Managing desk space allocation and usage within Modern Office Environments

A dissertation submitted in partial fulfilment of

the requirements for the degree of

BACHELOR OF ENGINEERING in Computer Science

in

The Queen's University of Belfast

by

Saoirse McCann

9TH May 2017

**SCHOOL OF ELECTRONICS, ELECTRICAL ENGINEERING and COMPUTER SCIENCE**

**CSC3002 – COMPUTER SCIENCE PROJECT**

**Dissertation Cover Sheet**

A signed and completed cover sheet must accompany the submission of the Software Engineering dissertation submitted for assessment.

Work submitted without a cover sheet will **NOT** be marked.

Student Name: Saoirse McCann Student Number: 40104396

Project Title: Managing desk space allocation and usage within Modern Office Environments

Supervisor: Dr Barry McCollum

**Declaration of Academic Integrity**

Before signing the declaration below please check that the submission:

1. Has a full bibliography attached laid out according to the guidelines specified in the Student Project Handbook
2. Contains full acknowledgement of all secondary sources used (paper-based and electronic)
3. Does not exceed the specified page limit
4. Is clearly presented and proof-read
5. Is submitted on, or before, the specified or agreed due date. Late submissions will only be accepted in exceptional circumstances or where a deferment has been granted in advance.

**I declare that I have read both the University and the School of Electronics, Electrical Engineering and Computer Science guidelines on plagiarism - http://www.qub.ac.uk/schools/eeecs/Education/StudentStudyInformation/Plagiarism/ - and that the attached submission is my own original work. No part of it has been submitted for any other assignment and I have acknowledged in my notes and bibliography all written and electronic sources used.**

*Student’s signature* *Date of submission*

Acknowledgements

Firstly, to my supervisor, Dr Barry McCollum, thank you for all of the support and guidance you provided through this project and for always answering my endless questions.

To all the lecturer’s at Queens’ who have taught me over the past four years, and to all of my teachers at Dominican College Fortwilliam, thank you for passing on your knowledge and for your enthusiasm for teaching.

Finally, to my family and friends, thank you for your patience and for always encouraging me to keep going and never give up.

Abstract

This thesis examines the methods that could be implemented by a company to maximise the spatial utilisation of resources such as desks and meeting rooms in an open planned office space. In this paper a system is developed for managing the allocation of resources in an open planned office. As part of the system, an executive Officer Dashboard will display the spatial utilisation rates for the company allowing the workspace to be analysed and managed. As part of this evaluation, research is presented on the drive behind the paradigm shift from private individual offices to open-planned workspaces.

Table of contents

[Acknowledgements iii](#_Toc481339299)

[Abstract iii](#_Toc481339300)

[Table of contents iv](#_Toc481339301)

[Table of figures vi](#_Toc481339302)

[Chapter One 1](#_Toc481339303)

[1.0 Introduction and Problem Specification 1](#_Toc481339304)

[1.1 INTRODUCTION 1](#_Toc481339305)

[1.2 BACKGROUND TO THE PROBLEM 2](#_Toc481339306)

[1.2.1 Current trends 2](#_Toc481339307)

[1.2.2 The Problem 2](#_Toc481339308)

[1.3 RESEARCH FOR THE SOLUTION 2](#_Toc481339309)

[1.3.1 Agile working 2](#_Toc481339310)

[1.3.2 \*\*\* Civica’s approach 4](#_Toc481339311)

[1.3.3 PARETO’S 80-20 RULE 4](#_Toc481339312)

[1.4 ANALYSING SPACE UTILISATION 4](#_Toc481339313)

[1.4.1 Frequency rate 5](#_Toc481339314)

[1.4.2 Occupancy rate 6](#_Toc481339315)

[1.4.2 Utilisation rate 7](#_Toc481339316)

[1.4.3 Utilisation rate 8](#_Toc481339317)

[Chapter 2 9](#_Toc481339318)

[2.0 System Requirements Specification 9](#_Toc481339319)

[2.1 SOLUTION OVERVIEW 9](#_Toc481339320)

[2.1.1 Introduction 9](#_Toc481339321)

[2.1.2 End users 9](#_Toc481339322)

[2.1.3 Executive Officer Dashboard 9](#_Toc481339323)

[2.1.4 Resource allocation 10](#_Toc481339324)

[2.2 ASSUMPTIONS 10](#_Toc481339325)

[2.2.1 Functional Requirements 11](#_Toc481339326)

[2.2.2 Non-Functional requirements 12](#_Toc481339327)

