3.2.1 SASS

SASS (Syntactically Awesome Stylesheets) is an extension of CSS. SASS introduces features that help to maintain large stylesheets in more effective way. The SASS main features are variables, nesting, mixins, inheritance, and math calculations. Unlike CSS stylesheets, SASS stylesheets are stored with scss extension. SASS files need to be compiled to CSS [8].

As mentioned, SASS is an addition to the CSS and it is not necessary to be used. However, this project might benefit from that because it enables to create separate CSS stylesheets which will help to structure the project stylesheets. Stylesheets will be divided into several files by components such as menus, tables, sections, tiles, panels and so on. Using SASS may seem to be an investment to the future when changes start to occur but in fact, stylesheets tend to change quite frequently while developing a website so using SASS will help to reduce a time when these changes need to be made. As a real example, variables can be used to store widths of various devices (320px, 480px, 768px) and then these variables will be used throughout in many places in different stylesheets. If any of these variables needs to be changed, it requires finding the variable and changing its value and whenever the variable is used it will hold the updated value, whereas with plain CSS this would involve finding every location when the variable is used and changing its value which is ineffective.

2.3.2.2 BEM Naming Methodology

BEM stands for Block, Element, Modified and is a component-based model to web development. The idea behind is to divide a user interface into small independent blocks. It makes the user interface development easy even if the user interface is more complex. It allows to reuse existing code without creating duplicate content [9].

The BEM methodology will be used in this project because writing CSS without any naming convention can result in a style overriding where one selector is more specific over the other. The BEM methodology is expected to be used with SASS as BEM also declares a convention how to keep stylesheets separate. For instance, one stylesheet as a one file will only contain a CSS style for different menu components, whereas another stylesheet could only contain a style for buttons. Having separate stylesheets allows to find styles quickly, much quicker compared to having a large file with all CSS styles. Additionally, this methodology

focuses on component names to be as informative and descriptive as possible which will help to identify blocks and elements from an HTML document.

2.3.2.3 Bootstrap

Bootstrap is an open source HTML, CSS, and JavaScript framework for developing responsive, mobile-first projects on the web [10]. Bootstrap comes with a set of styles and predefined components that can be used on a website. Nowadays, there are millions of websites that are being built with Bootstrap and that makes Bootstrap one of the most used CSS framework. Bootstrap is built using CSS pre-processors LESS and SASS. Using Bootstrap helps web developers speed up web development process as it already includes CSS styles which they would have to create themselves otherwise. So, Bootstrap is a great tool that allows fast prototyping websites that will be nicely rendered on mobile phones, tablets, and desktops.

Some of the Bootstrap features will be certainly used such as styling buttons, styling typography, responsive classes, and styling forms as the Youmanage already makes use of Bootstrap so it will be easy to integrate. The Youmanage version 4 is built entirely on the Bootstrap and the most used features are buttons, forms, menus, navigation bars, and responsive helper classes. Furthermore, Bootstrap provides a number of components which might be used in this project such as modals and panels. Obviously, using Bootstrap will speed up the development process and whenever any component is used it will not have to be created from the scratch.

2.3.3 JavaScript

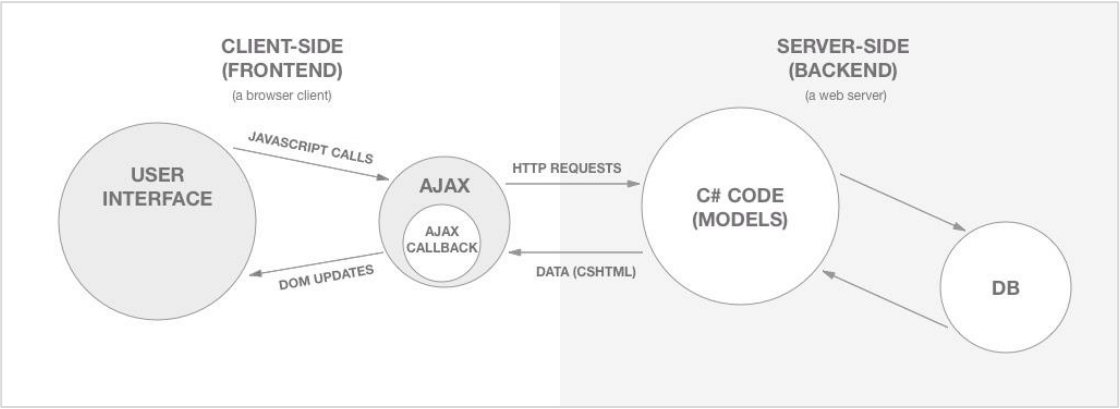

Figure 14. JavaScript Diagram

JavaScript (often seen as just "JS") is a programming language that supercharges HTML documents with interactivity, animations, and dynamic visual effects. JavaScript can make websites more useful by supplying immediate feedback. For instance, a customer who is shopping on the online store can see how many items they have got in the cart with the total price of the order. JavaScript can help to update information of a part of the website as cus-

tomers add or remove items to the cart. JavaScript can be used to validate user's input from web forms. Users then get to see if they fill out certain web form correctly or if there are some information missing [11].

There are more cases where JavaScript can be used. Generally, JavaScript can access and change the entire hierarchy of HTML elements (referred to as DOM[2]) and their CSS styles. In that case, all HTML elements and CSS styles can be dynamically changed using JavaScript. A new HTML markup can be inserted into an HTML document as well as existing elements can be removed. Some HTML elements may be hidden and be shown only after a certain action has been performed such as clicking on a button, hovering over an element, changing a value of an element. Hiding elements and showing them via JavaScript is a common way of creating pop-up windows.

Figure 14. shows how Javascript/jQuery is used in the Youmanage architecture. Javascript as a technology that runs in a browser on a client side uses AJAX (Further explained in the following section 2.3.3.1) to make asynchronous HTTP requests to the server and cause code on a server to execute. Once the HTTP request is processed, the server returns a response back (usually an HTML markup) which can be used to update particular part of the website.

2.3.3.1 AJAX

AJAX (Asynchronous JavaScript and XML) is not a new technology, it is a term for a mix of technologies – JavaScript, the web browser and the web server. AJAX allows to send requests to web servers and receive an answer back without having to reload the page. Of course, reloading a page takes time. In some cases, there is a need to send little piece of information to a server and receive a response back so it would not be sensible to refresh the whole page to be able to do that. Interacting with websites that use AJAX almost feels like using a native desktop application. Communication with the server happens in the background of the web browser and content of the website get dynamically changed [11, p. 447].

AJAX will be certainly used a lot when building a survey because it is going to be a dynamic page when questions and answers will be added dynamically to the page. Using AJAX is not necessary but it will make better user experience when creating surveys. As mentioned, creating surveys will be a dynamic page and without AJAX a page would have to get reloaded even after a small change which is not ideal in terms of network usage and user experience. AJAX is more likely to be used elsewhere too when a communication with the web server is required and reloading a page is not good solution. The Youmanage version 4 makes use of

[2] DOM (Document Object Model) is a term for object-oriented representation of a tree graph consisting of HTML elements.

AJAX in many places throughout the application particularly for updating forms such as client's contact information.

2.3.3.2 jQuery

JavaScript has one big disadvantage – writing it can be quite hard. It is still a programming language, even though it is not as complex as other programming languages and many people including web designers find programming difficult. Besides, different web browsers understand JavaScript differently which makes web development longer due to many hours spent on testing final website on different machines and browsers to make sure the website is working correctly. This is where jQuery comes in [11].

jQuery is a JavaScript library intended to make JavaScript programming easier. It is a complex set of JavaScript code that solves two biggest problems of JavaScript – complexity and cross-browser compatibility. Things that can be accomplished in jQuery with a single line of code would take hundreds of lines of code plus many hours of testing in Javascript [11].

jQuery will be used because it is already a part of the Youmanage application and Bootstrap for some of its components also requires jQuery. Using jQuery will be beneficial thanks to not having to worry about cross-browser compatibility and writing less code. jQuery provides a nice API for working with AJAX, so jQuery will be used to handle all AJAX requests. Another potential use of jQuery might be for client-side validation of surveys. There is plenty of alternatives to jQuery (other libraries) but jQuery is chosen for its popularity, API, cross-browser compatibility, and already being it used by other developers at Youmanage.

2.3.4 ASP.NET MVC

ASP.NET MVC is a popular framework for building web applications with the general Model-View-Controller (MVC) architectural pattern built-in. The programming language that is used to develop web applications with ASP.NET MVC is C#. Figure 15. shows the current statistics on which frameworks are used on one hundred thousand websites. A majority of websites use PHP with 31% followed by ASP.NET with 18%. ASP.NET is mentioned in the pie chart twice, that is because the second case is ASP.NET MVC with 3% which is a newer version of ASP.NET. PHP is leading thanks to being free and open source, whereas adopting ASP.NET involves hosting a website on different server than PHP websites which makes the whole process of deployment a bit trickier especially for smaller projects. PHP is further described in section 2.4.1 PHP as the alternative technology for this project.

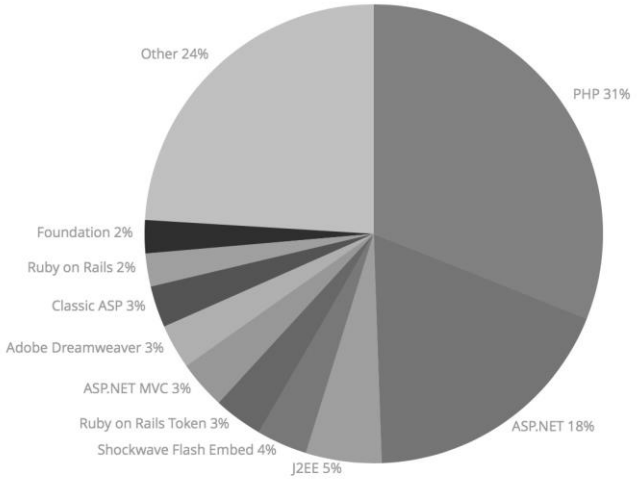

Figure 15. Framework Usage Statistics across 100k websites [12]

The new version of the Youmanage system is entirely built with ASP.NET MVC and thus this project will be developed using ASP.NET MVC as well.

Figure 16. shows the interactions in an ASP.NET MVC application. Controllers and models are written in C#. A controller contains methods that are called action method. Each action method is associated with a URL through the ASP.NET routing system. When an HTTP request is sent by a URL, a controller looks for action method included in the URL. If it finds an action method it performs that method and returns a view that displays data from the controller [13, p. 65].

For instance, the ASP.NET routing system by default is set up in a way that if a request with a URL as follows http://www.xxxx.com/Index is sent, then a controller looks for an action method 'Index'. Of course, the routing system can be further configured, individual routes can be set manually or which action method should be called when no URL parameters are provided.

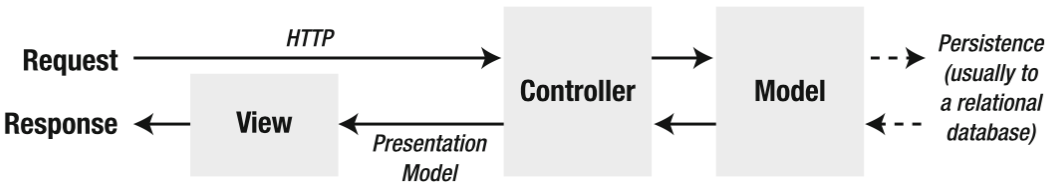

Figure 16. The interactions in an MVC application

As Figure 16. shows the flow of requests, it is clear that views do not communicate with models, they do not even know that models exist. As long as views get data in a format they require view will display it. A controller is a part that passes data between models and views.

MVC 3 has introduced the Razor View Engine and it uses entirely different syntax compared to the standard ASP.NET view engine which was used before in ASP.NET Web Forms [13, p. 65].

2.3.4.1 The MVC Pattern

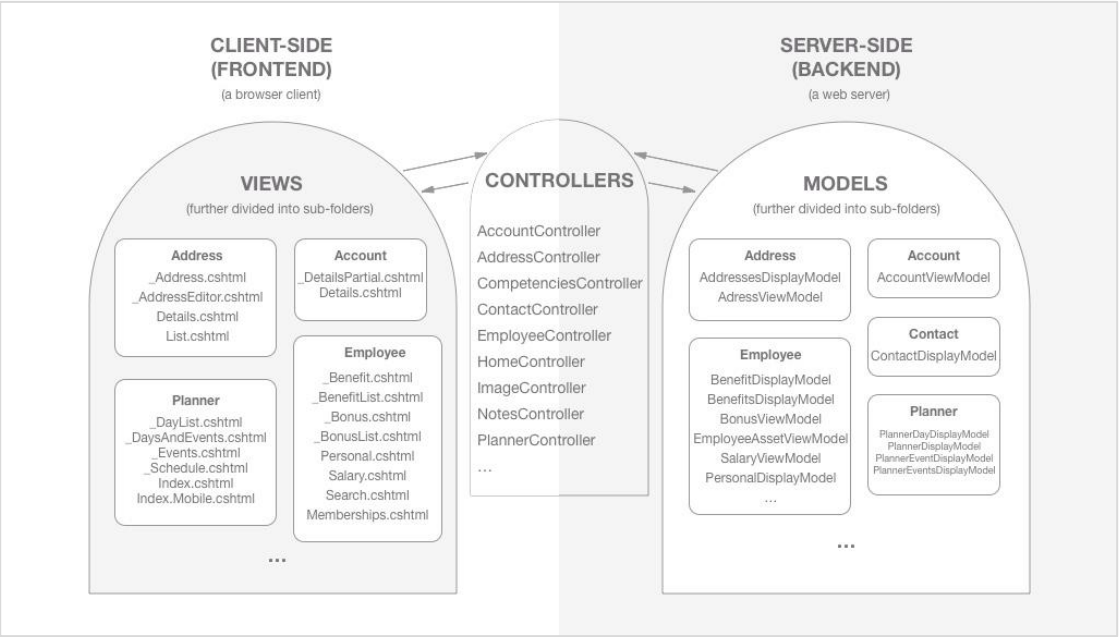

Figure 17. Youmanage MVC Architecture

The MVC pattern is powerful and elegant architectural pattern that is mainly used for developing web applications. The MVC pattern has been in use since the 1970s when it came up from the Smalltalk project. The MVC pattern naturally follows the cycle of user actions and view updates and that makes the pattern well suited to web applications. Moreover, the MVC pattern forces developers to separate domain logic and controller logic from the UI. In other words, all business logic code is kept apart from the HTML views which results in a more maintainable web application. The purpose of the pattern is to separate concerns within an application into at least three pieces [13, pp. 63–64]:

- *Models* – classes which contain the data that users work with. These may contain just simple objects with properties that are used to transfer the data from the database through the controller to the views or they can contain operations for manipulating with the data.
- *Views* – files that are used to render the data passed from a controller as a part of a UI. Views are sent to the web browser. According to the MVC pattern, views should not contain any logic.

