Inventory Management App

BO20-G27

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28. January 2020
BACHELORThESIS

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<td>Field of study:</td>
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(30/12 2029)

Tilgjengelig etter avtale med oppdragsgiver

Tittel: Inventory Management App

Dato: April 23, 2020

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Avdeling / Program: Department of Computer Science

Gruppenummer: BO20-G27

Oppdragsgiver: Superior Racking and Shelving Ltd

Kontaktperson hos oppdragsgiver: Alan Byrne

In a world that is getting ever more digitized by the second, the importance of moving more and more aspects of business operations online cannot be understated. There are huge amounts of human and monetary resources to be freed from doing so. A shelving and racking business located in Dublin, Ireland has seen that they could potentially save a lot on inventory management costs by introducing a system to handle this, and human resources previously used to keep track of stock could be used on more important tasks that would help expand the business. By having a customer facing smartphone application, they can get live information on the inventory of the company while also staying up-to-date on news published by the company and easily reach out when needed, while a web application will help the company itself update information and easily keep track of what they have.

3 emneord:

| Web Application |
| Smartphone Application |
| Inventory Management |
Abstract

The Abstract (in layman’s terms known as summary) will be a roughly 1-2 pages long text compressed version of the report. It will allow anyone who reads the report to get a close to full overview of the report.
Gratitude

I wish to thank family and friends for endless support during the development of this project. Østfold University College also deserve lots of praise for assisting me throughout the development process, in particular my supervisor for giving important feedback and clues during supervising meetings. A big thank you to Superior Racking and Shelving is also deserved for taking me onboard and taking an interest in this project.
Innhold

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Chapter 1

Introduction

1.1 Project Group

This student group consists of Patrick Gilstad, a 4th year computer science student at Østfold University College in Halden, Østfold, Norway. I was born in Oslo and grew up in Moss, Østfold. Afterwards I moved to Halden for half a year before relocating to Dublin, Ireland where I am currently residing. My computer science knowledge is quite broad, having been through many computer languages, different types of programming and even database management. Web development and .NET are my areas of expertise, with moderate knowledge of databases and how to manage them. Having touched upon the human sides of software engineering makes me very flexible in terms of being able to handle both the developer and manager roles of this project. Software documentation and the business aspects of software engineering are topics I have dealt with throughout my education. My primary interests are travelling and watching movies. This group ended up being a one-man group due to less flexibility on my side since I am not currently situated in Norway, and I am also holding a part-time job on the side. Being a one-man group gives me the freedom to tailor the work schedule around myself.

1.2 Employer

The Employer’s name is Superior Racking and Shelving, a private limited company situated in Dublin, Ireland that makes storage solutions for a wide variety of customers. Their primary market is Ireland, but they support clients all over the country. This company is a small-sized company. The name of the person of contact is Alan Byrne who is also the managing director of the company.

1.3 Assignment

Overview This assignment was created to help inspire my employer. The employer has researched ways and tested out solutions to help their clients get a better overview of inventory, while they at the same time can better keep tabs on what they have and easily update inventory so costumers got the most exact information readily available. Current situation A problem with this is that the
business does not have a set inventory of different shelves or racks. They make custom shelving based on what the customer wants.

The problem the company is currently facing is one of efficiency. A more comprehensive system is dearly needed in order to minimize the loss of time and resources being wasted, whereas it could be used somewhere else. In the day of automation and mass production, every company needs to evolve and make sure as little of the human resources available are squandered as possible. Taking companies more and more online are needed for survival in our ever so digital and data-driven world. Based off company feedback and a shadowing session, the current system of manually counting all the inventory has proven to be in dire need of a change.

1.3.1 Purpose

**Main goal**
The main goal of this project is to make the system more efficient. Users currently can look at previous work by the company and have to make a call or send an email to talk through their options with the company. In order to achieve the main goal of making the current system more efficient, there are sub goals that will make up the main goal.

**Subgoals 1**
One of the sub goals will be to develop an application to improve customer interaction, which will improve the system by allowing customers to do many of the initial formalities themselves, allowing company resources to be freed up and be spent on creating the products the customers want.

**Subgoals 2**
The other sub goal will be to help the business track their inventory. Employees currently have an unclear and highly manual way of tracking inventory, and this application would not only benefit customers, but also staff at the business.

1.3.2 Deliverables

What the company wants to show clients is what kind of accessories they have and what kind of shelving-parts models they have while also help customers get an estimate on what a project might cost. The system would need to be able to allow customers to get inventory of shelving accessories, and also be able to allow customers to get an estimate on their project by filling in information about what they want. On the client-side, the customers should be able to either use a phone application or a web application to interact with the system. The phone application will need to be able to run on both android-based devices as well as iOS-based ones. The company wants to be able to update all of their different applications with ease without having to handle lots of different code for each platform, so using a common language infrastructure will be essential here. The user will be at the centre of this application. Universal design will play a vital role here, especially with the onset of new laws stating that websites have to be accessible to all people, whether they are visually impaired or suffer from something that makes using websites harder than for the average person. Many design choices will also be impacted by this, whether it be text size or colour choices for instance. What will be provided to the business is an application intended to solve a problem the company is currently facing – customers being able to do very little online, having to call and email a lot, which results in time being lost, rather than a more efficient system of customers doing most online. The business would also definitely find benefit in this by having an improved way of tracking their inventory.
1.3.3 Method

The goal here is to help customers more easily find the information they want. What I make will help the business get ideas as to what and how they can achieve this goal, so my phone and web applications will serve as inspiration. All of this will be reached by researching my employers’ current situation, doing market research by looking into customer needs and possibly see if any competitors or other businesses have made solutions that can be used as inspiration for my own project. Focus groups will be involved and other relevant parties to ensure that the user is always at the centre. Getting an insight into how the company operates will also be a part of the process, perhaps by shadowing workers for a day, depending on suggestions or choices the company makes.