[Chapter 3 14](#_Toc481339328)

[3.0 Design 14](#_Toc481339329)

[3.1 SYSTEM ARCHITECTURE 14](#_Toc481339330)

[3.1.1 System Architecture Overview 14](#_Toc481339331)

[3.2 PRESENTATION LAYER 15](#_Toc481339332)

[3.3 DOMAIN/BUSINESS LAYER 15](#_Toc481339333)

[3.4 DATA LAYER 15](#_Toc481339334)

[3.5 USER INTERFACE 16](#_Toc481339335)

[3.5.1 Design Overview 16](#_Toc481339336)

[3.5.2 User Interface Design Guidelines 16](#_Toc481339337)

[3.5.3 Screen Mock-Ups 16](#_Toc481339338)

[Chapter 4 18](#_Toc481339339)

[4.0 Implementation and Testing 18](#_Toc481339340)

[4.1 IMPLEMENTATION 18](#_Toc481339341)

[4.1.1 Server 18](#_Toc481339342)

[4.1.1 Languages 18](#_Toc481339343)

[4.1.2 Frameworks 18](#_Toc481339344)

[4.1.3 Libraries 19](#_Toc481339345)

[4.1.4 Development Environment 19](#_Toc481339346)

[4.1.5 Source Control 19](#_Toc481339347)

[4.2 TESTING 20](#_Toc481339348)

[Chapter 5 21](#_Toc481339349)

[System Evaluation and Experimental Results 21](#_Toc481339350)

[Chapter 6 22](#_Toc481339351)

[Conclusion 22](#_Toc481339352)

[Appendices 26](#_Toc481339353)

[Appendix A – Office Distribution Scenario 26](#_Toc481339354)

[Appendix XX – Use Cases 27](#_Toc481339355)

[Appendix XX – User Interface Design Guidelines 28](#_Toc481339356)

[Appendix XX – Screen Mock-Ups 29](#_Toc481339357)

[Appendix XX – Acceptance Tests 30](#_Toc481339358)

Table of figures

Chapter One

1.0 Introduction and Problem Specification

* 1. INTRODUCTION

In this day and age, companies face major overheads for office space, resources, licenses, etc. Many companies now have an open-planned workspace for their employees in order to allow the company to expand and continue to grow.

The paradigm shift from private individual offices to open-planned workspaces was driven by financial advantages, the promise of increased productivity and the potential for better interaction between employees.

With an open planned layout companies could make better use of space, allowing for more employees in one building reducing the overheads of paying for extra space. In environments were teams have to interact with one another on a continual basis, then an open-planned layout could increase productivity and allows colleagues to approach one another without the need to arrange a meeting.

The issue many companies are now facing is how best to allocate the space and resources. It is this area that this thesis will focus on.

* 1. BACKGROUND TO THE PROBLEM

1.2.1 Current trends

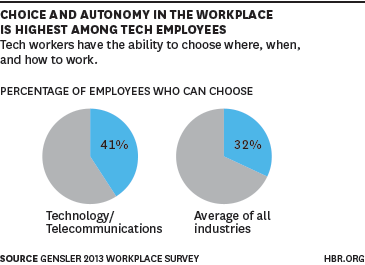
For the most part, office workspaces allocate awork area for each employee. It is easy for the company as they just have to do a simple calculation of one desk for every employee and no further planning or analysis is required. Employees tend to prefer to have their own personal desk space which they can personalise and become accustomed to. This approach, however, is inefficient for the company, as when resources are left vacant they cannot be reassigned when required.

1.2.2 The Problem

With people working from home, off sick, on annual leave or on customer sites, a number of resources can be left vacant. If each employee has a personal desk, then these resources cannot be utilised by others as they are still technical “occupied” by said employee even when they are vacant.

It’s becoming more normal for companies to move away from the normal resource allocation process of providing each employee with a desk. The more efficient agile approach is to allocate resources when requested, which ensures no resources is not utilised when it could be, and allows employees to request the type resource they require.

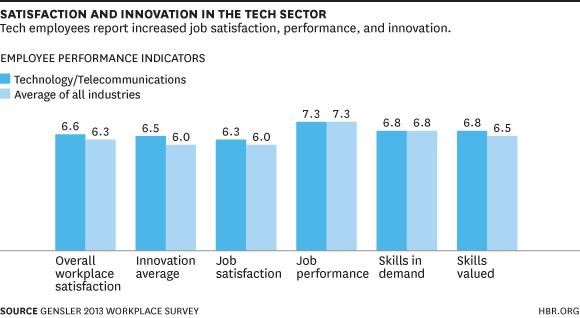
* 1. RESEARCH FOR THE SOLUTION

1.3.1 Agile working

With technological advances it is becoming more common for people to work from home. Different industries require employees to be on company sites or out of the office for meetings.