- *Controllers* – classes which process incoming requests. Based on those requests it calls particular models to retrieve the data if any data is needed, a model returns the data back to the controller and the controller completes its job by passing the data from the model to a view.

Figure 17 shows an example of the Youmanage MVC architecture with real classes that are used. The general idea is to have one controller for each particular area and one folder for each, models and views. In regard to this project, a survey folder will be created in models and in views along with a survey controller.

In order to properly integrate the survey component into the existing Youmanage application it is sensible to use the existing Youmanage MVC architecture as shown in Figure 17 and implement the survey component accordingly.

2.3.5 MS SQL

Microsoft SQL Server is a Microsoft's solution for relational database management system (RDBMS). Microsoft SQL Server is a part of a larger Microsoft ecosystem which means that it can be used either as a standalone application or as a part of other Microsoft's products. Using only Microsoft's products and technologies is beneficial, easy to setup as they are designed to work well with each other.

As mentioned earlier, the Youmanage software is completely built with Microsoft's products and technologies. As a RDBMS, the Youmanage system uses MS SQL for all its databases and thus any other database solution cannot be used in this project.

2.3.6 Entity Framework

Entity Framework is an open source, object relational mapping (ORM) framework created by Microsoft. It is a part of .NET framework and the current version is Entity Framework 7. The idea of object relational mapping is to keep web developers away from using SQL commands when working with the database and use objects to manage data from the database. Entity framework takes care of handling SQL commands and communicates with the database using SQL commands. In other words, Entity Framework creates an abstract layer (see Figure 18) between a database and a developer and it defines a set of SQL commands that are mapped to objects methods. Whenever a method on any object is called Entity Framework will create corresponding SQL command(s) which are then sent to the database.

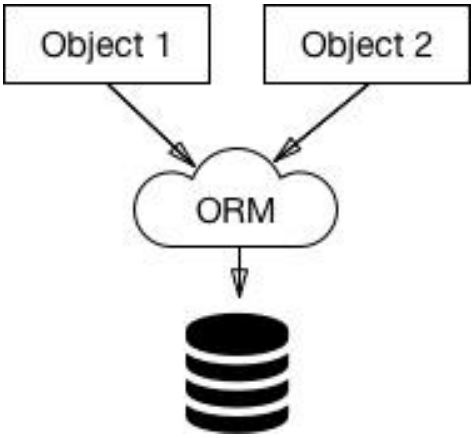

Figure 18. ORM

There are two scenarios when Entity Framework can help right at the beginning. The first scenario is having the database already, whereas the second scenario is not having the database. In both cases Entity Framework can help with the other part that is missing. In the first case Entity Framework can create model classes based on the existing database. It will create a class for each table in the database along with associated columns as their properties. In the second case Entity Framework can create a database from model classes. Even though model classes have to be created it is easier for web developers to create classes rather than having to use SQL commands for creating a database.

As mentioned already, MS SQL must be used as a database management system for this project, hence Entity Framework will be used along with MS SQL.

This section explains technologies that will be or might be used while developing the survey component. It covers HTML and CSS as technologies that are vital to any website on the internet followed by JavaScript as a programming language that can make a website more attractive and intuitive. After technologies which are often referred to as frontend technologies the chapter continues to describe other technologies often referred to as backend technologies such as ASP.NET MVC and MS SQL.

2.4 Exploring Alternative Solutions

Even though all technologies that will be used in this project have been introduced in the previous section it is necessary to explore some alternative solutions that could be used if the project was not developed into the Youmanage system.

Nowadays, there are many different technologies or programming language to choose from when developing a web application. It is up to a company or an individual need which technologies or which programming languages to use. Sometimes this decision is made after knowing what a project will be about, how large a project is going to be, or whether it is a pro-

ject created from a scratch or based on an existing project. These are only some of the questions that need to be asked because each technology or programming language excels in different area or they are sensible to use only for smaller projects. There is nothing worse than finding out a feature that a project needs to make use of is not supported at later phase of a project.

Some technologies are maintained by larger organizations and they often provide a full pack of services and technologies, usually own solution to one area. If an organization starts to provide more and more products (meaning services and technologies), they tend to create something what is called "an ecosystem" which means products provided by the same company tend to work well with each other, whereas if one piece of larger project is provided by any other organization then a communication and an integration is not always as good and smooth as if all parts were provided by the same company. It does not necessarily mean whenever something is being developed it only should use products of one single organization but when it is possible it works usually better as all products within the same organization are designed to work well with each other.

That is the case of Youmanage and using only products provided by Microsoft. It uses MS SQL for managing databases, ASP.NET framework for the application, and IIS[3] for hosting the application. However, this chapter lists two alternative technologies that could have been used in this project instead of ASP.NET and C# if non-functional requirements (See 4.3 Non-functional Requirements) were ignored.

2.4.1 PHP

PHP (PHP HyperText Preprocessor) is a widely used open source, general-purpose scripting language used to create web applications. It has grown rapidly because of its many advantages. PHP is fast, free, easy to use, versatile, secure, customizable, and technical support is widely available [14, p. 10].

PHP has been around for over twenty years now and it has come a long way since then. Figure 15. shows how popular PHP is where it leads with 31%. Nowadays, there are several frameworks that are built on PHP to make PHP web development even easier to use. Some examples of the popular PHP frameworks are Laravel, Zend Framework, and Symfony. PHP in its entirety is not object-oriented, that is the point where PHP frameworks come in and make a huge difference as many of them implement the MVC pattern (See 2.4.4.1 The MVC Pattern) and are meant to be used in an object-oriented manner.

[3] IIS stands for Internet Information Services and is software web server created by Microsoft

2.4.2 Java

Java is a high-level object-oriented programming language which was developed by a company called Sun Microsystems back in May 1995. There are four Java programming language platforms: Java SE (Standard Edition), Java EE (Enterprise Edition), Java ME (Micro Edition), and JavaFX. Java EE is built on top of the Java SE and it provides an API and runtime environment for developing and running large-scale, multi-tiered, scalable, and secure network applications [15].

Java EE is mostly used for developing web applications that are required to be robust and secure which is exactly something that banks or other financial institutions want. Developing web applications using Java EE takes more time compared to developing apps using PHP and that is the reason why a lot of start-ups[4] companies use PHP as opposed to Java EE as they want to come up with a solution as soon as possible.

2.5 Summary

To sum up, this chapter describes the state-of-the-art of this dissertation. It starts off with the overview of the Youmanage HR software that is divided into the user perspective and the technical perspective. The user perspective aims at giving brief information about the Youmanage software from a user point of view or what a potential client might be interested in seeing, whereas the technical perspective is about what goes on in the background particularly with focus on the programming languages, the architectural pattern, and the server architecture.

The existing Youmanage system section is followed by the section about the competitor products. The objective of this section is to get to know similar existing products that are already on the market to get inspiration from and form a set of requirements.

Another section covers technologies that are already used in the Youmanage system as well as technologies that may be used in the development of this project. Moreover, this section also gives reasons why each technology must be used or why each technology may be useful or what each technology might be used for in the survey component.

Finally, the last section that concludes the state-of-the-art is about exploring alternative solutions that could be used if this dissertation was not going to be developed into any existing project.

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[4] Startup is a term for a company which is typically newly emerged, fast-growing business.

The next chapter explains a software development process, it compares two common software development approaches along with which approach was used in this project and which approach is implemented at Youmanage.

3 Software Development Process

Developing software is a complex process that consists of several steps. Essentially, there are two scenarios in software development that can happen. The first scenario is that a definite set of requirements is known at the beginning and it is not likely to be changed during the development phase. If a set of requirements does change during the development then it has an impact on every phase before the phase a project is currently in. The second scenario is having a set of requirements at the beginning but in this case requirements are likely to change during the development. Both scenarios have just been briefly introduced and there are two approaches (or methodologies) that help to manage those scenarios and the entire software development lifecycle. Choosing the right methodology depends on a type of the project and it takes time to decide which one to choose.

3.1 Waterfall Development

Waterfall is a linear approach to software development. Waterfall methodology is the one that is well suited for projects whose requirements do not change during its development. The ideal situation for waterfall methodology is to have a complete set of requirements at the beginning. However, sometimes a set of requirements does change even though it was not initially planned it would. If that happens those changes are difficult and costly to implement [16].

Advantages

- Progress is easily measured as all requirements of the work are known in advance
- A customer is not strictly required after the requirements phase
- Since all requirements are defined at the beginning, a software can be designed completely and more carefully

Disadvantages

- Gathering requirements in early stage of the project is often difficult for the customer to visualize how a final product is going to look like. Sometimes mock-ups and wireframes can help them visualize the final product.
- Customers may be dissatisfied with delivered product as they might not actually see from documented requirements what will be delivered until it is finished

3.2 Agile Development

Agile is an iterative, team-based approach to software development. The agile approach focuses on the rapid delivery of a software application where requirements change as a project is being developed. All time is divided into phases called “sprints”. Each sprint has a defined duration (typically in weeks) with a list of deliverables. A list of deliverables is discussed at

the start of each sprint and generally says what will be delivered until the next sprint starts. Deliverables are prioritized by their business value and determined by the customer. The key idea is to have always working version that can be tested or ready for a new capability to be added in [16].

Nowadays, the Agile approach is mostly used in web and mobile app development using more specific agile approach called SCRUM. The agile development is well suited for projects when a client comes with an incomplete set of requirements or with just an idea how the final product might look like. Thanks to the agile approach it is possible to come up with wireframes or mock-ups.

Advantages

- The customer can see the project being delivered and they also get to make changes and decisions during the project (the customer is expected to be a part of the project)
- If the customer decides to go to the market with the product before initial launch they can do that due to agile iterations and always having a working version
- Development is more user-focused

Disadvantages

- Some customers may not have the time or an interest to be highly involved in the process of project development
- Customer involvement throughout the project often leads to an increase in the overall time and cost of the implementation
- An agile project is harder to manage when the team members are not located in the same physical space. However, there are a variety of tools which help to handle this issue via collaboration tools such as Slack or Microsoft Teams.

3.3 Which Approach Was Used?

The development team at Youmanage uses the Agile approach and this project was developed using the same approach. The reason for choosing the Agile approach over the Waterfall approach was mainly because not all requirements were known at the beginning and coming up with a time scale was challenging and difficult to estimate how much time it is going to take to develop. However, what was beneficial of using the agile approach was having working prototype. Basically, the whole development of the survey component was divided into two iterations. The first iteration was focused on working towards a basic prototype whereas the second iteration was dedicated to further improvements and extensions. Developing the survey component was specific in a sense that all parts (requirements) had to be completed otherwise it would have been incomplete (See 4. Requirements for further details).

The development team at Youmanage uses Bitbucket for managing source code. As a starting point of this project one of the project recent branches was used to create a new branch dedicated only to the survey component. At the beginning, it was crucial to spend some time to get to know the existing system especially the architecture of the system.

3.4 How Agile Is Implemented at Youmanage

As mentioned, the development team at Youmanage uses the Agile approach. The way they approach the Agile approach is that they run one-week iterations. They have got a board in the office (Figure 19) divided into four columns (project, todo, doing, test) and three rows. The project column explains a name of the task/project a developer is working on at the moment. The todo column usually splits the task/project into smaller more manageable chunks as tasks/projects are usually composed of several parts. The doing column is intended to have sticky notes (smaller chunks of a project) that developers are currently working on. The test column contains sticky notes that are ready to be tested. Once it is successfully tested it is removed from the board. The ideal lifecycle of sticky notes is when sticky notes go from the left side of the board to the right side and never return back. However, this happens very rarely. Sticky notes at Youmanage tend to move between the todo and the test columns quite frequently.

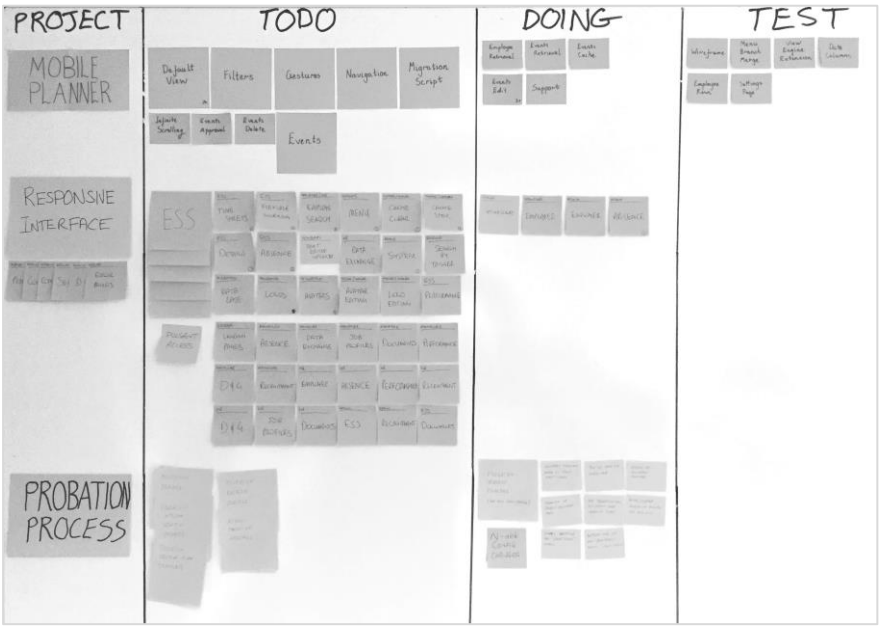

Figure 19. Youmanage's Board

4 Requirements

This chapter covers all requirements that were followed while the development. Most of the requirements listed in this chapter are based on the analysis of the competitor products (See 2.2 Competitor Products).