As for the method that will guide the group towards the goal, it has been decided that an agile work method is the best option, and scrum fits the project the best. A set of goals has been made, sprints, that will be met, and individual planning will be held through weekly planning sessions, and weekly scrums to document progress and alter the sprints if more or less time is needed. While scrum has a focus on team work, it works well for one-man operations as well. It is important to get the product in other people’s hands during the project, whether that be beta testers, end users or even people the group knows such as friends or family. This will help make sure that the user always stays in focus throughout the project.

1.4 Structure of report

In the following Chapter 2, we will be taking a closer look at the task at hand, different approaches to the solution and existing solutions from other players in the market. Information acquired from the employer will be presented more in-depth as well. Following that, the design of the application will be discussed further in Chapter 3 whereas the implementation comes afterwards in Chapter 4. As the development progresses, an evaluation will be made which can be found in Chapter 5. In the end, the result will be discussed in Chapter 6. Following this, we will be discussing the result in Chapter 7 prior to the final Chapter 8 where everything will be wrapped up.

Multiple elevation
Chapter 2

Analysis: In-depth look at the project

In this chapter, we will talk about the information gathering process and what all future decisions will be based on. A closer look at different types of frameworks, existing solutions and design guidelines will be made in addition to involving the company and users in the development process and learning more about their motives and thoughts. All of this will form the basis of what will become the final product.

2.1 The business

Superior Racking and Shelving[^1] is a private limited liability company located in Dublin. My person of contact at the company is managing director and co-founder Alan Byrne. The company was founded in 2015 and has had its home in Dublin, Ireland since. Primary area of operations for the business is assembling shelving and racking solutions.

2.1.1 Operations

Customers can request a custom shelving system or racking system and the company will assemble it the way they want. Accessories for the different racking and shelving systems can also be requested from the company. The company does not manufacture the shelving and racking parts, they receive these from third party companies. Once the parts arrive at the company, they are stored in a warehouse until use. These parts come from many different companies originating from multiple countries such as from Armes in Italy and Rackline Limited in England.

2.1.2 Inventory management - present day

Currently the inventory is handled in an old fashioned manner with the number of units in inventory, location, origin and destination all being written down on paper documents. Very little has been brought online. As operations grow bigger, the process of keeping track of all this in an analogue manner has proven difficult in recent times due to higher volumes on items being processed in and out. The idea of transitioning the business more and more online has been floated around within the company, and I reached out to them and pitched them my idea, which led to them launching an operation that will revolve around exploring new methods of managing inventory, in addition to bringing the business more online if they feel like this project will bear fruit. This project will help

[^1]: https://superiorracking.ie/
Figure 2.1: Shelving system being assembled in the background. Sourced from https://superiorracking.ie/

them see how their inventory management could be handled online and at the same time see how they can help customers interact with the business more easily and find up-to-date information about what they have in stock in an easier manner.

2.2 Current problem

The problem the company is currently facing is one of efficiency. Very little has been brought online, so the company has a hard time keeping track of all stock, and the little manpower they have is being stretched very thin. Bringing the inventory management online could help cut costs, which is would the company a huge relief.

2.2.1 The age of automation

A more comprehensive system is dearly needed in order to minimize the loss of time and resources being wasted, whereas it could be used somewhere else. In the day of automation and mass production, every company needs to evolve and make sure as little of the human resources available are squandered as possible. Taking companies more and more online are needed for survival in our ever so digital and data-driven world. Based off company feedback and a shadowing session, the current system of manually counting all the inventory has proven to be in dire need of a change. Transitioning over to an inventory management system online would drastically increase efficiency. It has been established by many actors on the market that inventory management is very important.

2.2.2 Importance of inventory management

Inventory is an asset according to Steve Ciemcioch, CEO of Warehouse Anywhere, an American third party logistics and warehouse services company [2]. It does not only boil down to efficiency, there are also regulations stating that demands inventory is properly tracked. Automating this
process increases the chances of avoiding future legal headaches. Minimizing the loss of goods will also help the bottom line.

2.3 Existing solutions

The client aspects of this application can draw some inspiration from other already existing solutions. There are many B2C services, with the more known ones internationally being Amazon and Alibaba. Domestically within Norway Komplett would be more of a household name. Some more unique features would have to be added due to the nature of the company.

Amazon is a multinational IT company with operations within multiple sectors, where their most notable asset is the marketplace amazon.com, which is a B2C shopping service. Business who sell through the marketplace can also make use of Amazon’s internal inventory management system. This management system allows business to keep track of stock while also giving consumers an insight into stock, so that they know whether a product will be shipped out quickly or if they have to wait for stock to be replenished which could result in long waiting times. Transparency increases the likelihood of consumers making a purchase. By offering inventory management services, Amazon is able to easily coordinate with businesses that sell through its platform. This also makes it easier for the business itself to communicate with its suppliers.

Swisslog holding AG is a global company headquartered in Switzerland and is part of the German robotics group KUKA Group. Swisslog operates within many sectors with automation being at the centre of it all. One of the products it offers is an inventory management system used by many companies globally, including many companies in Norway. Maske Gruppen, which Østfold University College is a customer of, uses Swisslog internally in its systems. The system allows for goods being scanned and easily updated within the system, through infeed and similar solutions. A system for printing labels can be connected towards this system, allowing for more simplicity of the user, giving them the opportunity to put their attention to more important matters. Adding or removing goods from shipments is also easy, and information as to where goods are going, and where goods come from, is also part of the system.

2.3.1 Competing solutions and research

There are many solutions available at the market currently that help businesses move online and implement storefront-like solutions. Shopify would be a very known solution to several enterprises, and they have notable clients such as PepsiCo and KYLIE. Shopify saw a need in the market that many businesses are attempting to fill where analog systems cannot keep up with demand and time that could have been spent on growth is spent on inventory management and other non-growth areas. Many patents have been filed in the area, and there has been made extensive research on the topic. SAP AG’s US patent application underscores this, where they state that “Instead of receiving periodic reports of aggregated inventory changes, the system enables inventory changes to be reported real-time and without human intervention. Instead of replenishment planning occurring only according to a fixed schedule, the timing of replenishment planning can be adaptive, occurring more or less frequently depending on the reported real-time inventory levels.”. The importance of inventory management systems cannot be understated.