For this reason, it is becoming less common for all employees to be in the office every day. For this reason, let us consider each employee of the company as a “visitor”, who has the option to use office space if required. If space is required then the most appropriate resource for the “visit” can simply be booked, e.g. a hot desk.

An article in the Hazard Business Review by Diane Hoskins states that overall performance and attitudes to the working environment increases when employees have free reign of the space where they work. The study stated this approach worked particularly well in technology companies.



The reason why these technology companies noticed an increase in productivity and satisfaction of the workforce were due to the principles of agile working. Agile working gives employees a choice of where, when and how to work. A number of different space options are provided, such as meeting rooms, hot desks, team workspaces, etc. Agile working gives the workforce the freedom and flexible to pick the best working environment for them and their task.

An agile workspace has more focus on the actual space and what the employees do and require, rather than having an emphasis on departments and eliminates desk ownership.

* + 1. \*\*\* Civica’s approach

1.3.3 PARETO’S 80-20 RULE

The Pareto principle states that roughly 80% of outputs come from 20% of the inputs.

Applying Pareto’s rule to the issue of space allocation within an office would indicate that 80% of space is underutilised. In order to improve this rate and to understand how best to manage it, a thorough analysis of the space and how it is used is required.

* 1. ANALYSING SPACE UTILISATION

Space utilisation is a measure of well a space is being used, and how it is being utilised.

Frequency, occupancy and utilisation rates measure how efficiently a space is being use. In this thesis, we will consider resources such as desks, meeting rooms, team work areas, etc. as space.

Calculating the frequency, occupancy and the utilisation rates for a company can help in many ways. These rates are very useful when a company is seeking to expand, these indicators will allow them to see which resources are being underutilised, meaning they could be replaced with workspaces for new employees and resources which are in high demand. In turn, this will have fiscal benefits for the company allowing them to expand, while staying at the same location and not having to consider paying for more space. Overall, if a company has a thorough analysis of their space utilisation, it provides endless possibilities for the company to improve and manage the company’s workspace. For a scenario on how these rates can aid in analysing the layout of an office space refer to appendix A.

1.4.1 Frequency rate

The frequency rate represents the percentage of time space is used compared to its availability.

Example:

A company has a working day from 9am to 5pm. The table below shows when a resource was in use for one working week, Monday through to Friday

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
| 9am - 10am | **VACANT** | **UTILISED** | **VACANT** | **UTILISED** | **VACANT** |
| 10am - 11am | **UTILISED** | **UTILISED** | **UTILISED** | **UTILISED** | **VACANT** |
| 11am – 12pm | **UTILISED** | **VACANT** | **UTILISED** | **VACANT** | **UTILISED** |
| 12pm - 1pm | **UTILISED** | **UTILISED** | **UTILISED** | **UTILISED** | **UTILISED** |
| 1pm – 2pm | **VACANT** | **UTILISED** | **UTILISED** | **UTILISED** | **VACANT** |
| 2pm – 3pm | **UTILISED** | **UTILISED** | **UTILISED** | **VACANT** | **UTILISED** |
| 3pm – 4pm | **UTILISED** | **UTILISED** | **UTILISED** | **UTILISED** | **UTILISED** |
| 4pm – 5pm | **UTILISED** | **UTILISED** | **UTILISED** | **UTILISED** | **UTILISED** |
| Hours in use | 6 | 7 | 7 | 6 | 5 |

HOURS IN USE

Then the sum of all of the hours the resource was utilised needs to be calculated.

(Monday) 6 + (Tuesday) 7 + (Wednesday) 7 + (Thursday) 6 + (Friday) 6 = (Total) **30 hours**

HOURS AVAILABLE

Total availability is the total amount of hours the resource is available to be used, 8 hours a day for 5 days.

Total availability: 5 \* 8 = **40 hours**

%

1.4.2 Occupancy rate

The occupancy rate represents how full the space is compared to its capacity.