4.1 Client Interviews

All requirements mentioned in this chapter are based on a number of interviews with the team members of Youmanage. Youmanage did not provide a fixed specific set of requirements. However, we had conversations about a general structure and we agreed that most of the requirements were going to be defined from the analysis of competitor products (See 2.3 Competitor Products). It was determined that the survey component will be placed under the Core HR module (See Figure 20).

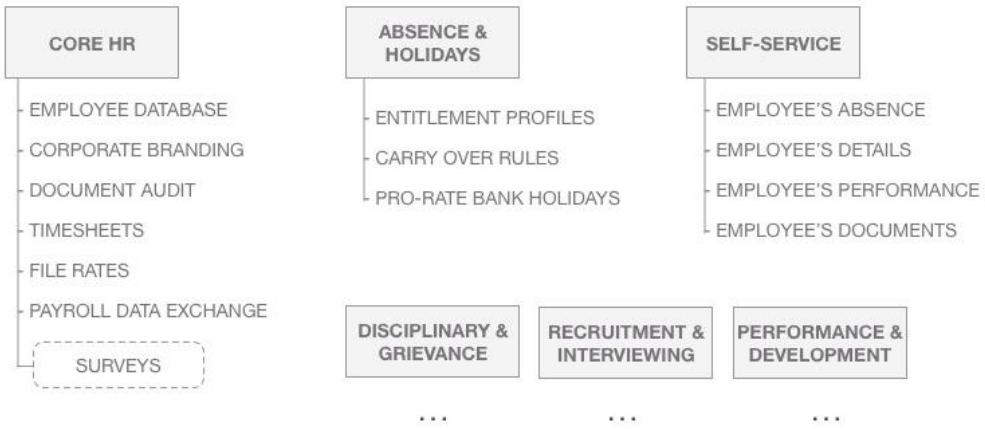

Figure 20. Youmanage Modules – Survey Placement

4.2 Functional Requirements

Functional requirements can be broken up into two sections. The first section is about user roles and what they can do with surveys, whereas the second section focuses more on the survey perspective and the capability of surveys on their own.

This section comes up with a set of requirements for what is necessary to be implemented as well as what would be useful to have implemented. Of course, there are many possible features that would be nice to implement. On the other hand, it is very difficult to estimate how long it will take to develop certain functionality.

4.2.1 Modelling Use Cases

Use case modelling is useful when there are different actors using the system. It is a self-explanatory and easy way of showing which tasks a different group of users can perform in the system. The Youmanage system divides users into four different groups (See 2.1.1.2 User Roles) – Admin, HR, Manager, and Employee. In case of surveys, it was decided with the team members of Youmanage that there is no need to create a survey settings for administrators. HR and Managers will be able to perform the same set of actions and they will be the main actors who will have an ability to manage surveys.

4.2.2 HR and Manager Use Case

HR employees and managers are two different user roles within the Youmanage system and both user roles usually have slightly different access to data. However, in terms of surveys HR employees and managers have the same access to actions which they can perform. Use case diagram below simply represents all actions that can be performed by both groups of users, HR employees and managers.

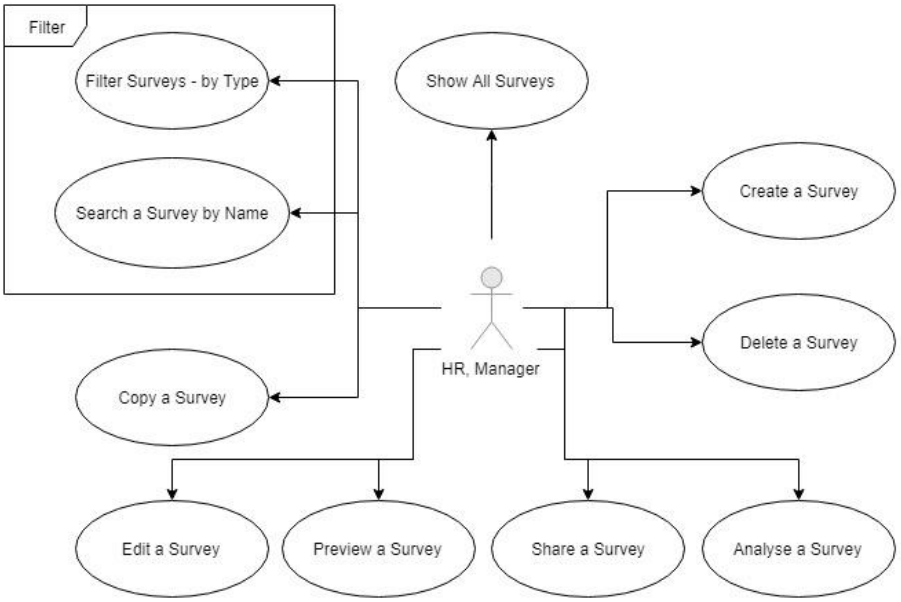

Figure 21. HR and Manager Use Case Diagram

4.2.3 Employee Use Case

Employees do not get to do much compared to HR employees and managers. They are only allowed to fill out surveys which have been created for them.

Figure 22. Employee Use Case Diagram

4.2.4 Survey Requirements

Based on the competitor analysis (See 2.3 Competitor Products) a basic set of requirements was created consisting of requirements that are vital and the ones that enhance the capability. All suggested enhancements may not be implemented due to the time constraint or being too demanding.

4.2.4.1 Welcome Page

When an HR employee or a manager comes to the survey module for the first time they should not feel overwhelmed by the amount of information that is given to them. That is what a welcome page is supposed to be used for. Its purpose should be to give users who are new to surveys a brief introduction about how they can use the surveys as well as what features the component has. Of course, this page should also include a form for creating a survey.

4.2.4.2 List

Once the first survey has been created, it should take users to another page that will be something like a survey manager. A survey manager is meant to be a page that lists all surveys that have been created by a currently logged user and it should allow to perform actions with surveys. The survey manager should be displayed as a table where each row represents a single survey. Each survey is likely to have a basic information associated with it which should be displayed in the table. It is important to think about what happens when there are tens of surveys and a user wants to find one survey. It would be tedious job to scroll through all surveys and find the one that is being searched for. For that reason, the page should allow users to filter and search surveys. To conclude, the main components of the survey manager page should be a table with filter/search capability and a form for creating a new survey.

4.2.4.3 Overview

An overview page should be the first subpage of the survey lifecycle (Overview-Build-Preview-Share-Analyse). The purpose of this page should be to give general information about one survey such as who created the survey, when it was created, how many questions the survey contains, how many responses are collected. Each survey needs to be identified by a title

and a description. A part of the overview subpage is expected to be equipped with a form that allows to update the title and the description. Additionally, this page could include a graph of responses showing what days responses were submitted once the survey is shared.

4.2.4.4 Build

A build page should be the second subpage of the survey lifecycle. This subpage needs to be quite dynamic in terms of giving an ability to add unlimited questions and unlimited answers. Before a question gets added in a survey people should be given a list of all types of questions which could be added into a survey. The phase one requires implementing at least three types of questions such as a text field, multiple choice with single answer, and multiple choice with multiple answers. If the time constraint allows, the phase two is planned to be an implementation of a few other question types that might be useful to have implemented. Another possible feature to include might be an option to define whether a question is required or not.

4.2.4.5 Preview

A preview page should be used to display a survey in the same way as it will be displayed for employees. Clearly, a user who creates a survey should see what questions and answers the survey contains from the build subpage but still being able to see a neater version of the survey to check possible typos or mistakes that may have been overlooked on the build page may be useful.

4.2.4.6 Share

A share page is supposed to be used to select a target group for the survey. Selecting the target group should be based on an existing hierarchy dictionary which comprises companies, divisions, locations, departments, and job levels.

4.2.4.7 Analyse

An analyse page is the last subpage of the survey lifecycle. It is likely to be a type of the page that HR employees and managers will want to see the most. They should be able to analyse responses in a way that they are able to compare two different sets of responses. An ability of selecting which sets of responses will be based on the target group that was selected before the survey had been shared. The analyse page is required to be equipped with different types of charts for HR employees and managers to be able to see responses in more visual way rather than just displaying tables.

4.2.4.8 Fill

A fill page needs to be used to render a survey for employees. It should look similarly to the preview subpage as the preview subpage is supposed to display a survey in the exact way how

it is going to look like from employee's perspective. The basic requirements for this page are to show a survey title, a survey description, all questions with answers associated with each question, and a submit button.

4.2.5 Mobile Responsiveness

One of the crucial features of Youmanage version 4 is mobile responsiveness and the development of this component should not be an exception. The whole component should be mobile responsive, in other words, the same capability that will be available on desktop computers must be available also on mobile phones and tablets.

4.3 Non-Functional Requirements

4.3.1 Programming Language

It is necessary to use C# and ASP.NET as the programming language for this project as the Youmanage system is built using those technologies. However, two alternative solutions are suggested in the section 2.2.1 Exploring Alternative Solutions. This project will be developed from the beginning as a new module of the Youmanage system and one of the requirements for successful completion and integration of the new module is to follow company's programming conventions and technologies that the development team at Youmanage are working with.

4.3.2 Database

Mostly, when an existing system gets extended there is a requirement to use what is already created. Especially, when an existing system is up and running and data is being manipulated by many users. This is the case of sticking with MS SQL in this project. The Youmanage database contains many tables which in live version have a lot of data in them. This project will certainly involve using some of that data about employees so tables that are necessary for the survey component itself are created in MS SQL and whenever some data is required to be used from other tables in the database it will be as easy as making a query.

4.3.3 IDE

Another requirement that relates to the programming language and to the database is using Microsoft's IDE such as Visual Studio and SQL Server Management Studio. Developers at Youmanage use these IDEs and they are Microsoft's products so they work well. There is no need or preference to use any other software.

4.3.4 VCS (Version Control System)

The development team at Youmanage has adopted Bitbucket as a web-based hosting service for managing source code. Bitbucket allows developers to create public and private repositories for free which is the main advantage over another web-based hosting service called GitHub. Keeping track of the source code while developing this project will be done with Bitbucket.

4.3.5 Collaboration Tool

Since not all developers at Youmanage come into the office every day it is crucial to keep up with them and report what has been worked on throughout the development. Microsoft Teams is a software that helps a collaboration among developers that do not work in the same physical place but working on the same project. While developing this project it is important to be a part of the development team and whenever there is an issue or misunderstanding somebody from the development team will always be around to help thanks to this tool.

4.3.6 Existing System Consistency

Furthermore, another very important non-functional requirement which is a bit different compared to the ones that are listed above in this section. The entire component has to nicely fit into the broader existing Youmanage system, particularly with the newer version 4. This relates not only to the overall design but also to what components are used or generally to user behaviour on the website, in other words how users are used to interacting with the website. The important thing is to avoid situations where a component that is already used in the existing system elsewhere is implemented differently which would cause many users to feel confused.

4.3.7 Performance

There is always a trade-off between design and speed. There is usually a requirement that a website should be user friendly and aesthetically appealing. Sometimes that website may end up having demanding animations or too much information which causes to use too much processor time or network load. A scenario that is sometimes forgotten is that a website should also be able to display larger amount of data in reasonable time. Fortunately, if there is a performance requirement it is most likely known in advance which then plays a key role in choosing the most appropriate technologies.

4.3.8 Summary

All the functional and non-functional requirements have been defined. At this point it is sensible to move on to another phase in the software development which is design. The following

chapter discusses the design of the user interface, the project structure, and the database design.

5 Design

5.1 Youmanage Rebranding

Due to the undergoing rebranding, it was necessary to design and develop the whole survey component according to the new version of the Youmanage system. The entire design of the user interface of the Youmanage version 4 has changed dramatically. While this project was implemented the version four was still in the development however a majority of the new version in terms of components such as a header bar and a menu was completed so it was possible to get an idea of what the new version was going to look like. Figure 23. shows a one page of the survey component seamlessly integrated into Youmanage version 4.

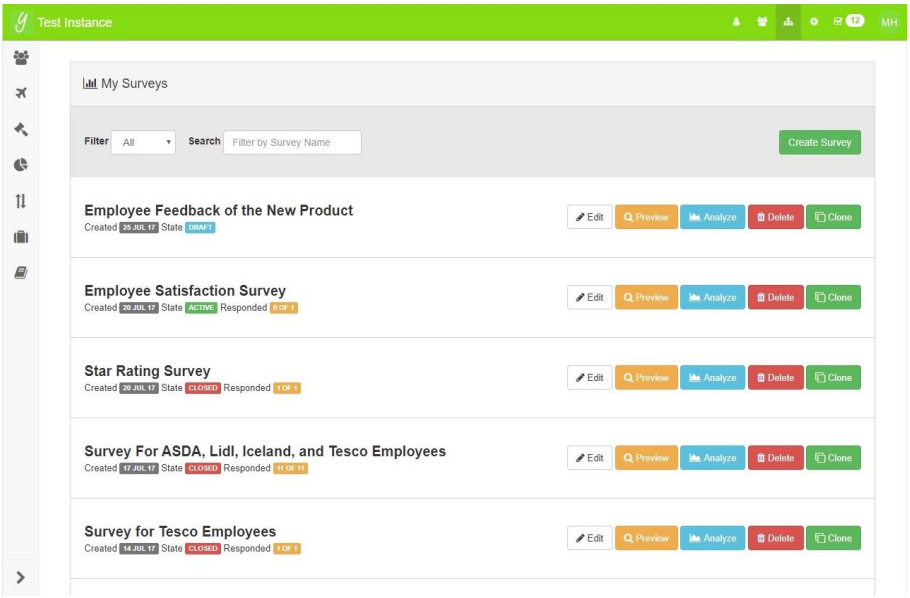

Figure 23. Survey Component in the Youmanage Version 4

As Figure 23. shows the component was appropriately integrated into the Youmanage application version 4. The objective was not only to make the whole component aesthetically pleasing but also simple and easy to use.