Chapter 2. Analysis: In-depth look at the project

2.3.2 Planned solution

There are different approaches already available to solving this problem, such as just having an internal inventory management system that handles inventory, however, the company does not wish to go down this route and would prefer a flexible solution that is both customer facing and solves internal inventory management. By having a hybrid solution like this, it gives the company more wiggle room and flexibility to tackling customer and internal problems.

2.3.3 Web application and phone applications

The solution for the current problem is a web application for the company and phone applications for the consumer, as outlined in Chapter 1. It will be written in C# and build on the Xamarin framework for the consumer application, while the company application will be written in javascript. This application will help keep track of inventory to minimize monetary loss from lost goods in addition to increasing efficiency and making sure compliance with legal regulations is made.

For the consumer there will not be any new hardware associated costs, seeing as the user base already have smartphones. There are currently 3.5 billion smartphones users in the world, or 45.12% of the world’s population [1]. A higher amount of people have smartphones in wealthier nations, including Ireland where the company is based where there are 3.86 million smartphones...
users out of a total of 4.921 million people (April 2019). A web application for the company makes the system more accessible to the different devices at the firm seeing as it will only require a web browser.

Communication between the different systems will either be handled through a database or a JSON file that will store the information online, allowing the different applications to access inventory information as needed. More and more people are going online, so businesses around the world have to make sure they are present where their customers are.

2.3.4 Native App and Web App

This project involves the making of both native apps and a web app, and what separates these two is that a native app is built for a specific platform, for example Google’s Android or Apple’s iOS, while a web application is accessed through an internet browser and is therefore not platform restricted and adapts to the device it is being viewed on, whether that be a PC, tablet or smartphone. As seen in fig 2.2, each app type comes with its own set of advantages. There has also been an attempt to look at substitutes for native applications, and a possible solution that is commonly looked into is web applications that utilize HTML5. A study published in the International Journal of Interactive Mobile Technologies [4] did a case study on this by looking into how this could help developing countries. Researchers concluded that web applications utilizing HTML5 that need to interact with hardware elements such as GPS, GPU or camera performed poorly while applications that only require a native interface and content consumption perform well on HTML5 web applications.

2.4 User Experience

When it comes to user experience, there are three factors that are often mentioned:

- Usefulness
- Usability
- Desirability

The user experience (UX) design process starts long before the product is in the hands of the user. Products with good user experience in mind focus on more than just the product’s use in mind, but also about the process of acquiring it and troubleshooting it. The inventor of the term user experience Don Norman once said “No product is an island. A product is more than the product” [3]. There is no single definition as to what good user experience is, however, you can say that good user experience is one that meets a user’s need in the context the product is being used in. Users want to feel like the application is easy to use, that it is pleasant to use and that it offers value, so it is important all these criteria are met when the application is being developed.

Evaluating the subprocesses of the application and the processes within the application is also central in UX [3]. User-centred design, where design is based of the needs and wants of the user, will play an important role in this application. This way of thinking is in stark process to a couple of decades ago, where what the developers found interesting and the brand was what stood in the centre, with little regard for users. As electronics hardware and the internet plays an ever more important role in the lives of people around the world, this way of thinking changed. There are a few things to be asked when it comes to user experience, but the first thing to start with is

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3 https://www.interaction-design.org/literature/topics/ux-design?page=7
what motivations a user must adopt a product as in why they should use this application. Once the user motives have been established, the next step is to figure out what can users do with the application, also known as the functionality. Then afterwards the process is rounded up with the design of functionality in an elegant and smooth fashion.

Accommodating for different types of users is of the utmost importance, since the application is designed with human users in mind. Since the user is at the centre of the application, it is important to do user research, designing wireframes, have interactive prototypes and testing different designs. Both qualitative and quantitative data will be gathered from the users to help influence the user experience. User research is how you know the application will perform in real life scenarios. This will reveal the user needs and lay the basis for the application design. End user must be involved, otherwise the application would suffer. Relying only on our own opinion and thoughts is not advised, since people carry their own biases, whereas this application is being developed for people who are not like us.

At first questions and ideas are formed, where we then progress to making research and learning about our users and their needs. What is the problem at hand, what is the knowledge gap, then we see what we believe to know about our users, before we select research methods. Research methods vary, and resources and manpower also have to be factored in.

Due to being a one man group, certain methods are not suitable and not all methods can be completed. Other methods of research could be to use analytics software, user testing and feedback software or split testing. By doing user research, valuable information about the user such as when the application will be used, and what main problems the application will solve. There are also direct business benefits to this process, by being able to speed up application development, circumvent redesign costs and have an increase in user satisfaction. UX design also offers the huge benefit of putting the user in the centre, there will be no bias from the developer or any third parties.

While conducting user research, there are multiple approaches to consider. A focus group is what has been chosen for this project, which involves having a structured interview with multiple people in a quick and inexpensive manner. It will reveal the experience of the target audience when it comes to interacting with similar solutions, what they desire from the application and what attitudes the target audience has. When a lot of insight is required in a short time span, this solution is preferable. Due to time constraints, this method was preferred.

### 2.4.1 Usability

The usability defines to which degree users can achieve quantified objectives, where how well the clarity and how smooth the experience of interacting with the application is designed. Through user testing and focus group meetings along side following design guidelines. Successful usability is measured in user satisfaction, where higher user satisfaction is preferred. The design should be simplistic and memorable. The first time the users interact with the application, they should be able to complete their goals quickly. All of this is also measured throughout the whole process, from wireframes all the way to the final product. This research method falls under attitudinal research, where what the users think and say about the application is what will be focused on. This differs from behavioural research, where you look at the actions from the user and how they would interact with a product. What people say is quite different than what people do.
A mixture of both qualitative data and quantitative data will be used throughout all the development phases. Quantitative data is data that can be measured. Raw stats are gathered. How many times a certain action is performed would be quantitative data. Qualitative data looks into the reasoning behind actions. Why was a certain action performed as opposed to a different action. Qualitative data is descriptive and open ended, as opposed to quantitative that is not open ended and not descriptive.