Example:

A company has a working day from 9am to 5pm. The steps below show how to calculate the occupancy rate for a resource. The table shows how many people occupied the resource for one working week, Monday through to Friday

|  |  |
| --- | --- |
| CAPACITY | 20 |
|  | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
| 9am - 10am | **0** | **0** | **0** | **20** | **0** |
| 10am - 11am | **10** | **20** | **20** | **15** | **0** |
| 11am – 12pm | **10** | **0** | **18** | **0** | **19** |
| 12pm - 1pm | **15** | **20** | **20** | **10** | **20** |
| 1pm – 2pm | **0** | **0** | **17** | **10** | **0** |
| 2pm – 3pm | **15** | **5** | **0** | **0** | **20** |
| 3pm – 4pm | **20** | **1** | **15** | **15** | **16** |
| 4pm – 5pm | **20** | **0** | **20** | **15** | **16** |
| HOURS IN USE | **26** |

HOURS IN USE

Add up all of the hours the resource was utilised (where the occupants is greater than 0).

Hours in use: **26**

NUMBER OF PEOPLE OCCUPAYING THE SPACE

Add up the number of occupants for when the resource is in use.

Total number of occupants: **412**

%

1.4.2 Utilisation rate

The occupancy rate represents how full the space is compared to its capacity.

Example:

A company has a working day from 9am to 5pm. The steps below show how to calculate the occupancy rate for a resource. The table shows how many people occupied the resource for one working week, Monday through to Friday

|  |  |
| --- | --- |
| CAPACITY | 20 |
|  | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY |
| 9am - 10am | **0** | **0** | **0** | **20** | **0** |
| 10am - 11am | **10** | **20** | **20** | **15** | **0** |
| 11am – 12pm | **10** | **0** | **18** | **0** | **19** |
| 12pm - 1pm | **15** | **20** | **20** | **10** | **20** |
| 1pm – 2pm | **0** | **0** | **17** | **10** | **0** |
| 2pm – 3pm | **15** | **5** | **0** | **0** | **20** |
| 3pm – 4pm | **20** | **1** | **15** | **15** | **16** |
| 4pm – 5pm | **20** | **0** | **20** | **15** | **16** |
| HOURS IN USE | **26** |

HOURS IN USE

Add up all of the hours the resource was utilised (where the occupants is greater than 0).

Hours in use: **26**

NUMBER OF PEOPLE OCCUPAYING THE SPACE

Add up the number of occupants for when the resource is in use.

Total number of occupants: **412**

%

1.4.3 Utilisation rate

For a scenario on how these rates can aid in analysis the layout of an office space refer to appendix A.

The utilisation rate is a function of a frequency rate and an occupancy rate. The frequency rate measures the proportion of time that space is used compared to its availability, and the occupancy rate measures how full the space is compared to its capacity. Utilisation rates can be assessed in terms of both actual use and predicted use.

system constraints.

* A complete set of function definitions (as use cases if preferred), as far as possible written so as to be testable
* Measurable and testable non-functional requirements
* Description of interfaces required such as with other software or systems
* Any specific user interface requirement
* User characteristics

The target to aim for here is that your requirements could be the basis for a contract or handing to external developers to complete.

Chapter 2

2.0 System Requirements Specification

2.1 SOLUTION OVERVIEW

2.1.1 Introduction

The goal is to develop an end to end software solution which will aid in the planning and management of resources within a modern office environment.

Research has shown that technology companies appear to be most flexible and are more likely to adopt an agile working environment. For this reason the prototype solution will be developed with a technology company in mind. However, this is mainly to aid with examples and scenarios, the end solution should be versatile enough for all office environments.

Research shows that employees perform better when they can control and choose their working environment. This was the main motivation for the system, a focus on allowing employees to choose their space as opposed to simply automatically assigning the next available space. There will be no concept of desk ownership; if a resource is required it must be booked.

2.1.2 End users

The system will be designed with two end users in mind:

1. Administrators – all end users who are added to the system as administrators will have access to the Executive Officer Dashboard and the resource booking functionality. Administrators will also be able to add, update and remove users, teams, resources and time slots.
2. Non-Administrators – all end users who do not have administrative rights will only have access to the resource booking functionality.

2.1.3 Executive Officer Dashboard

The system must have an intuitive user experience design. Information relating to employees, teams, resources and time slots should be easy and straightforward to add to the system. Once all of the information has been entered the system will provide an Executive Officer Dashboard that will display any relevant Key Performance Indicators that the company requires to effectively manage their resource allocation. The dashboard will display the frequency, occupancy and utilisation rates in the form of charts and graphs which will aid the end user in making decisions on how best to manage and allocate their resources to make the workspace more cost efficient. The Key Performance Indicators will be displayed per week, for the overall company and for each resource

2.1.4 Resource allocation

When a user is selecting a resource the system will provide functionality for them to auto assign their desk space, selecting the desk that is located closest to their line manager.