5.2 Wireframing

Wireframing is an important step in software development that should happen before the development begins. It allows to think about the project once most of the requirements are known in terms of what components might be used, how many pages might need to be used, and how components on a website might be laid out. Moreover, wireframing also allows to experiment with different layouts such as whether a menu should be on top of the page or on a side.

In this project, a few wireframes of how the survey component might look like were created during the requirement phase. The good thing that comes out of creating wireframes during the requirement phase is converting some text requirements into more visual way. Most of the wireframes that were created, remained the same without making any significant changes to them during the development. In this case, when looking back at the beginning of the workbook[5], it was interesting to spot that most of the wireframes ended up being implemented in the same way they were designed.

Wireframe.cc[6] is a minimal online tool for creating wireframes which was used to create wireframes for this project. All sketches and wireframes were created on a paper in first place. The following section describes the user interface layout concerning this project by showcasing a few wireframe examples.

5.3 User Interface Layout

Normally, when it comes to designing user interfaces a special software is required such as frequently used Adobe Photoshop or any other graphic software. None of those tools were used in this project. As mentioned (See 4.3.6 Existing System Consistency), the overall design of the new version was already created so it was not necessary to use any other graphic software.

The most important thing was to remain the consistency and develop the survey module in a way it matches the current design. The module uses a set of components that get repeated in many places throughout the module such as tiles, buttons, form control, icons, labels, and so on. A one thing that helped to remain the system consistent was using Bootstrap. Bootstrap had been part of the Youmanage system before the development of the survey module started. Whenever, a button or any other component was placed in the module, it used Bootstrap's classes which made it look the same as in other places in the Youmanage system.

The survey module uses three different layouts. The first layout is used on the welcome page, the second layout is used on the survey manager and the third layout is for the single survey view. Since each survey consists of a few steps from an overview to an analysis which means the single survey layout is reused for each subpage.

[5] A workbook is included along with this dissertation. This workbook contains a collection of notes that were written whilst developing this project.

[6] Wireframe.cc can be accessed via this link: https://wireframe.cc/

5.3.1 Survey Manager Layout

A survey manager layout (Figure 24) was designed to be simple and to have a quick access to surveys and their actions. The main components of the survey manager are a header bar and a table. The aim was to come up with a layout that can be nicely scalable down to target different devices (mobile phones, tablets, desktop computers).

Figure 24. Survey Manager Layout

5.3.2 Single Survey Layout

A single survey layout (Figure 25) is a general layout for the whole survey lifecycle (Overview – Build – Preview – Share – Analyse). Each part of the survey lifecycle can be imagined as a subpage and then it is wise to have the same layout for each subpage where the only part that will change is content.

Figure 25. Single Survey Layout

5.3.3 Mobile Layout

Designing an interface for mobile phones can be sometimes challenging due to limited space on the screen. Every page that was created as a part of this project is mobile responsive meaning it is accessible on mobile phones and the entire user interface scales down according to the device the website is viewed on. Figure 26 shows an example of how components of the survey module are laid out on mobile phones. Similarly, it makes use of the wireframes (shown in Figure 24 and Figure 25) with a difference making them look readable on smaller devices.

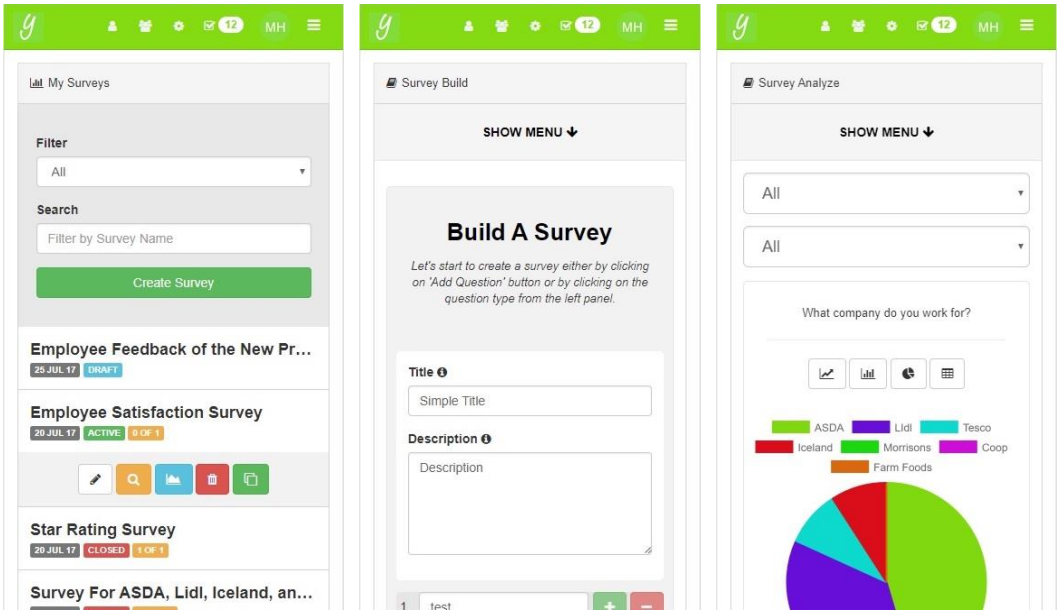

Figure 26. Mobile Layout

5.4 Project Structure Design

A project structure design follows the MVC pattern and all files that were created while developing have their own allocated place in the project structure. Visual Studio provides a sample project structure when creating a new project. This structure is likely to be extended as the project gets larger and involves having more abstract layers.

The most important folders worth mentioning in the project structure are: Content, Scripts, Controllers, Models, and Views. Content folder is mainly used to keep CSS stylesheets. Due to use of BEM methodology (See 2.3.2.2 BEM Naming Methodology) it was sensible to create a folder inside the content folder for all stylesheets that belong to the survey module. Controllers folder contains all controllers and there is only one controller that handles all requests related to surveys. Models folder has many subfolders including a survey subfolder that contains all models that are used as a data source for rendering views. Lastly, Views folder contains all the markup (HTML + Razor Tags). Similarly, views folder is further divided into many subfolders and even some of the subfolders are divided into more levels. The reason for that is that any view can be split up into smaller files called partial views. While developing the survey module many partial views were created and they are usually a part of larger views. Partial views are particularly useful when AJAX requests because AJAX is used to update only a part of the website and usually partial views are called to get an updated markup as opposed to views.

Visual Studio allows to add many solutions to projects. A solution is a self-contained project that encapsulates certain functionality and it can be used elsewhere for example as a part

of any other larger project. The Youmanage project has many solutions and one of the solutions is the business layer that is responsible for managing database queries. Having a separate layer in the application for handling database queries helps to keep controllers easy to maintain. Sometimes queries may involve joining a few tables together and that query can get quite long.

5.5 The MVC Structure

The MVC pattern is widely used throughout the whole project. Figure 27. shows the project structure behind the survey module. Though, it does not show all files and classes that were created. However, the general structure of the project and how the MVC was implemented can be seen from the figure. The entire project structure can be found in 6.1 Application Overview.

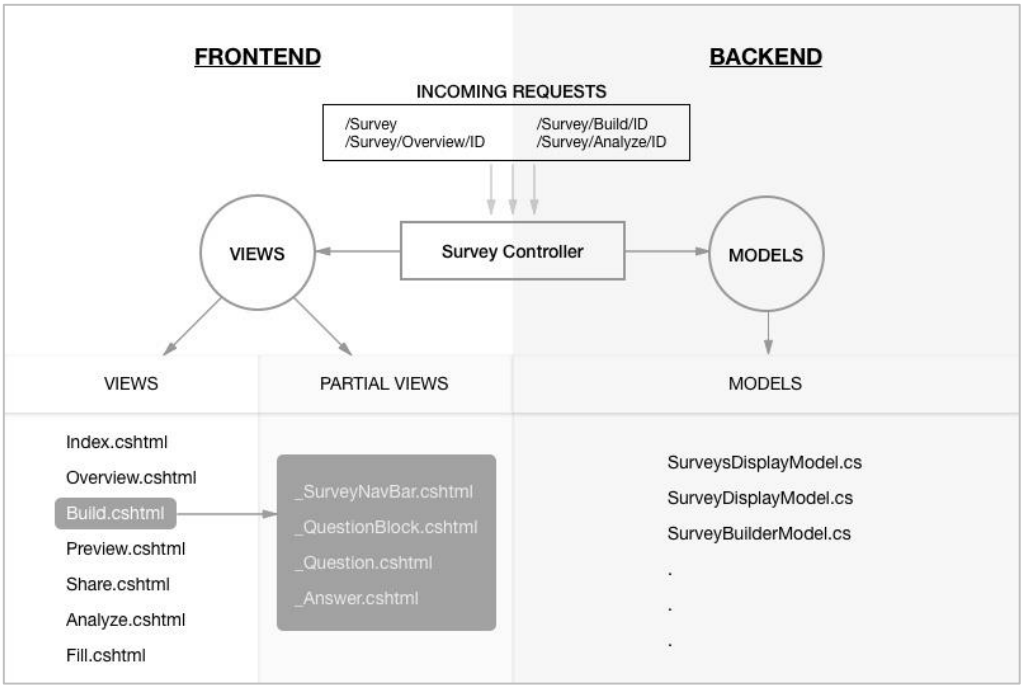

Figure 27. MVC Project Structure

To explain a bit about the MVC structure showed in Figure 27, incoming requests trigger a chain of actions. An incoming request is an HTTP requests which is represented by an URL. A controller can be described as an intermediary between models and views. In this case, it finds out which method to invoke from a provided URL. When a method gets executed it usually needs to obtain some data from the database and then pass that data into a view. Mostly, a method knows which view to return and which data to pass into the view if a return statement is provided.

As an example, from this project, Figure 27 shows four possible incoming requests which is not the whole list of the requests that can be used. Now, if an incoming request is as follows:

/Survey/Build/1 then it executes a Build method in the controller. Somewhere in that method, SurveyBuilderModel gets created as a data source for a view. Once the model is ready and an execution of the Build method gets to the end it calls to render the Build.cshtml view with the SurveyBuilderModel that gets passed into the view as an input parameter. Finally, a view uses the provided model to display the data. In the meantime, the Build view is composed of another four partial views that make up the whole view which gets displayed to whoever sent the initial incoming request.

To conclude, the execution in the MVC architecture has always the same order: controller -> (model) -> view. A model is surrounded by brackets because it may not be used in some cases. A view can use other partial views to display its content.

5.6 Database Design

The development team at Youmanage has a convention for naming tables in the database. Each table is prefixed by "t_" followed by a name of the module that is being developed, which in this case is "survey". This convention shines when a project is composed of many modules, therefore the database is likely to have many tables depending on how large a module is. All tables that belong to certain module are kept together as opposed to being mixed together with other tables.

The database for this project (Complete database diagram can be found in Figure 28) was created gradually as the project progressed. At the beginning, it was important to learn how it all works together with Entity Framework. The process of creating the database was divided into five phases. Each phase involved extending/updating the existing database structure. The five following paragraphs explain each phase with justifying decisions that were made when making these changes.

5.6.1 1. PHASE – t_survey

In the first phase, there was a need to store information about surveys for the survey manage page. "t_Survey" was the first table that was created with the following columns: id, id_employee, title, description, and created_at. These columns were added to store information which will be displayed on the survey manager page. Id column is a unique identifier of each record (each survey) in the table. Id employee is a foreign key that identifies an employee who created a survey. Id employee points back to the t_employee table which is the table already in the Youmanage system that holds all data about employees. The relationship between t_employee and t_survey is one-to-many (an employee can have many surveys and each survey can have only one employee associated with it). Title, description, and created at are self-explanatory.

5.6.2 2. PHASE – t_surveyQuestion, t_surveyQuestionAnswer, t_surveyQuestionType

In the second phase, once the survey manager page was done, the development continued to the survey build subpage. At this point, the database had to be extended. As the requirement for the build subpage (4.2.4.4 Build) says, a survey can contain unlimited questions with unlimited answers. Consequently, it is not possible to extend the t_survey table and store questions there because surveys would be mixed up with questions which would break data integrity. Each field in the table should not represent more than one thing. Another table t_surveyQuestion had to be created with columns as follows: id, id_survey, and question. Id as a unique identifier, id_survey as a foreign key to the t_survey table, and question as a column that holds actual text of the question. Each record represents one question and since a survey can have many questions one-to-many relationship is created between t_survey and t_surveyQuestion.

Following the same structure, another table t_surveyQuestionAnswer had to be created to store all answers as a question can have many answers. This table is placed one level deeper than the t_surveyQuestion table. Its columns are id, id_id_question, and answer. The similar columns as in t_surveyQuestion, id as a unique identifier, id_question as a foreign key to t_surveyQuestion (to know which question the answer belongs to) and answer as a column that holds actual answer. Each record in the t_surveyQuestionAnswer table represents one answer and since a question can have many answers, one-to-many relationship was created between t_surveyQuestion and t_surveyQuestionAnswer.