Regardless of all this, why does usability truly matter? A joint research from 2015 states that among B2B web users as many as 46% of users leave a website because they cannot tell what a website does, 44% leave due to lack of contract information while 37% leave due to poor UI design [7]. The application must be developed with longevity in mind and usefulness, otherwise it will lose out to competition. Input device is also important to factor in, since navigation differs heavily depending on whether a user is on a computer or a smartphone.

The most important aspect of usability is usefulness. If the product is easy to learn, takes little effort to use and satisfies every area of the user experience, it will in the end still fall short due to not being able to maintain a userbase if it cannot do what you use it for. If the application allows users to do what they want, people are often more willing to overlook other flaws of the application. Usability combined with usefulness in the application is what will create a pleasant experience and make sure users come back.

2.4.2 Accessibility

Accessibility is the practice of making websites and applications available and usable to as many people as possible. Whether a person has a disability, or people live in areas with poor network connection, the product should be usable by as many people as possible. The application will be used on mobile devices, which makes it very possible that the userbase will venture into areas where network coverage is low. The World Health Organization states that over a billion people suffer a form of disability [5] and there is a high likely of many people with disabilities using this application.

Vision impairment is a common disability and there are a lot of factors to count in when making software tailored towards users suffering from this (or web pages for that matter). British Telecommunication Engineering made an in-depth analysis of this back in 1999 [9], and today it is ever so important with all the advancements in colour and how much more central of a role both computers and smartphones play in our lives. According to report Designing for colour-blind users, they state that 1 in 12 men suffer from colour blindness to some degree, whether that be they cannot see certain colours or many colours. When deciding which colours to use, it is important to factor this in, so that certain elements of the application do not become inaccessible to some users. Even for people who are not colour blind it is important to consider colour choices, since certain colours can trigger certain parts of the brain and either create a pleasant response, or a negative one.

2.4.3 Guidelines

Mobile application design and web application design differ in several ways. While a web application stays similar on different devices and if it is a good website would be following the one size
fits all guidelines, and adapts based on screen size, mobile apps have different design guidelines depending on which platform they are for, whether that be Android or iOS. Android follows the material design guidelines laid out by Google, whereas iOS follows the human interface guidelines laid out by Apple. There are many differences between these guidelines, and following them based on platform is greatly advised, so they fit in with the UI of the rest of the platform.

### 2.4.4 Material design by Google

Material design is a design language created by Google which focuses on the Android platform. It puts an emphasis on touch screen features and motions that resemble objects from the real world. The idea behind this approach is that by involving objects that resemble elements in the real world and by applying basic natural laws users are familiar with, the cognitive load on the users will be reduced, the users can focus on the task at hand and feel a sense of familiarity and predictability while avoiding any sense of ambiguity.

A central core of this design is to have elements behave in a way that meet user’s expectations of how they should behave. Objects should be affected by gravity the same way real world objects are. Elements in the design should also differentiate in a way that is reasonable to the users. Elevation and shadows play an important role, as seen in figure 2.3 where the ideas and concepts behind the design is demonstrated. There are different concepts that need to be implemented. These concepts are:

When it comes to user experience, there are three factors that are often mentioned:

- Designs should be bold, color and whitespace use must be appropriate and there has to be immersive imagery and typography implementation. By doing so, users can instantly understand the hierarchy and draw appropriate meanings.
- Show functionality through icon and surface cues, help prompt the user to act.
- Have the user in the driver's seat, display changes that come as a result directly from their actions.
- Avoid odd and unpredictable behavior and movements.

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6[https://material.io/design/](https://material.io/design/)
2.4.5 Human Interface Guidelines by Apple

The Human Interface Guidelines is a design language created by Apple which focuses on the Apple ecosystem of products[7]. It focuses on aesthetic integrity, consistency, feedback, manipulation of onscreen content, metaphors and user control. On the iOS platform, the user should always be in control, not the application itself. People learn at a quicker pace when virtual objects and actions are metaphors for familiar experiences. The appearance and the behavior of the application should not be a distraction, it should integrate with the functions.

Three primary themes within the design guidelines differentiate iOS from other platforms:
- Clarity
- Deference
- Depth

2.4.6 Design aspects

Taking into account that people come in different shapes and forms, there are other aspects of designing that needs to be factored in, such as not all users being able to see, some have reduced hearing or no hearing at all and some users have ataxia – also known as coordination impairment. The application would have to offer solutions for the different types of users that would be using this application, such as support for screen readers so that people with vision impairment can still access the application. In the screen reader case, how the screen reader should function also needs to factored in. Should the page be read in a linear manner, from top to bottom, or should the user be able to move their finger on the screen and have the selected element read out.

Elements on mobile devices also need to be designed in a manner that they are easy to access on touch screen devices. A website on a PC can have smaller buttons, while mobile applications needs to be clickable with a finger. The security aspects are also different. The iOS platform usually features more security steps than Android in terms of permissions, and this will have to be taken into account, especially with cross platform applications. Monetizing is also different, where mobile applications are usually distributed through application stores belonging to the OS owners, which would be Google and Apple in most cases, with the exception being the Chinese market, but the company has no ties with the Chinese market so this does not apply to this project.