The system shall also have an end point to allow users to log on and book a resource from their mobile device. This will involve touch screen development.

When booking a resource, consideration will have to be taken into the schedule of each resource to ensure it is not double booked or booked beyond its capacity.

2.2 ASSUMPTIONS

Due to the time constraints that have been set for developing the solution the following assumptions have been made:

* A prototype solution will be developed for one office consisting of a single one level building, for an IT company.
* When an employee is off work on annual leave or working from home they do not need to book any resources for said days
* It is the responsibility of each user to book their resources for the upcoming week
* Archiving of the “Timetable” table in the database will not be implemented for the prototype developed. Although possible approaches on how this would be carried out will be investigated.
* Users only have to book resources for Monday – Friday between 8am and 6pm.
* Users will only be able to book resources for the current week and the upcoming week.
* Resources can only be booked against existing users of the system

2.2.1 Functional Requirements

1. Administrators shall have the functionality to add information regarding the office’s measurements
2. Administrators shall have functionality to add new users to the system
3. Administrators shall have functionality to add new resources on the system
4. Information regarding existing resources should be available to the administrator to update
5. Information regarding existing users should be available to the administrator to update
6. Accounts shall be automatically created for each employee when they are added to the system
7. An email shall be sent to users with their log in credentials when their account has been created
8. Administrators shall have access to an executive officer dashboard which will provide information of measurements of utilisation
9. Analytics for the key performance indicators on the executive officer dashboard shall be displayed in the form of charts and graphs:
10. Utilisation rate: frequency rate \* occupancy rate
11. Frequency rate: percentage of time space is used compared to its availability
12. Occupancy rate: how full the space is compared to its capacity
13. A user shall be able to send a change request for an occupied resource
14. A user shall have access to functionality to delete a resource booking for the current week, the week prior and the upcoming week
15. The user shall have functionality to book resources for themselves for the current week and the upcoming week
16. The system shall have functionality to allow a user to auto assign their desk for a day which will select the closest desk available to their line manager.
17. The system shall prevent users from booking multiple resources for the same time period
18. The system shall keep a timetable of allocation for each resource
19. The system shall keep a timetable of resource allocation for each user showing their bookings for the current week, the week prior and the upcoming week
20. The system shall prevent a resource being double booked
21. The system shall prevent a resource from being over booked

2.2.2 Non-Functional requirements

1. The system should be mobile compatible to allow a user to easily:
   1. book a meeting room for themselves and other attendees
   2. delete a resource booking from their schedule
   3. book resources
2. Modified data on the system should be updated in the database within 2 seconds for all other users accessing it.
3. The system should allow the user to easily switch between booking a desk, room or other resource.
4. The UI should be intuitive and user friendly, requiring minimal trianing for the end user.

**3. Design**

This section should describe the design of your proposed system. Normally this several parts, depending on your project:

1. Architectural Description of the system – textual and/or diagrammatic. This could be a simple diagram showing the components and how they relate or it could describe the choice of architectural style or pattern used.
2. User Interface Design (if applicable). Show sketches of the design or screenshots with explanations of choices made, if necessary.
3. Software System Design.

The role of each component and the interfaces between components should be described. There should be a clear correlation between your design and your specification.

The design should be linked to requirements and, where applicable give a critical discussion of key design decisions/styles/patterns used. There might be a data model, a UI design, details of external interfaces, and of other important issues e.g. concurrency, event handling, error and exception handling, security, data persistence. No particular notation or tool is mandated.

Chapter 3

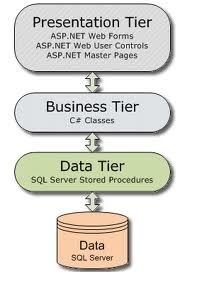
3.0 Design

In this chapter I am going to talk about the overall architecture of the end solution. An insight into how each layer was implemented will be discussed along with reasoning as to why each decision was made.

3.1 SYSTEM ARCHITECTURE

3.1.1 System Architecture Overview

A three tiered architecture approach was selected as it allows for separation of concerns. After doing research, there was a lot of help and support for implementing an n-tiered architecture, especially with ASP.NET MVC.

The end solution will consist of a presentation layer, a business/domain layer and a data layer.

The separation into layers results in a more practical end solution which is easier to update and extend, making it overall more flexible, manageable and extendable.

Having all of the business logic in a separate layer means that’s the service methods can be updated as business rules change. This means that only the project containing the domain layer needs to be updated, and no changes will need to be carried out to the data layer or the presentation layer.