Additionally, the requirement (4.2.4.4 Build) also states different types of questions. It is obvious from that requirement that it relates to questions, hence to the t_surveyQuestion table. The t_surveyQuestion table could have been extended by a few other columns such as question_type, question_type_label but it would have led to a lot of duplicate content as information about particular question type would repeat in every record. Thus, it was better to separate all information about question types in another table named t_surveyQuestionType and then add a reference (foreign key) column named type into the t_surveyQuestion table. Each record represents a type of question and it is connected to the t_surveyQuestion table by one-to-many relationship. Having separate table for all question types has many advantages for instance a predefined set of records (question types) can be created in advance, and whenever something needs to be changed it can be changed in one place and thanks to the reference in t_surveyQuestion, every associated record will be able to get the updated record values.

5.6.3 3. PHASE – t_surveyTargetGroup

In the third phase, the structure for creating the surveys is accommodated in the database. The velopment moved on to the share subpage. The objective was to create a structure that would

store which employees a survey is for. As a solution, the new t_surveyTargetGroup was introduced with one-to-one relationship to t_survey which can be interpreted as each survey can only have one record (one target group) associated with it. t_surveyTargetGroup contains id, companies, divisions, locations, departments, employeeLevels, and size. Id as a unique identifier, a size representing how many employees is in the target group, and the rest of the columns are taken from the Youmanage hierarchy dictionary.

Furthermore, two new columns (state and accessCode) were added into the t_survey table. State represents a state the survey is currently in and accessCode stores a unique string that is used to access the survey. Besides title and description columns in t_survey, it was determined that it would be useful to provide different title and description for employees. As a result of that, title_public and description_public columns were added into the t_survey table.

5.6.4 4. PHASE – t_surveyResponse, t_surveyResponseAnswer

In the fourth phase, it was time to think about how responses from employees are going to be stored. The only way was to add additional two tables in the database. Responses do not belong to any table in the existing structure. As a result of that, it was determined that two new table must be introduced. The table t_surveyResponse will store general information about responses such as who submitted a response, which survey a response belongs to, what time a response was submitted. There is one-to-many relationship between t_survey and t_surveyResponse as each survey is most likely to have many responses. The second table t_surveyResponseAnswer will store all answers for each response. Usually, there will be one record in the t_surveyResponse table per employee per survey associated with a number of records in the t_surveyResponseAnswer table (each record per answer).

5.6.5 5. PHASE – Extensions

In the fifth phase, a few other columns were added in the existing tables. Once the development progressed to the analyse page it was necessary to add a few additional columns in the t_surveyQuestion table. The analyse subpage shows a two-column layout so each question may have two different display modes how it is displayed such as (bar chart, pie chart, line chart, table). This information had to be stored in the database because the analyse should be persistent. In other words, when an employee comes on to the analyse subpage it correctly displays all questions in the display modes based on the values in the database. Finally, two one-to-many relationships were added to help connect survey questions with response answers. These relationships allowed to select all response answers associated with particular question.

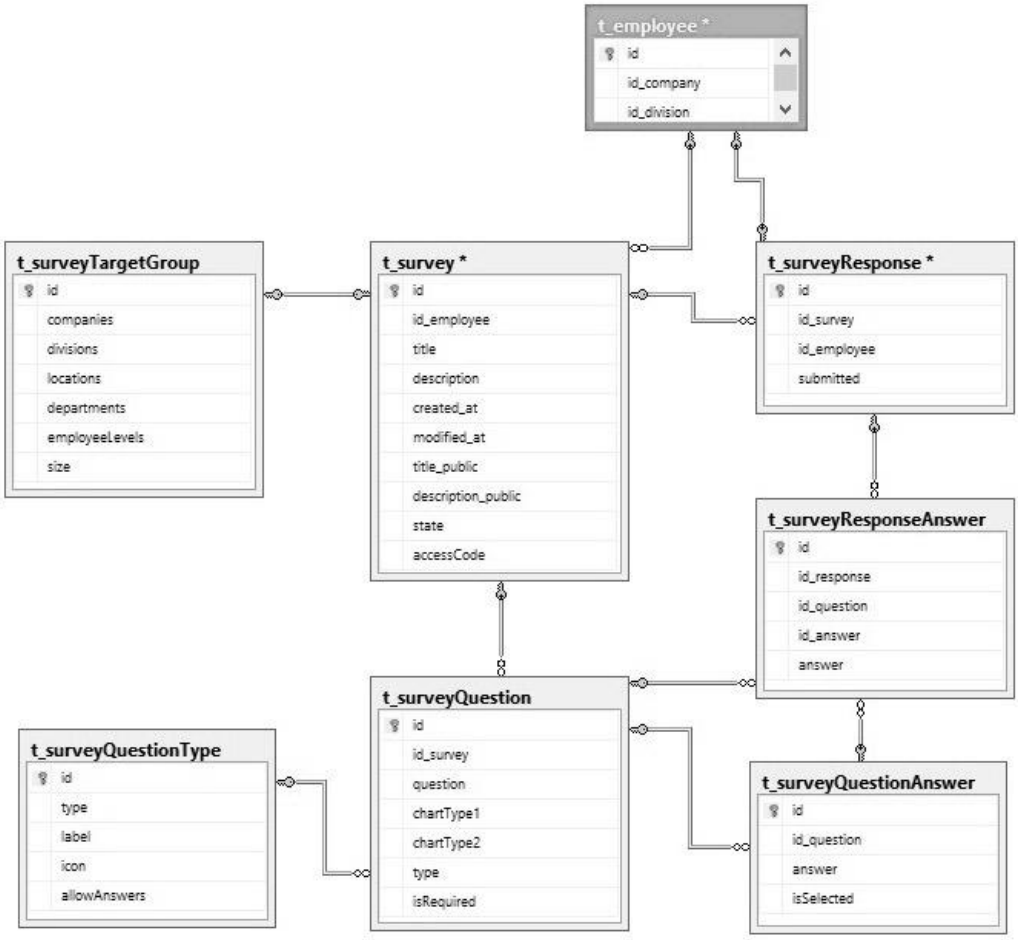

Figure 28. Database Diagram

5.7 Summary

The objective of the first part of this chapter was to present wireframes and layouts based on the requirements defined in the chapter 4. Requirements, whereas the objective of the second part was to give an insight into how the project is structured and how the database is designed. More importantly, the database design section is further divided into five distinct phases to see how the database was taking shape during the development. The following chapter focuses on the implementation of the survey component.

6 Implementation

This chapter explains what has been implemented in the project based on the defined requirements (4. Requirements).

To give an overview of the project, the survey component was developed into the Youmanage HR software. HR employees and managers can create surveys for their employees. First of all, if they are new to the component, the welcome page (6.2 Welcome Page) is shown to showcase the main features of the survey module. Once the first survey is created, the Survey Manager (6.3 Survey Manager) gets displayed to show all surveys. When it comes to creating a survey, each survey is supposed to be created in the following order of the survey lifecycle (Overview-Build-Preview-Share-Analyse). The overview page (6.4 Survey Overview) shows basic information about the survey. The build page (6.5 Survey Build) is used to create content of the survey such as questions and answers. The preview page (6.6 Survey Preview) previews the survey in the same way as it will be seen by employees. The share page (6.7 Survey Share) allows to select which employees the survey is meant to be for. The analyse page (6.8 Survey Analyse) is used to analyse employee responses from the survey using different types of charts. Lastly, the fill page (6.9 Survey Fill) is similar to the preview page and is used to render the survey to employees to fill out.

6.1 Application Overview

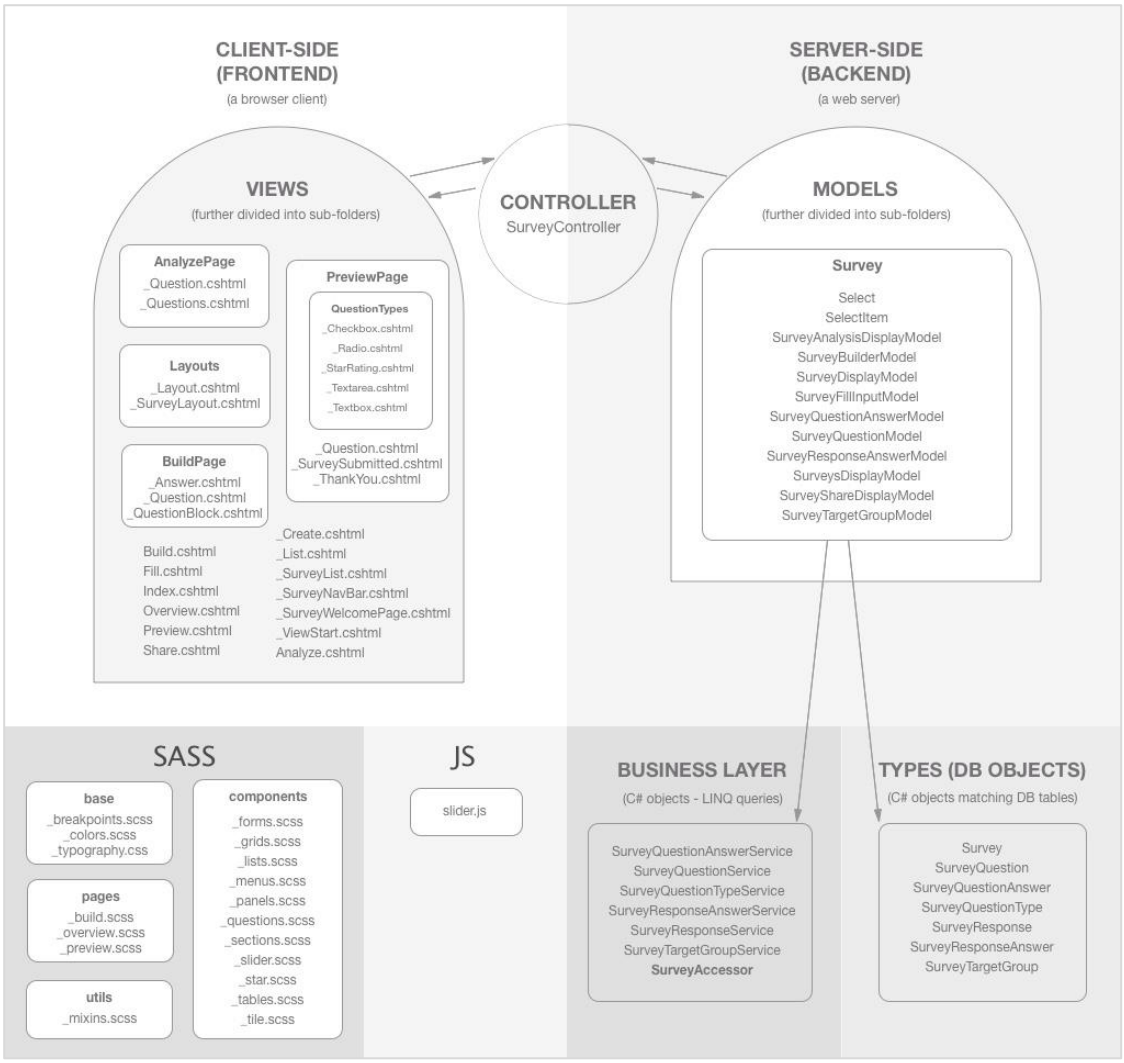

Figure 29. The Final Project Structure

Figure 29 shows the complete structure of this project. It shows all classes/files structure that were created. The project structure is divided into two parts, the client-side and the server-side. Additionally, it also nicely captures how the MVC pattern was implemented. The following two paragraphs further describe both parts of the project structure.

The client-side includes all the HTML markup, SASS stylesheets, and JS files. All views have cshtml extension which contain C# + HTML markup. These views are processed on the server and the HTML markup is returned back to the browser. If a view starts with the underscore it is a partial view. SASS stylesheets are divided into four folders based on the BEM methodology. There is only one javascript file shown in the figure, however most of the scripts are defined in the views within the inline <script></script> html element.

The server-side contains all C# code that get processed on the server. It is broken up into three additional layers as follows: models, business layer, types. Models contain classes that are used to prepare data for views. The business layer contains all classes that involve making queries and joining tables and so on, basically a purpose of the business layer is to keep working with data from the database separate. Lastly, types contain C# objects that are mapped to the database tables. Objects in types are used by Entity Framework.

Finally, there is one controller called SurveyController that receives incoming HTTP requests and calls appropriate methods accordingly. To put it more simply, it is a link between Models and Views. Each method in the SurveyController knows which data it needs in order to display a view.

6.2 Welcome Page

A welcome page (Figure 30) is most likely to be the first page that employees will see when they come into the survey module. This page is meant to showcase how HR employees and managers can use the module. Once they skim through all functionality they can create the first survey.