2.5 Focus group

A focus group has been created to do market research in terms of user feedback for an upcoming application. The group is small, but demographically diverse and consists of 5. The reason behind this number is that it is not so small that a dominant personality will control the narrative, but also not too large so a healthy discussion is not hampered by a large group size. Keeping the group odd numbered contributes to this. Even in the digital age, focus groups are still desired by many

The first focus group member is a woman in her 40s who works in the food industry. She described her knowledge of IT to be average, in the sense that she can use the systems at work perfectly fine, however, she occasionally needs help from her children to complete things online during out of work hours. Her feedback will be quite valuable seeing as the food industry is an

important customer and that the company has shelving units tailored towards that industry.

Second member of the focus group is a man in his 40s who works for an university in Ireland. This university has been a customer of Superior Racking and Shelving in the past. He considers his IT knowledge to be above average due to working for a university that is IT focused and offers several studies within the IT field. Extensive training and lots of computer and smartphone use makes him a very proficient tech user.

Third member of the focus group is a man in his 50s and he is employed in the industry in which the company operates. He considers his IT knowledge to be below average, he does not use his smartphone very often and usually only uses a computer to check and reply to emails and possibly read online about topics of interest.

Fourth member is a woman in her 50s who currently works as a cleaner. Her IT knowledge is described as average by both herself and peers according to her. She uses the computer a lot and is up to date when it comes to smart gadgets.

The last member is a man in his 20s who is a student at a university in Ireland. He studies computer science and his IT knowledge has been ranked very high by professors and peers alike.

2.5.1 Focus group as user centred tool

User centred design places the user at the centre throughout the whole development process, and not just during the initial research phase. Focus groups may be formed in order to consult so that one may consult a group of users a pre-designing process during different stages of development. It helps give an insight into the mind of the user, and if the limitations of the method are understood, it can be a valuable method to complement other forms of data collection. This can be repeated at different stages, and is applicable to both large-scale and small-scale studies [8].

Focus groups can be of great assistance when developing a new product, and they provide important insights into the mind of the users and how the application can be improved in order to provide a better user experience. In the age of user centred design, it is important to include the user in on the development process, so that you can clearly get an overview of what the user needs in the product and how they feel about it before interface design has even started, and a long time after implementation. Current design methods such as questionnaire, interviews and design audits are not fully able to cover every aspect of user centred design where products satisfy certain needs. These needs are emotional, functional, aspirational and cultural [8].

In relation to developing mobile applications and other interactive system design, the purpose of a focus group is to discover what the user wants from the system. A common misconception is to use focus groups for design usability and to assess interaction styles.

Focus groups are low-cost and easy to put together as well, making them an optimal choice. The sample size is low, and focus group meetings are not time consuming. While the sample size is low, the group should include a few people. In order to tap into the differences in people, there must be enough people so that there are enough differences to be found, thus making a focus group of 2 too small in order to be useful and would just be similar to an interview. Having a very small
focus group could also harm discussion due to dominant personalities taking over the discussion and would result in a group member dictating the opinion of the entire group.

On the other hand, a focus group should not be too large either, as it will harder to control and maintain the group. The more people who are added to the discussion, the more time is needed to ensure everyone makes an input. Longer sessions also result in people losing focus and interest; thus, they withdraw from the discussion. The energy of the group would be inhibited.

Identifying the target audience and getting a sample base of said audience is what will produce the best results. A rich amount of qualitative data can be gathered from this, however, no quantitative data can be collected. Positive synergy in group work and the data produced from this is what the method attempts to use, instead of obtaining it from an equivalent string of individual interviews. Questions are formed in a manner that promote discussion rather than just creating an atmosphere of collecting direct answers from the group. While the answers coming from the group are at the core of the session, it is also necessary to keep an eye on the body language, as this also speaks volume.

What is important to make sure of when recruiting focus group members is to have some diversity, but at the same time not make them too different. The focus group should include people from the target audience, but they also need to be from different walks of life in other to create an environment where discussions and ideas can thrive. Having different people helps get different perspectives but including the opinions of someone who will never use this product is counter intuitive. In this case it is important to involve people who need shelving units for their business, but who may be of different ages, different genders, and who come from different industries. By doing so, it is easier to map out their commonalities and differences, both of which are important to acknowledge. Once the differences have been discovered, it is important to explore the reasoning behind the difference, why people have different needs.

Focus groups are a good tool for assisting in the development process, however, it does have some limitations and it is important that it is used for the right purposes, otherwise it will taint the results. In a focus group, you only get to know what customers say they do, and not the way they would actually use the application. There are often big differences between what people say and what they do, so observing one user at a time should be done as well. Due to the nature of focus groups, the opportunity for a user to venture into the system on their own rarely arises. Discovering what users want from the system is a good goal for the focus group meeting, and it is much time and cost efficient than meeting each group member one by one at their location.

The focus group meeting should give the attendees the impression that it is unstructured, however it should actually be planned in advance and have a set of goals for the type of information to be gathered.

2.6 First focus group meeting - summary

The first focus group meeting was very valuable and gave important feedback that will help shape the application for the better. What the focus group considered important was universal design in the form of text elements being easy to use and the interface being welcoming to people from all walks of life. Some elements of the application were unnecessary from the user perspective and
a few additions were made in order to help users make better use of the application and prevent the users from leaving the application due to lack of features. An example of such feature was by changing the contact page from just having plain text into make the information interactive by letting users click on the email address and be redirected to their email client and by making the phone number into a button that starts a call once clicked. Several aspects of the application were praised, among those being the interface keeping important functions constantly within reach such as the contact page button.

Having a focus group come together and discuss the application created an environment where different people with common goals shared helpful insights into how they think this application could be shaped in a way that is user friendly. By having people who are or could be potential users of this application, but also come from different industries and are of different ages and gender, this group session produced a lot of helpful information and helped remove developer bias. This application is not designed for the developer, thus it is important to learn more about how other people think.

2.7 Frameworks

There is a wide selection of frameworks and programming languages that could be used to tackle the problem at hand. Flutter, a programming framework by Google based of said company’s coding language Dart is used in development in the development of applications on a wide variety of platforms such as Android, iOS and web applications. Flutter offers a lot of benefits, however, with it being dependent on developers who write in Dart, it can be difficult to recommended it to non-IT businesses seeing as it could be hard to find staff to maintain a system based on Dart.