Within the solution, each layer was created as a separate project to further help separate all of the areas of concern.

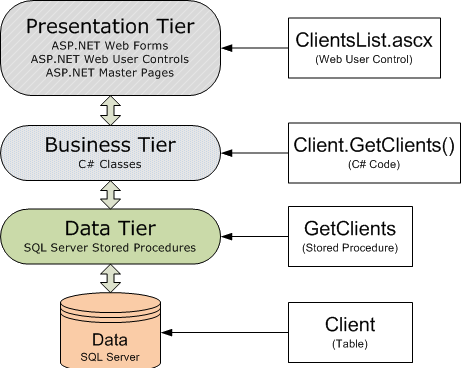
\*\*\*add photo of folder layout -> need to add testing projects first

3.2 PRESENTATION LAYER

The presentation layer will consists of the unser interface which the end user will interact with. It will be made up of an ASP.NET MVC application. Using MVC will provide a solid platform for separation of concerns, it is also easy to integrate with other frameworks and librarie such as JQuery and Highcharts. MVC provides a solid structure which makes unit testing more manageable, providing an extra layer of protection.

3.3 DOMAIN/BUSINESS LAYER

The domain layer will consist of C# classes which will contain service methods containing the business rules of the system. The business rules will be separated out into components making the solution more manageable. This means, the will be a User Service containing all of the service methods required to get, manipulate, delete and add users to the system. The same pattern will follow for teams, resources, time slots, bookings, accounts and rate calculations. The domain layer communicates with the data layer to retrieve the data to then filter and manipulate it into the required results and then send them to the presentation layer to be displayed for the end user.

3.4 DATA LAYER

The data layer follows an entity framework code-first migrations approach. This approach was selected due to its flexibility. It allows the database structure to be changed and updated as new requirements are added. Also when more thought and understanding is given into a requirement providing a clearer view of what is required, resulting in a change of the current database structure. The data layer is used for interacting with the database to access, manipulate and add data.

3.5 USER INTERFACE

There are two main endpoints in mind for this solution. Ideally, there would be two end solutions, a phone app and a web application. The phone app would simple allow users to book a resource and view their allocation. And the web app would allow full use of the system, including access to the executive officer dashboard.

Although, dud to time constraints it was decide to design one end solution that would cater for both end points. For this reason, the system will be responsive and compatible to use on both mobile phones, computer, tablets, etc.

3.5.1 Design Overview

The main goal is for the end system to have a clean and professional layout. Consistency and ease of use are vital for the solution to be user friendly and intuitive. The application UI consists of Twitter Bootstrap 3. Twitter Bootstrap provides a structure which allows the system to be responsive, and therefore compatible with different hardware devices.

3.5.2 User Interface Design Guidelines

Before any implementation started, a brief list of design guidelines was created. This list contains an overview of how components should be implemented and displayed on screen. Having design guidelines in place aided in keeping the user interface consistent across the whole solution, which makes the system easier to use and in turn increases the user experience. Refer to appendix XX to view the list of design guidelines.

3.5.3 Screen Mock-Ups

Screen mock-ups were designed before any implementation started. This helped to visualize what the final solution should look like and also provided a clear goal to work towards. Although producing the mock-ups was initially very time consuming and tedious, overall, in the long run, it saved time when it came to implementation as the design decisions had already been made. Although, at times, the implementation did stray away from the design mock-ups, but the overall concept and outcome was the same. Refer to appendix XX to for the initial wireframe screen mock-ups.

**4. Implementation and Testing**

You should describe any languages, packages, and libraries etc. that are used in the development of your system. There is no need to describe your code in detail. You may highlight data types and implementation techniques that are of special interest. If appropriate, you may provide:

Key implementation decisions

1. A description of how some important functions and algorithms were implemented.
2. A description of how each component is implemented.

Program code can be accessed by the assessors via the git repository **so there is no need to print code listings**. It is recommended that you comment code appropriately. Programs should be written in a clear style with good program structure and well-defined data structures. The program code should reflect its design.

Chapter 4

4.0 Implementation and Testing

This chapter provides a detailed description of the implementation approach and the testing strategies adopted in producing the final solution. All of the technology choices, libraries and frameworks used were chosen carefully and a rationale for each choice is provided. This chapter also includes an insight into how testing was carried out to ensure the system meets the requirements and that the functionality is performing as expected.

4.1 IMPLEMENTATION

4.1.1 Server

The end solution is comprised of two servers, a database server and a rest api server.