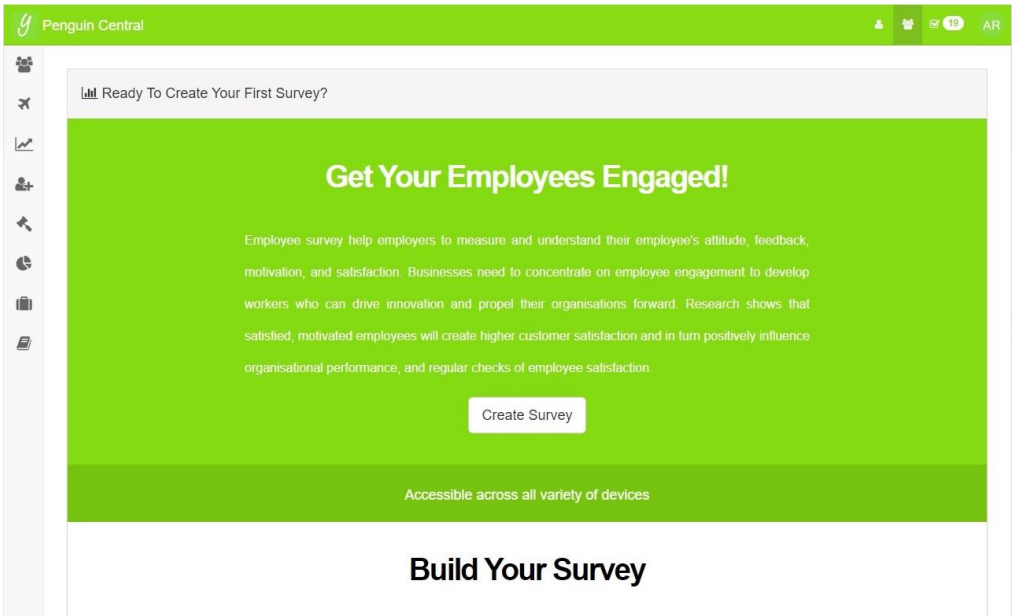

Figure 30. Survey Welcome Page

6.3 Survey Manager

A survey manager (Figure 31) displays all surveys created by a currently logged employee. This page comprises of a filter bar and a table. The filter bar is placed above the table, whereas the content of the table is placed below. Each row in the table represents one survey.

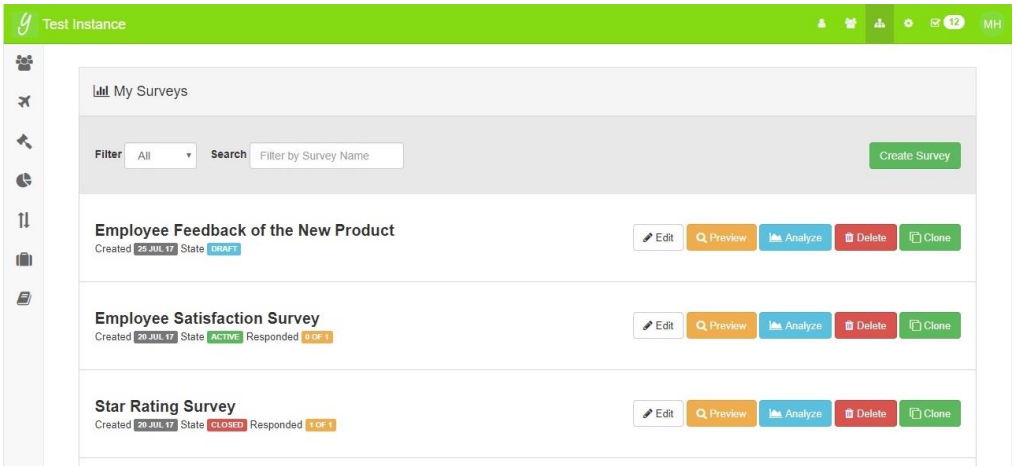

Figure 31. Survey Manager

6.3.1 Filter Bar

The filter bar is used either to filter surveys by the state or to search surveys by the title. Filtering and searching uses AJAX to dynamically update the list of surveys matching the entered criteria. Thus, whenever a user changes a value from the filter drop down list or types in the title, the table gets automatically updated without refreshing the page. In addition to that, there is a button that opens a modal and lets a user create a new survey by giving a title and a description.

6.3.2 Survey List

The survey list is what makes up the survey manager. It is a full-width table consisting of surveys. To simplify what the survey list is composed of, an explanation could be provided on any row. On the left side of each row there is a survey title, a date when a survey was created, and a state a survey is in. Furthermore, if a survey state is active or closed it shows additional information about how many employees have responded to a survey.

On the right side of each row there is a set of buttons which enables to edit a survey, preview a survey, analyse a survey, delete a survey, and clone a survey. Any survey can be cloned regardless of the state the survey is in. The cloning process copies all questions with all answers associated with them, creates a new survey marked as a draft with the same title and description. The title and the description can be changed later. Having a cloning functionality implemented saves a lot of time especially in scenarios when an employee decides to create a survey that is similar to the one of the existing surveys or when an employee decides to send out a survey on annual basis.

6.3.3 Survey States

Each survey can go through three states (Draft, Active, Closed). A survey is marked as a draft when it is not sent out yet. A survey is marked as an active when it is already sent out and not everyone from a target group has filled out the survey. A survey is marked as a closed when every employee from the target group has successfully filled out the survey. Survey states get changed automatically as the survey goes through its lifecycle.

6.4 Survey Overview

A survey overview (Figure 32) shows basic information about the survey. The page is divided into three sections whereas one section is hidden until a survey is shared. The first section contains a date when a survey was created, a name of the employee who created the survey, a state the survey is in, how many questions the survey has, and how many responses have been collected. The second section lets an employee update the title and the description. Lastly, the third section that is hidden when a survey is marked as a draft displays a bar chart illustrating what days responses were collected.

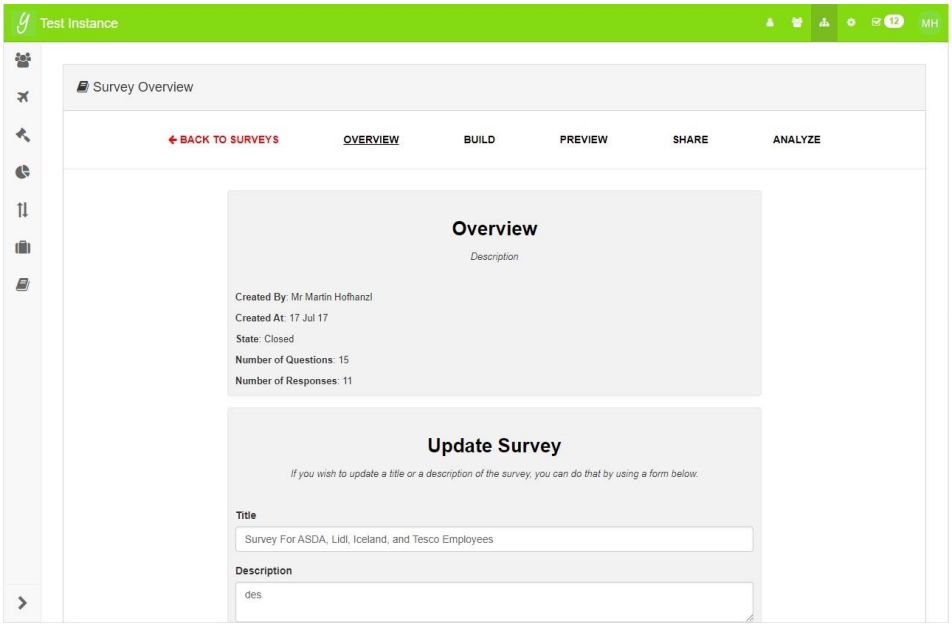

Figure 32. Survey Overview

6.5 Survey Build

A survey build page (Figure 33) is the type of the page that has the most functionality implemented in and it was the most challenging page to develop. It is all driven by AJAX. The most challenging was particularly to remain the same functionality of building a survey on mobile phones. When it comes to mobile phones it was difficult to figure out what the best layout for creating questions with answers is due to the limited space on the screen.

6.5.1 Layout

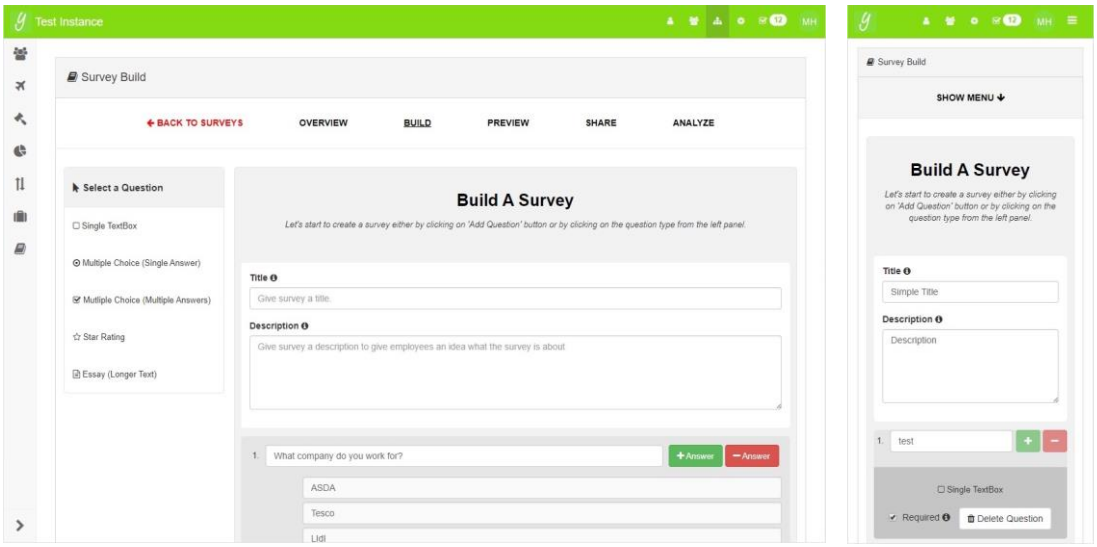

Figure 33. Survey Build Layout

6.5.2 Question Types

Having a few question types to be able to create a survey with is what makes up a survey. Many HR employees who have previously used any of the competitor products such as Survey Monkey, Google Forms, or any other survey tool are used to seeing decent amount of question types they can include in a survey. Of course, the survey component that is a subject of this project cannot be compared with just listed survey tools that are significantly larger. The first iteration started off with implementing three types of questions and they are a single text field, a multiple choice with a single answer, and a multiple choice with multiple answers. These three question types are the most basic ones but they all give a good flexibility in creating surveys. Moreover, there were additional two question types (a star rating and an essay text) implemented in as the part of the second iteration.

All question types are stored in the separate table in the database with a few additional settings (columns) associated with them. For example, each type of the question can have defined information whether it allows answers or not, because some question types do not require a set of pre-defined answers such as a single text field, an essay text, and a star rating, whereas multiple choice types require a set of pre-defined answers.

6.5.3 Add/Delete Question

Each survey can have unlimited number of questions. Question can be added in either by using a panel on left-hand side (available only on desktops and laptops) or by using a button at the very bottom of the page. When the question is added into a survey it inserts an empty block with a text field for the question, two buttons for adding/removing answers (that are either en-

abled or disabled depending on the question type), a checkbox for setting optionality, and a button for deleting the question. Once an employee starts typing in the question field, finishes typing and continues to do something else, that is the moment when the question gets saved in the database (every time when the question field goes from focused state to unfocused that is when a saving action gets triggered).

6.5.4 Add/Delete Answers

If a question allows answers it can have unlimited number of pre-defined answers. The mechanism of saving answers in the database is the same as for saving questions. Again, it is all done by AJAX and gradually saves content of the survey in the database as the survey is being created.

The main reason for using a lot of AJAX on the build page is that creating a survey can be a bit time-consuming process and there is nothing worse than going offline or accidentally switching off the PC or anything that can happen half way through the process of creating the survey. Using AJAX and storing the survey content (questions and answers) as it is being created prevents from recreating the entire survey from the scratch again if anything goes wrong. The exact opposite way of approaching it could have been, not to have used AJAX at all and to have included a save button at the bottom of the build page that would save the content of the survey. The problem with this approach would have been that if anything went wrong half way through the survey creation it would lose every data that has been created in the survey. However, the only positive thing that comes with using this approach is that it would have been much easier to implement, but this approach is not very ideal so that is why it did not end up being implemented in this project.

6.5.5 Question Numbering

Question numbering is something that may be obvious but question numbers are dynamic and they get updated whenever any question gets deleted. For instance, when a survey has ten questions and an employee decides to remove the first question then the first question will get deleted and the other question numbers get updated automatically.

6.6 Survey Preview

A survey preview (Figure 34) shows how a survey is going to look like from the employee perspective. It is meant to be the last step before the survey gets sent out. The preview page gives an employee neater version of the survey to check for possible typos or missed questions/answers. Still, it does not display any additional information compared to the survey

build page, its purpose is really to display the survey in a way that is easier to spot as many mistakes as possible.

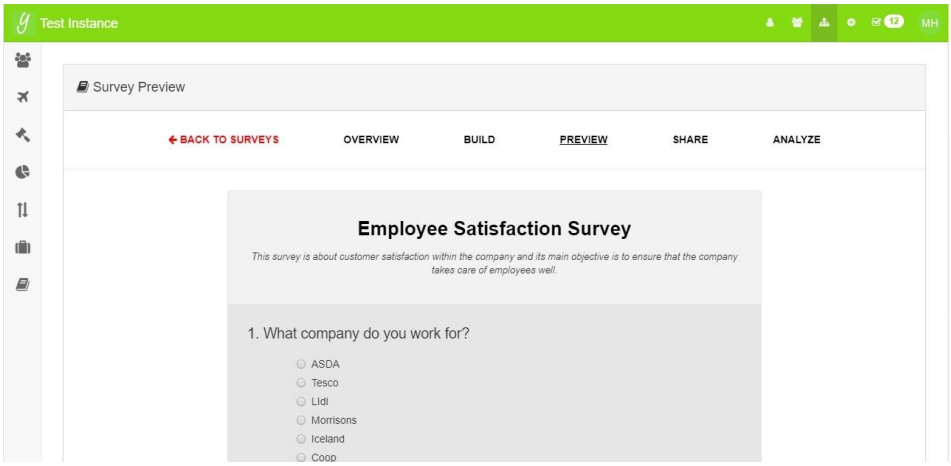

Figure 34. Survey Preview

6.7 Survey Share

A survey share page (Figure 35) is used to select the group of employees the survey will be sent to. Once a survey is completed meaning it has all questions with answers and an employee is satisfied with how the survey looks, then it is time to send that survey out. Selecting a target group of employees is based on a hierarchy dictionary which is how the Youmanage software divides employees into groups. A hierarchy dictionary consists of companies, divisions, locations, departments, and job levels. These five categories make up the hierarchy. Of course, values in these categories vary for each client who adopts the Youmanage HR software.