React Native is a common framework made and maintained by Facebook based of React which is a javascript library. It supports cross platform on many of the same platforms as flutter. While Javascript itself is highly popular and has many developers, the library React is not as popular, and React Native is also relatively new and changing a lot quite often. In addition to this it suffers from the same drawbacks as Javascript itself does, such as only having a single device thread. Native code is free to use whatever code it wants.

Xamarin is a framework made by Microsoft based off their own programming language C#. It supports crossplatform development on Android, iOS and Windows UWP. It does not natively support crossplatform onto web applications, however, in the case of this application, the android/iOS app and web app will be separate applications so this will not be a drawback. Xamarin also has a huge talent pool to draw from, so when it comes to the company developing the application further and maintaining it, there will be few problems finding people who knows the framework. C# is a popular language, and Xamarin being based off this plays to its advantage.

2.8 Wireframes

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8https://flutter.dev/
9https://dart.dev/
10https://facebook.github.io/react-native/
11https://dotnet.microsoft.com/apps/xamarin
Figure 2.4: A wireframe of the product page of the application
Figure 2.5: A wireframe of the product page of the application during early stages
2.8. Wireframes

Figure 2.6: A wireframe of the contact page of the application
Chapter 3

Design of the application

This chapter will take a look into how the application will be shaped and designed based on information from [2]. The analysis laid out the groundwork for the project, and in this chapter the next step will be explored.

3.1 Creating inclusive applications

In modern society there is a larger focus on making different aspects available and accessible to more and more people. Wheelchair access into buildings, handicap parking and crutches are a few out of many examples of how our lives are adopting the universal design principles – making our society accessible, usable and inclusive to all people regardless of their abilities, age, language or education. This also applies to the digital world, seeing as it makes for a better user experience and increases the potential userbase, thus generating higher traffic to websites and applications. It also increases the likelihood of converting a visitor to a user.

Benton Painter, innovation and strategy lead at EY Wavespace once said “Often, we choose to build products and services for a fictional person with strong literacy, perfect vision and hearing and who can use a touch device or mouse with no problem. Few people are like this.”. Many people have a form of disability, or use weak hardware or have a slow internet connection, all of which alters how people approach a website or application.

3.1.1 The impact on design by color-blind users

The importance of colour has also taken a more central role now that computers support more and more colours. With users coming in all shapes and sizes, with and without disabilities, there are a lot of factors to count in when making software (or web pages for that matter). British Telecommunication Engineering made an in-depth analysis of this back in 1999 [9], and today it is ever so important with all the advancements in colour and how much more central of a role both computers and smartphones play in our lives. According to report Designing for colour-blind users, they state that 1 in 12 men suffer from colour blindness to some degree, whether that be they cannot see certain colours or many colours. When deciding which colours to use, it is important to factor this in, so that certain elements of the application do not become inaccessible to some users. Even for people who are not colour blind it is important to consider colour choices, since certain
colours can trigger certain parts of the brain and either create a pleasant response, or a negative one.

### 3.1.2 Communication through sound

Deaf people are among the more invisible disabilities. We largely rely on sound to communicate and this is often evident on apps and websites that allow people to contact the company through a phone call only. Adding a form so that deaf users can alert the company to their disability and add a comment stating that phone calls are not an option will go a long way in making communication easier for deaf people.

### 3.1.3 Language design

Language considerations have to be factored into the equation as well. According to an international study by the OECD in 1999, 25% of Irish citizens are functionally illiterate – as in “they would have difficulty reading a newspaper, filling in a form or following the instructions on a medicine bottle”. This means that instructions and text have to be kept simple. Large blocks of text are advised against. People who do not speak English as their first language or who do not read very well will find large text blocks extra difficult to get through.

### 3.1.4 Users impacted by mobility issues

While making proactive changes to UI elements and allowing third-party solutions to connect will go a long way to help include more users, it is also important to think of universal design by allowing users to use fewer solutions. Users with mobility problems, as in restricted control over their arms, hands and fingers, might not be able to navigate with a mouse in a precise manner or may not be able to properly touch buttons on a smart phone very easily. Allowing computer users to only navigate by keyboard, and having buttons sensibly sized will make sure users with mobility users are included.

### 3.2 Findings from the focus group meeting

The meeting was called in and a suitable area was found for the meeting. Upon arriving at the meeting, I introduced myself once again to everyone at once, made it clear that this meeting was for research purposes and that this conversation would be logged and used in the project. Each participant was guaranteed anonymity and that the information from this meeting would only be shared in a way that would make it impossible for third parties to identify their identity and in no way would their names, address or other personal information be shared or used. The members of the group then went on to introduce themselves to each other, before I went on to the next step of the meeting.

Next step on the agenda for the meeting is to introduce the topic of the day. Each member received a thorough explanation of what it is they are gathered for. An inventory management application is what is being developed and having the users at the centre of it all is part of the vision the employer and I have for this application. Each member of the focus group were given a mock-up of the initial vision of the application and were asked a number of questions about it. Platforms this application would be available for were talked about, and who the application is
3.2. Findings from the focus group meeting

The focus group was first asked if any elements of the application immediately caught their attention and why. The majority (60%) of the focus group liked the separation of the description and stock list of each product into a tabbed view, with distinction between new and used stock items made using a tag UI-element. The remaining two participants liked the easy-access contact option, as they said that this type of bespoke product often needs to be discussed over the phone for further information. One of the group members who liked the contact option said “This is so handy! I can just click contact wherever I am. I hate having to look all over the place for contact info”, followed by another group member supporting this statement. As a result of this, it became immediately clear that the customers prioritise two key elements: 1) clear, clean and detailed presentation of stock and 2) the ability to easily contact the company.