When researching for a database server the main requirement was for platform that could support complex SQL queries and more importantly store data in a relational way. Only open source options were considered. In the end Microsoft SQL Server was chosen due to the amount of support and information that was readily available for it. Another factor why Microsoft SQL Server was selected was due to the fact that the Management Studio was also free and very easy to use. The Management Studio meant that any information in the database could be easily viewed and analysed during development, helping to enhance performance and provided a vital insight into the data while debugging. Other options that were considered were MySQL, CSQL and PostgreSQL.

Now the api one…

4.1.1 Languages

1. Choice of implementation language(s)/ development environment(s)

4.1.2 Frameworks

MVC

Entity framework

4.1.3 Libraries

Highcharts

SQL

Bootstrap

JQuery

4.1.4 Development Environment

4.1.5 Source Control

GitHub was used for source control. GitHub was chosen as it intergrated nicely with GitLab which was a requirement for all Queen’s students. The project was set up so that when code was pushed it would go to both repositories meaning there was always two versions of the system that could be accessed at any time. GitHub was used on top of GitLab as GitHub allowed to be raise issues and provided a nice user-friendly interface showing the different branches were which active.

Although there is only one developer for this system, thought was still given to the practice of continuous integration. Commits were made regularly, and were as small as possible. Clear descriptions where added to each commit to allow reverting, if necessary, easier. Integrating new functionality and updates into the master code base frequently helped keep the bug count to a minimum and made regression testing easier.

4.2 TESTING

1. Discussion of Test Approach e.g. unit testing, system testing, regression testing etc; Test cases described; Testing tools used. Evidence that testing coverage was complete.

**Testing strategy**

**Unit testing**

**Acceptance testing**

**Regression testing**

**5. System Evaluation and Experimental Results**

Different projects will have a different emphasis. In all cases you are expected to provide empirical results and to draw conclusions from those results. You may use your software to generate experimental results. Be sure to describe the methodology of your evaluation or experimentation. An experiment is typically described in terms of its goals, the hypotheses being tested, the subject of the experiment, what is being measured and what is controlled, the results obtained and the analysis and interpretation of those results. Alternatively, you can assess the product in terms of how it compares with other similar products and/or in terms of user feedback (e.g. via a survey) or some measurable quality aspect such performance efficiency or reliability. Your supervisor can guide you on what is appropriate, but typically the very best projects have shown results that could be publishable with little or no work or show an exemplary empirically based evaluation of a software product

Chapter 5

System Evaluation and Experimental Results

**6. Conclusion**

A general summary evaluation of the success of the project should be given with respect to criteria identified in the introduction. A discussion of the significance of your experimental results may be appropriate. Do they agree with other previous work or ideas? How does your system compare with similar ones? An evaluation of the hardware/software environment and language used may be presented, if appropriate. Draw conclusions on the process used in the project as well. What went well? What did not go well? What are the strengths of your solution or conclusions? What are the weaknesses? Suggestions for further work should also be discussed. You can be critical and draw a negative conclusion. Not all projects will be successful. A well-explained failure is as an acceptable an outcome as a spectacular success. Assessors are looking for excellence in a critical appraisal of the work and a convincing argument for the significance of contribution in the context of wider work.

Chapter 6

Conclusion

**References**

A list of references to documents (books, papers, web pages etc.) which are referred to in the main body of the text. Use the IEEE citation style as detailed here <https://www.ieee.org/documents/ieeecitationref.pdf>

References

Famuyide, Stephanie, and Stephanie Famuyide. "15 Tips For Writing Better Requirements". *Business Analyst Learnings*. N.p., 2017. Web.

"What Is Executive Dashboard? - Definition From Whatis.Com". *SearchCIO*. N.p., 2017. Web.

"Writing Quality Requirements". *Processimpact.com*. N.p., 2017.

Thinking, Fresh. "Utilisation Analysis | Fresh Business Thinking". *Fresh Business Thinking*. N.p., 2017. Web.