The default behaviour when an employee comes on to the share page is that every single value in the hierarchy is checked which means it targets all employees. Furthermore, if an employee wishes to exclude some employees, they can do that by unchecking items from the hierarchy. One of the features of this page is a dynamic number showing how many employees is in the target group. This number gets updated every time when an employee clicks on any of items in the hierarchy. That way employees who create surveys can instantly see how many employees they are targeting.

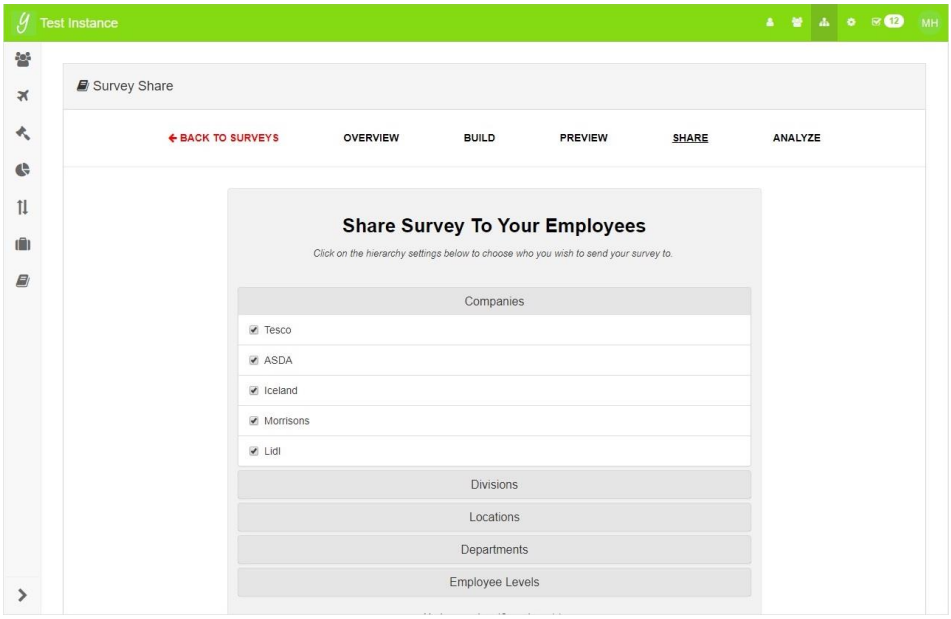

Figure 35. Survey Share

Displaying the hierarchy is done by collapsible panels where each panel collapses its content down when an employee clicks on their headings. It was sensible to use collapsible panels because they were also used elsewhere in the system for the same purpose to show the hierarchy.

6.7.1 Employee Notification

As soon as an employee clicks on the share button at the very bottom of the page, every employee from selected target group gets notified about the new survey that is ready to be filled out. Creating notifications for employees is all done by tasks that are widely used in the Youmanage system for various purposes how to notify employees. Notifications (Figure 36) are placed in the navigation bar on the right next to the employee initials.

Figure 36. Employee Task – Complete Survey

6.8 Survey Analyse

Analysing results from surveys is probably the most important reason why surveys are created. A survey analysis page (Figure 37) had to be designed in a way that it is easy for HR employees and managers to analyse results they received. The survey analyse page is available at any time regardless of the state the survey is in. The survey analysis can be even accessed while

responses are being collected which means if HR employees or managers want to see and analyse responses half way through it is possible to do that just by accessing the analyse page. Apparently, the analyse page will then show only responses that have been collected (from surveys that have been successfully submitted).

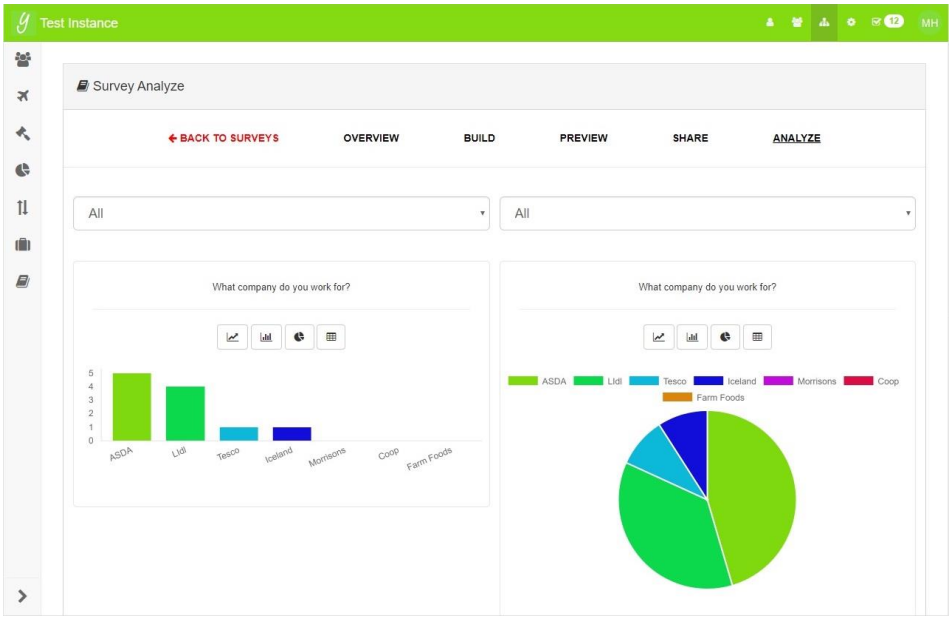

Figure 37. Survey Analyse

6.8.1 Two-column layout

Since the analysis is one of the most important things it was determined that the page should include a functionality that will make the page even more interesting and useful than just showing collected responses in the table. There are many ways how survey data can be analysed. Figure 37 shows that the page is divided into two columns where each column can show different set of responses based on selected values of two drop-down lists placed right under the survey navigation bar.

Values in those drop-down lists show values from the hierarchy dictionary but only the ones that were selected on the share page before the survey was sent out. So, when an employee wants to send the survey out to managers, the only value that will be available in drop-down lists is managers which will then not give any options to further narrow down the responses. The analysis gets more interesting when the survey is shared among all employees or at least when a survey involves a few different groups of employees.

A URL that is used to access the analyse page has the following format: /Survey/Analyze/ID. By providing that URL it looks for the SurveyController and then looks up the Analyze method in that controller and it invokes the analyse method and passes in the ID parameter. The ID is used to identify the survey. Inside the analyse method it uses the ID

parameter to select one survey from the database to create a model that is then used as a parameter to the Analyze.cshtml view.

6.8.2 Four Display Modes

Each survey usually consists of many questions. It is crucial to be able to change a display mode how responses are displayed. Four different display modes which were implemented are line chart, bar chart, pie chart, and table. An employee can change the display mode for every question and when they access or refresh the analyse page again it will remember which display mode they selected and it will then pick up and display the questions in the correct display mode. Changing display mode is done by JavaScript using AJAX which provides better user experience by not refreshing the whole page. All charts use a JavaScript library called Chart.js[7].

Figure 38. Survey Question Display Modes

6.9 Survey Fill

A survey fill page (Figure 39) is used to render surveys to employees. It is almost identical to the survey preview page. However, the survey fill page does not include the navigation bar but it does add a submit button.

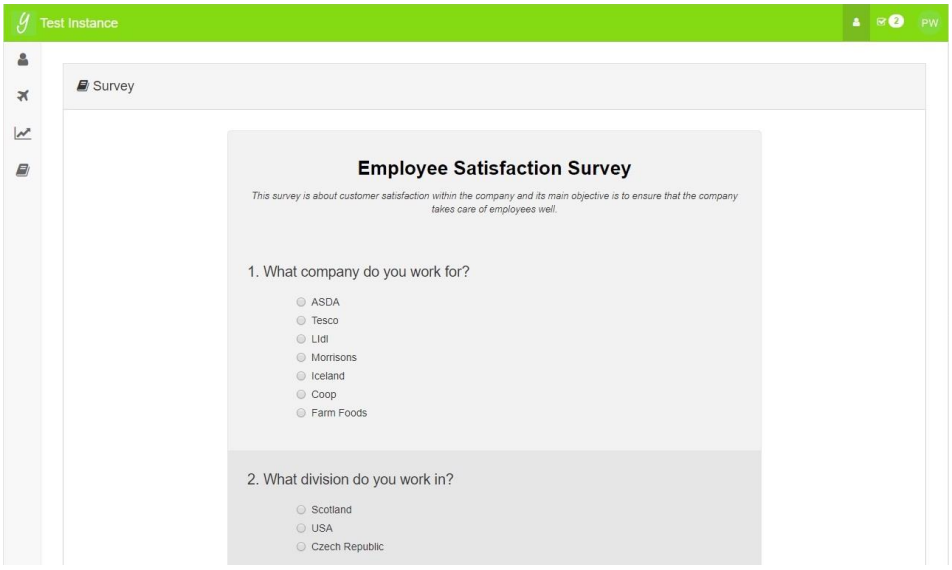

Figure 39. Survey Fill

[7] Chart.js library can be accessible on http://www.chartjs.org

Once an employee fills out the survey and clicks on the submit button, it triggers a method in a survey controller that takes a model as an input parameter. That model contains all submitted questions with their answers. Firstly, a response is created with survey id, employee id, submission date. Once the response has been created as an object in C# it can use its internal collection of response answers to insert all submitted answers from a model that was passed into the method. Once all submitted answers have been added into the internal collection then the Entity Framework takes care of creating corresponding SQL commands to create one record in the "t_surveyResponse" table along with the many associated records in the "t_surveyResponseAnswer" table.

If a survey has been successfully submitted, the same method in the survey controller that creates a response also completes a task. Completing a task means it will no longer be in the task list as the task has been completed (in this case a survey has been completed).

There is a possibility that a survey is accessed via URL by the same employee more than once, even though a survey has already been completed. If that happens and the same employee tries to access and fill out the survey again it displays a message that the survey has been already submitted which prevents from resubmitting surveys. It follows the following pattern: one employee = one survey = one response.

6.9.1 Client-Side & Server-Side Validation

Whenever a system expects data from users it cannot rely on a fact that data will always arrive in the format the system requires. It is more than necessary to always check the user input by providing validation, especially when it will be saved in the database. When a database is involved it is even more important to provide validation to keep the database consistent and not to break data integrity. Validation can be done either on the client-side or on the server-side or combination of both. The best solution is to combine both the client-side and the server-side validation. The client-side validation is entirely done in a browser and usually by JavaScript which means a user can do anything. If a user disables JavaScript for some reason then it is like as if there was no validation at all. This is the reason why having validation on the server is sensible as whatever data comes in it will always be validated.

When developing this project validation on the client-side as well as on the server-side was implemented. The validation on the client-side is done by JavaScript using a jQuery library called "jQuery Validation Plugin", which again was already included in the Youmanage project.

The last step in the software development once all requirements have been implemented is testing. The following chapter discusses the way the survey component has been tested.

7 Testing

The testing phase is the important and most likely the last step in the software development process. The main goals of testing are to demonstrate to the client that the application has met its requirements and to ensure that the application does have as few bugs as possible before its release. Although, the testing procedure cannot guarantee that all bugs/errors will be determined and resolved because some of them may occur only in special occasions or they may occur on specific devices. Generally, these are types of bugs/errors are usually minor issues that will be discovered by users while using the application. The survey module has been continuously tested by the developer throughout the development, however some time had to be devoted to additional testing once the development finished and involve other users to get feedback in terms of usability. The testing involved three different groups of users such as the developer, the tester within Youmanage, and a number of existing Youmanage customers.

7.1 Unit Testing

Unit testing is the practice of testing certain functions and areas/units of the application. It gives developers the ability to verify that functions/methods work as expected. In other words, any function/method and given a set of inputs, it can be determined if the function/method returns the proper values. Ultimately, unit testing helps to identify failures in algorithms or logic to help improve the quality of the code. Unit tests can be run at any time during development to continually verify the quality of the code. Unit testing comes with a number of advantages such as writing code that is likely to be easily tested and preventing future changes from breaking functionality [17].

A significant benefit of using the MVC pattern is ASP.NET is that unit tests can be easily implemented in comparison to the ASP.NET Web Forms [18]. Visual Studio provides the Visual Studio Unit Test framework which was used to create unit tests in this project.

In regard to this project, Visual Studio Unit Test framework was used to write a number of tests to assess the different areas of the survey component. By structuring the component according to the MVC pattern, the component was divided into separate software pieces that could be tested independently. It was identified that the main areas of the survey component that could be tested are the construction and population of the model, the action methods in the controller, and the interaction with the database.

At the model level, a number of tests were written to assess if all models that are used in the survey component are correctly constructed and always return a new instance of each

model. Furthermore, additional unit tests were written to assess if models are populated with correct values from the database.

At the controller level, it was important to write a number of tests to evaluate every method in the controller as the controller consists of a lot of methods which handle all the incoming requests throughout the entire component.

At the database level, a number of tests were written to assess the effectiveness of the database retrieval and Entity Framework mapping to object. Tests were written for retrieving each of the question and its answers and checking whether their returned properties were as expected. Furthermore, tests were written for editing, deleting and creating new database records.

7.2 Portability

The survey module has been tested across a variety of the most common web browsers such as Internet Explorer, Google Chrome, Firefox, Opera, and Safari to ensure that all implemented functionality is properly functional in all listed browsers. This is exactly the phase where using jQuery in the project pays off due to its cross-browser compatibility. The survey component has been tested across different browsers once the development finished. Google Chrome was extensively used throughout the development to ensure all parts of the website are accessible from mobile phones to desktop computers.