Following this, we asked the focus group if they had any initial concerns or criticism of the application. One of the group members pointed out that they had a fear that text elements would be too small based on experience with other applications, especially if the descriptions for some of the shelving and racking units are too long. A couple of the other group members chimed in and agreed with this, stating that they have had to help older clients with poor eyesight in their field with using applications from their respective firms due to it not being developed with accessibility in mind. With studies indicating that an increasing number of people are developing degraded vision, this is an important concern to factor into the development of the application seeing as there is a larger focus on making applications more accessible.

After taking in the concerns of the group, we moved on to the next topic: do any existing brands come to mind when mentioning this application? One group member mentioned Dexion, a competing firm in which they used to work. Two other group members stated they were also familiar with this firm. These group members mentioned the storage solutions Dexion offers, however, said company does not have any customer focused solutions that allows visitors to view their inventory. The ex-employee admitted that they did not have any inventory management system during their time working for the company. They said “We kept everything on paper, had to constantly go into the back and check if everything was updated and sharing these documents, yeah, sharing was not easy”. The common conclusion is that this type of business often is lacking in adoption of new technology and e-commerce trends. Following the focus group, we investigated some other competitors and they did not have a customer-focused inventory system. The availability of such a system would appear to be a first for companies in this industry.

With initial formalities out of the way and mapping out the initial thoughts of the focus group – the next topic on the agenda was tackled: What are the biggest strengths of the application based on the mock-up presented and the explanation given regarding the application? The group unanimously agreed that the stock list was an immensely useful feature. Those in the group who have contracted companies to install these types of products in the past found it extremely useful to be able to estimate the price of a product prior to calling by viewing unit prices in the app. While they acknowledged that the pricing won’t be exact, a ball park estimate alone was thought to be a great advantage. One of the group members brought up that other industries use estimates as well, such as the taxi industry. The other group members (those without experience of these products) found the stock list design to be very simple, intuitive and informative. One member suggested adding the ability to see some information about the condition of used stock.
Building on the positive feedback from the previous question, the group were asked what the likelihood of recommending this application was. A large majority of the group said that they were very likely to recommend the application, while one of the group members said they were in-between and that they were neither leaning towards recommending nor not recommending. They all, however, saw huge potential in the application.

In terms of describing the application, most of the group members said that this is an application for viewing and reading about the stock and getting estimates of how much the different products cost. The more technical members of the focus group had greater interest in the news and contact elements of the app.

Regarding their opinion on the UI as a whole, several of the group members pointed out that the store page tab (as seen in figure 3.1) had a very intuitive design and they had favourable opinions regarding it. They found it very easy to navigate and had no problem browsing the selection. The simplistic design was cherished, which supports the design guidelines laid out by Apple and Google, where a simplistic design with the user at the centre improves navigation within
3.2. Findings from the focus group meeting

While the group had a lot of positive feedback to bring to the table about existing features, they were asked about what they wish to see implemented that is not currently present in the mock-up. The group pointed out that the application currently has a news section where the company itself can publish information about upcoming sales or show off their latest work, however they wanted a new stock tab so that they can see what new stock has come in since last time they opened the application. This feature is common among many e-commerce companies and having it another user-centred application seems like an obvious choice.

Another feature the group agreed that they wanted to see implemented was for the news tab to have categories for different types of news. The group had different types of news they wanted to see, and they agreed that what they want to see could change from day to day, and that the ability to be able to sort the news by category is something that would improve their experience of using this app.

A last feature requested by the group was for the app to have a “call me back” function, to allow users to be called back at a better time if the company was unable to take a call when reached out to. The group pointed out that they get deterred from making business with a company that they have to continually reach out to without success.

To round up the positive feedback from the group, they were asked if they see any aspects of this application that performs better than competing solutions. An agreement was reached within the group that the application allows the user to do more prior to having to reach out to the company. They noted some solutions involves having to make several calls for each step of the process and that they preferred being able to do some of the steps themselves. Some of the group members enjoyed the design of this application over that of competing solutions.

After taking note of the positive feedback the group gave on the application, the next step on the agenda had been reached – to locate areas of the application that need improvement. The group was asked what they are unhappy about with the application, and what they believe could have been done differently. One item that caught the group’s attention was the contact page. After they had self-served themselves as much as they could and decided they wanted to reach out to the business, they found it cumbersome to be able to contact the client. The contact information was in plaintext, and they wished that when they clicked on the phone number, a call would be initiated and when the email was clicked on, that it would redirect them to their preferred email client.

Some problems were highlighted by the group from the previous question, but to help understand what they prioritize, they were asked which issues they consider to be major issues, and which ones were minor ones. Major issues within the app were the ones that involved using unorthodox solutions in order to accomplish certain goals. Having to copy and paste text between apps were unintuitive and any solution that involved not being to click or type within the app were time consuming and frustrating to the focus group. They expected the app to be able to solve every goal within the app, without requiring them to move over to other applications manually to solve their goals. Minor issues were targeted as the ones that involved small design changes, such as moving an element or remove unwanted elements.
Chapter 3. Design of the application

Figure 3.2: A look at the old bottom navigation on the products page
3.2. Findings from the focus group meeting

While missing features were brought up by the group, there is also an interest in finding issues with the UI that either look odd, are designed poorly or exclude people based on disabilities or other problems people may have. A couple of the group members pointed out that they have iPhones and that the mock-up looks quite different than what they are used to from this platform. As highlighted in the guidelines for each application, there is an importance in making sure app layouts match that of the overall system to create a good flow for the users. A couple of the group members also mentioned that they found the favourite tab to be redundant, as seen in from the old bottom navigation menu in figure 3.2, since they saw no need to favourite certain items. The other group members agreed, and the favourite page will then merge with the store and form a new products tab.