<http://www.smg.ac.uk/documents/utilisation.pdf>

<http://reqtest.com/requirements-blog/functional-vs-non-functional-requirements/>

<http://www.requirements.com/Glossary/NonFunctionalRequirements/tabid/91/Default.aspx>

<http://softwareengineering.stackexchange.com/questions/162399/how-essential-is-it-to-make-a-service-layer>

<https://msdn.microsoft.com/en-us/library/ff648105.aspx>

<https://www.lucidchart.com/pages/er-diagrams>

<http://www.conceptdraw.com/examples/er-notation>

<http://survey.datassentialsurveys.com/help/Inquisite_ER_Diagram.htm>

<http://kc.litiumstudio.se/documentation/previous-versions/litium-studio-4-6/litium-studio-4-6-2/litium_studio_ecommerce/architecture-design/er-diagrams>

<http://www.tableau.com/sites/default/files/media/which_chart_v6_final_0.pdf>

<http://www.investopedia.com/terms/c/capacityutilizationrate.asp>

<http://www.businessballs.com/pareto-principle-80-20-rule.htm>

<https://en.wikipedia.org/wiki/Pareto_principle>

<http://ui-patterns.com/blog/The-8020-rule--the-Pareto-principle>

<http://www.archibus.com/ai/abizfiles/v23_help/archibus_help/user_en/Subsystems/webc/Content/web_user/space/planning/concepts/allocation.htm>

<https://hbr.org/2014/01/employees-perform-better-when-they-can-control-their-space>

<http://spendmatters.com/2011/01/05/six-strategies-for-it-cost-allocation/>

<http://www.flexibility.co.uk/flexwork/offices/facilities4.htm>

<http://staging.cl/wp-content/uploads/2014/07/Office-Space-How-much-is-enough.pdf>

<https://www.theregister.co.uk/2016/03/07/ibm_offshoring/>

<https://www.bloomberg.com/news/articles/2007-10-25/shaping-the-workforce-of-the-futurebusinessweek-business-news-stock-market-and-financial-advice>

<http://officeprinciples.com/agile-working/>

<https://forums.asp.net/t/1940843.aspx?Apply+3+layer+to+MVC+Application>

**The first citation should be the URL to the software code repository which should contain the code and any other resource required to run the software.**

**Appendices**

These should include as appropriate:

(a) A User manual giving details on how to use the software, including details of input data, output formats and error messages.

(b) Test results, if appropriate.

(d) Minutes of the Project meetings.

Delete functionality -> it was implement so that it would not affect the calculations Resources, Users and Slots

Add interview with workers -> reference in conclusion that perphaps and electronic tracker would be more useful. Say that employees would like to chose where they get to work

Strengths -> due to the architure fremwork, the protype can easily be updated for all kidns of companies, consisiting of diffrrent offciens and floors. Alsodoes not only have to work for an open planned floor plan.

Strenght -> due to using EF code first I was able to update the db all the time -> show migrations floder image

Strenght -> two end points, no need to design or implement second solution

Weakness -> mobile app would allow access to only whats needed

Improvement – Auto functionality should consider team memebers and sit you next to your line manager

\*\*Add chapter descitptions

\*\*tracker devices are invasion of personal privacy

\*\*Gantt chart

\*\*user manual

\*\*wireframes

\*\*methodology

\*\*folder layout in architecture

\*\* HEURISTIC HCI GUIDELINE

Appendices

Appendix A – Office Distribution Scenario

Scenario: The office is divided into two sections, one section contains desks, the second section contains two meeting rooms. The two meeting rooms each have a capacity of 100 people, while all the desk space for the office is cramped together. By looking at the frequency at which each of the rooms is used, how many occupants they have when they are utilised a company would be able to make decisions based on these calculations which will allow them to make changes to better suite their company needs.

Example 1: if the first room has an frequency rate of 90%, and an occupancy rate of 50%. And the second room has a frequency rate of 100%, and an occupany rate of 50%. This means the company could get rid of one of the rooms and spilt the toher room into two. Leaving space for more desks for the company to expand.

Example 2: Both of the rooms have a high frequency and occupancy rate. If the occupants in the room are company employess this means that their current desks are left vacant. Pareto’s rule is relevant here as it gives an insight into the fact the you do not need to provide resources for all employees. The company could still expand, keep the same location with the same rent. This is when a booking systems for resources would come in useful. And were a dashboard containing information on the frequency, occupany and the utilisation of each resource, on a certain day at a particular time may become very cost eefective.

Appendix XX – Use Cases

Appendix XX – User Interface Design Guidelines

|  |  |  |
| --- | --- | --- |
| **Component** | **Design guideline** | **Example** |
| Main headlines |  |  |
| Normal text |  |  |
| Table headings |  |  |
| Tables |  |  |
| Button (to add a new entry) |  |  |
| Button (to delete an entry) |  |  |
| Button (to go to new info page) | .btn-info |  |
| Button (to go back) |  |  |

Appendix XX – Screen Mock-Ups

Appendix XX – Acceptance Tests