Once the survey component was ready for testing it was uploaded into the live beta version accessible from the internet. At that time, once the module has been tested across all different web browsers it was time to test the survey component also on mobile phones. The survey component has been tested on devices running Android and iOS to make sure there are no inconsistencies in the design or in the functionality. Even though, these operating systems on mobile phones use the same web browsers such as Google Chrome or Safari their behaviour might be different from the desktop ones. Thanks to Bootstrap the survey component remained its design consistency across different platforms.

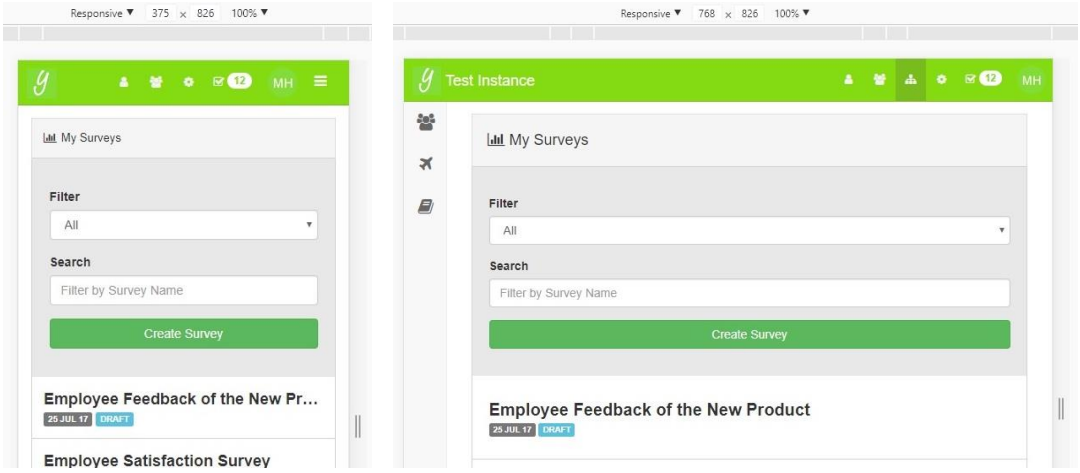

Figure 40. Google Chrome Developer Tools – Testing Responsiveness

7.3 Performance

Visual Studio provides built-in profiling tool to allow developers to monitor efficiency of their code and to determine the source of performance-related issues. Therefore, this tool has been used extensively throughout the development process to ensure the written code is efficient without any bottlenecks.

Upon the initial profiling, it was determined that Entity Framework has two methods of loading its properties from associated tables that are referenced by foreign keys. The two methods are lazy loading and eager loading. Basically, lazy loading means that related objects (child objects) are not loaded automatically with its parent object until they are requested, whereas eager loading means that related objects (child objects) are loaded automatically with its parent object [19]. The initial profiling also showed that Entity Framework were making queries to the database repeatedly to get the identical records. To resolve this issue, related objects were loaded at once by using eager loading as opposed to lazy loading.

On top of that, Google has recently added a new feature to Google Chrome Developer Tools called Audits which inspects a website and returns information about performance, accessibility, and best practices. This feature was run on the completed survey component and results are satisfactory as shown in Figure 41.

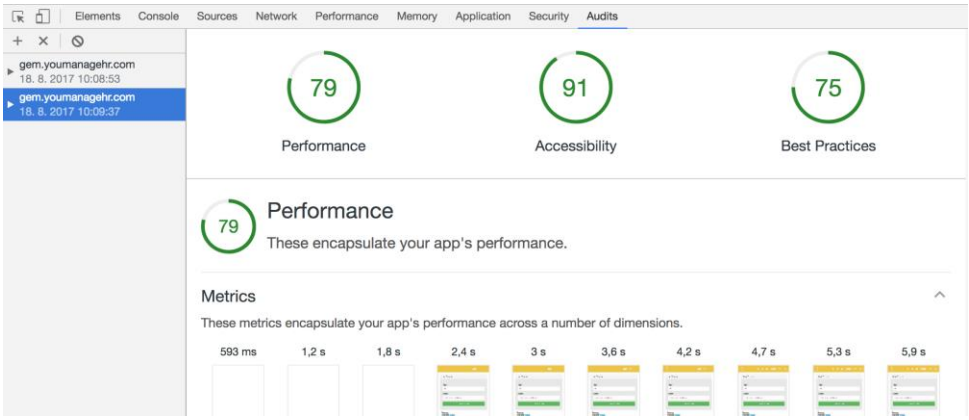

Figure 41. Google Chrome Developer Tools – Audit

To interpret the results, the survey component is the part of the Youmanage system and as shown in Figure 41 the page takes 2,4 seconds to load necessary CSS stylesheets and JS scripts in order to start displaying the page. Google suggests a few improvements that would result in faster rendering the page. Google claims that CSS stylesheets takes 1,7 seconds to load which is causing the page to wait for them to get loaded. However, the score of 79 is fairly good and when integrating the survey component into the existing Youmanage system there are several things that cannot be changed. From a more positive perspective, the score of 91 for accessibility just proves that it is appropriately accessible and readable without zooming in on mobile phones, tablets, laptops, and desktop computers.

7.4 Integration

The purpose of the integration is to ensure that the survey component is integrated into the Youmanage HR application without breaking the other parts of the application. Thankfully, the survey component does not update any existing data of the Youmanage application, it uses the employee data for selecting the target group. However, it was necessary to check whether tasks were created properly for all employees from the target group as well as completing tasks when employees submitted their responses.

7.5 Usability

In order to test the application and get feedback from clients who will be using the survey component in the next release of the Youmanage HR application it was important to get some feedback from them before its release to make appropriate changes accordingly if necessary. A number of Youmanage clients were asked to formally test the survey component at different phases in the development process. The clients who have recently requested the survey functionality as a possible extension of the existing Youmanage application were identified as the appropriate group of clients to involve in the usability testing.

At the end of testing procedures, each user was asked to rate their experience for the following three statements across five-point scale (Strongly Disagree to Strongly Agree):

- Surveys were easy to create
- Responses from surveys were easy to analyse
- The survey component is easy to navigate
- The survey component is aesthetically pleasing

The overall feedback received during the testing phase was very positive. A few clients also pointed out what they would like to improve which led to making a few minor changes in the implementation of the survey component. Other than that, the majority of client found surveys easy to create. More importantly, they were pleased with analysing the responses from surveys and with being able to choose different types of charts for each question. Overall, all clients stated that the survey component was easy to navigation and the user interface was aesthetically pleasing.

Despite the overall positive feedback from clients, some points during the testing prompted some minor changes in the implementation of the survey component.

The first minor change was made on the build page. A vast majority of clients stated that they would like to add questions into the survey more quickly than clicking a button, waiting for a modal which shows all questions types to show up, and choosing a question type from the modal. This point resulted in adding additional component (a list of all question types) on to the build page placed right next to the content section. With this newly added list, the process of adding question became significantly quicker. However, the list is only available on laptops and desktop computers due to the limited space on the screen on smaller devices.

The second minor change was related to the share page. All clients were confused by the way how selecting the target group was implemented. Initially, the share page was rendering all checkboxes (displaying values from the hierarchy dictionary) unchecked which meant by the default setting set at Youmanage, targeting all employees. It resulted in changing the behaviour the other way around to when they access the share page all checkboxes are checked which logically means the survey is targeting all employees.

7.6 Summary

To conclude, the testing of the survey component involved three types of users. Most of the testing parts were tested by the developer, especially parts such as unit testing, portability, performance, and integration. However, the internal tester who is responsible for all testing procedures at Youmanage was involved in the integration and the usability. The development

team at Youmanage was also involved in the portability and the usability which provided valuable insights from the other staff. More importantly, clients who has requested the survey functionality were involved in the usability testing. The feedback from the clients was positive which successfully wrapped up the software development process of this project.

8 Conclusion

8.1 Evaluation

All objectives have been met and the survey component will become the part of the Youmanage system in the next release. Although the client's feedback has been positive it is very important for the academic assessment to objectively evaluate achievements against the objectives. There is rarely a perfect solution in the end of the project when the developer does not have much experience or when the developer must learn a new programming language. In this case, the evaluation is especially important to mention what went well and how well the objectives were met.

As outlined in 1.3 Scope and Objectives section, the main objective was to create a new component from the group up that would provide a functionality to create, edit, share, and analyse surveys. The client's requirement was to integrate the survey component into the new version of the Youmanage application that was being developed while the dissertation period.

Developing the new survey component was quite challenging task in terms of learning new technologies, C#, ASP.NET, and Entity Framework. Fortunately, the developer has had some previous experience with other programming languages such as Java and also some experience with web development which helped to speed up the learning process. During the first two weeks of the development, the developer felt overwhelmed by a complexity of the existing Youmanage project and it took a few days to get an understanding of the project structure. As the time was passing by the developer was getting better day after day and the survey component was beginning to take shape. Despite all these difficulties at the beginning, the survey component was successfully integrated into the existing version of the Youmanage application in consistency with the project structure and coding conventions.

Another objective was to seamlessly integrate the survey component into the existing Youmanage system from a design perspective. However, meeting this objective was more difficult than it seemed to be due to the on-going rebranding and moving towards the new Youmanage version 4. The Youmanage version 4 specifications are a new design and moving away from Web Forms completely to C# and ASP.NET MVC which required to keep constant communication with the development team to ensure that the survey module has been constructed appropriately and integrated nicely with the new design and new technologies.

While developing the survey component, CSS stylesheets were continuously extended as the project progressed. CSS rules defined in stylesheets may get out of control when there is no convention or naming rules applied while creating them. It happened in this project, when the developer felt that some CSS could be reused to style other parts of the website but the

way styles were written did not allow to do that. Then a few methodologies were found on the internet about how to structure CSS styles to be able to reuse them in as many places as possible without having to create duplicate content. The methodology that was used is called a BEM and it resulted in self-documented, maintainable, effectively reused CSS styles.

When looking back and objectively evaluating the project, there is a few things that I would have done differently with knowledge gained throughout the development of this project. The first thing is on the build subpage which was the most challenging page to develop and it was developed quite early on. Due to the lack of experience all jQuery code was written using anonymous classes which is not ideal approach because it cannot be used elsewhere. The module pattern should have been used as it was used in the analyse subpage later on.

Another thing I would have changed is again on the build page. Since the whole build page is equipped with AJAX and it is generally very dynamic in terms of saving data into the database in the background without clients noticing it. The way it works is data gets saved in the database when a form input element goes from "focused" state to "unfocused". This approach is not ideal when a user writes a question or an answer and clicks on the preview subpage without clicking somewhere else beforehand. Actually, two things happen at that time, the browser displays the preview page and at the same time AJAX method for saving a question or an answer is invoked. So, sometimes the preview page might not display the latest value that has been added on the build page. Instead what would be better solution is to have a question block with an input field for a question and input fields for answers and when a user has created the question with answers they would click a save button which would trigger AJAX method to save that question into the database.

Overall, in my opinion the achievements surpassed both the developer and the client's expectations. At the end, the client showed an intent to include the survey module in the release of the new version 4 which proved to be a dissertation with a real output. From the developer´s perspective, the experience working as a part of the professional development team was highly satisfactory and beneficial for the future. On the hand, the development process has shown there is still a lot to learn as the IT will always be a rapidly changing environment.

8.2 Future Work

Due to the time constraints of this project it was not possible to create the survey component that is as complex as any of competitor products (2.2 Competitor Products) in terms of implemented functionality. Although, most of the defined requirements were fulfilled within the given time constraint. This project shows how requirements were well thought out in its early phase with regards to the time constraint. However, a few possible improvements/features

have occurred during developing this project which have not been implemented due to the time constraint.

There are three necessary things that have to be added in the component before its full integration into the new release of the Youmanage version 4. These three things are a menu placement, email notifications, and permissions. Currently, the survey component is only accessible by typing an exact URL in the browser which in the new version should be accessible from the main menu as any other modules. Another thing to be added is email notifications. Currently, employees get notified by tasks within the Youmanage system when a survey is created from them and as an enhancement they should also receive an email about a new survey. The third and the most important thing that must be certainly added is related to permissions. Currently, everybody from within the system can access the survey module which is not how it is supposed to be setup. Employees should be only allowed to fill out surveys. Permissions could not be setup properly in the component based on the user roles due to on-going rebranding.

The first feature that would be nice to have implemented is on the build page. Besides a panel with all question types it might be useful to be able to choose a question from a list of predefined questions something like templates for different questions. This feature may be helpful for HR employees or managers to give them some ideas where to take inspiration from. Basically, there are many improvements that could be added into the build page.

The second feature originally comes from the supervisor, Dr. Mario Kolberg as he suggested it would nice to be able to compare two surveys together. For instance, to compare a survey that was sent out in 2016 with the same survey that was sent out one year later in 2017. HR employees and managers would then be able to see if there is an improvement or a deterioration and take actions based on a survey comparison.

8.3 Summary

Youmanage, an SME software company based in Stirling Scotland was looking to implement a survey capability into their existing HR software. It was therefore proposed that a new survey component should be developed from the ground up and integrated into the new version of the Youmanage application.

The analysis of the competitor products revealed what parts are vital for any survey tool and then what needs to be implemented to fulfil expectations that clients may have. The requirements were based on the analysis and it was determined that the vital parts of any survey tool are creating a survey, editing a survey, sharing a survey, analysing a survey, and managing

a survey. Each part plays its own role in the survey lifecycle and if any part is missing the whole component would be considered incomplete.

This project was developed using the agile approach which allowed to always have working testable version and it enabled to divide the development of the component into two phases. The first phase consisted of working towards a basic prototype where every vital part was going to be implemented in fairly simple way, whereas the second phase focused on improving and extending a functionality from the first phase. That way it helped to ensure that all parts were being implemented without any vital part missing.

Feedback from the client has been positive throughout the whole development process. The CEO of the Youmanage has expressed full intent to include the survey component in the release of the new version of the Youmanage which is planned to be in late 2017. Once the new version gets released the survey component will be available to all Youmanage clients as it is intended to be a part of the Core HR module.

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