Certain flaws are present in the application, but would any of them deter the users from making use of the application? The group members had no issues that would deter them from using the app, but they repeated the issue of the contact page which could result in them using the application less. They said they might consider checking other sources for information first before going into the app if they get the impression that the app is lacking in information. Earlier on the group mentioned redundant features and decided to build on this to see if more features were deemed obsolete. The group members pointed out that additional navigation features felt unnecessary and duplicate paths to an element was confusing, so certain navigational elements will be removed depending on platform in order to stay in line with design guidelines for certain platforms.

Now that both positive and negative feedback had been gathered, the next point on the agenda had been reached: Competing services. The group might know about certain competing firms and solutions that neither I nor the company are aware of, so the group were asked about which other application or service they consider to be the main competitors of this app. The group could not think of any particular app the handles the same problems as this one. They went back to Dexion and pointed out that they prefer this solution that involves having to call the company less and be able to self-serve themselves.

To round things off regarding competitors, the group were asked if they believe any changes could be made to get ahead of the competition. The group pointed out previous features they wish see implemented, such as an interactive contact page and call me back function, and said they were not aware of any other changes that could be made to make the application better other than what has been mentioned. Even if the group felt there are no features lacking beside what is mentioned, does not mean that there is nothing that can be added. Users might not always know how to articulate themselves, and observing users is just as important as asking them.

Every point on the agenda has been answered, and before putting the meeting to a halt, the group members were asked if they had anything else to add, if they wanted to go to previous points on the agenda they wish to build on or if there is anything mentioned at all they wanted to talk more about. With none of the group members having any information on their mind they wanted to share, the meeting had reached its conclusion and was adjourned. All of the group members were thanked for their time and contribution and were informed that they may be called back again at a future date if needed and I hoped to see them all again if that is going to be the case.
3.3 Requirements Analysis

A requirements analysis is a capability or set of capabilities that must be met in order to satisfy the terms of a contract or other legal documentation. It is the capability needed by the user in order for them to solve a task. This also helps share the vision of the application with the parties who receive the application. If not all stakeholders in the project understand what the application will be and can do, then surprises will occur, which is never good.\footnote{https://www.visual-paradigm.com/guide/requirements-gathering/requirement-analysis-techniques/}

3.4 System Architecture

System architecture is a conceptualization of the structure and purpose of the application. If the system architecture is good, then it will meet the needs of the stakeholders and allow for further customization to the application, maintenance and embedding in any way as the customer sees fit.

The back-end system architecture will feature a JSON restful API that will help communicate with a database that will contain what is in stock, and a web application written in HTML and JavaScript will allow the company to update and manage the system that keeps track of their inventory. This will allow the company itself to keep track of stock, while also allowing the customer facing front end application to get up-to-date information on the stock situation. The database will be structured in an efficient way allowing for easy overview of the stock and have it processed in a reasonable manner.

The reason for having a web application as opposed to a native application in this instance is due to the company needing access on multiple devices. Whereas customers are more likely to be browsing on-the-go, the company will be utilizing the systems while at work, meaning that a combination of computers and phones will be used. There is also no need for utilizing any specific hardware abilities such as camera or gyroscope either.

3.4.1 API and database management

There are different ways to handle APIs, and a restful API is not the only option. While restful JSON api will be used for this application, SOAP is also a way of creating an API. APIs allow for between applications and machines.

According to the World Wide Web Consortium, or W3C, SOAP is a “lightweight protocol intended for exchanging structured information in a decentralized, distributed environment”. This is opposed to REST which is an architectural style. Communication through SOAP is based on using other protocols such as HTTP or SMTP. SOAP follows strict rules, due to being an official protocol. It is very complex, which could result in slower loading time.

Due to the disadvantages of SOAP, REST was born. Many of the advantages REST offer is the reason behind choosing it for this project. There are more lenient guidelines for REST, it has a more flexible architecture and allows for developers to interpret and implement guidelines how they see fit. This opens up for many different messaging formats, such as XML, HTML and JSON, the latter being what is used in this project. SOAP on the other hand is restricted to XML. Longer
loading time will have a huge negative impact with users expecting fast response times. REST is lightweight and thus has a quick response time, solving another problem SOAP has. Page load time and revenue is impacted by lost seconds.

There are a few constraints that need to be followed:

- The same resource should not have multiple URI
- Requests and responses are the only way client and server should interact with each other
- All the information needed by the server should be in each response
- If multiple layers separates the client and server, the request and response should remain unaffected by this
- Cacheable resources should have a version number to prevent duplicate requests

For web based APIs, it is more beneficial to use REST since it makes data available as a resource, while SOAP makes it as a service. As mentioned earlier, HTML, XML and JSON are some of the formats it can deliver data in, and JSON is also lightweight in addition to being very human readable. JSON can be used with any programming language, despite its name being JavaScript Object Notation. The structure of JSON consist of name and value pairs as well as ordered lists of values. This structure can be used by most languages, thus allowing for easy integration.

3.5 Use Cases

Use-cases is a way to describe how users will interact with a medium. The system takes user input, and the consequence of this input is outlined. In a use case, very simple steps are represented, starting with the intended goal the user wishes to accomplish, and ends with the goal being accomplished.

By having use cases, it is easier to explain how a system should perform, and also get an overview of what could possibly go wrong. Another benefit to having use cases is that by having a list of goals to be accomplished, you can evaluate the cost and complexity of a system.

Use cases include certain elements that are present in other user-centred tools, with pinning down who the users are, and what they wish to accomplish with this application being a common starting point. Afterwards, it is natural to look into the steps needed to take in order to reach the goal and how the medium should react to these steps. Details about the user interface or implementation languages are not touched upon by use cases.

A use case is made of several elements. These elements are:

- Actors – anyone or anything using the system
- Stakeholders – anyone or anything who are invested in the system in terms of behaviour
- Preconditions – what needs to happen before the use case can be initiated
- Triggers – the element(s) that set the use case into motion
- Main success scenarios – Use case with no errors
- Alternative paths – when errors occur, the new paths being taken to reach the goal are the alternative paths
- Primary actor – stakeholders who interacts with the system in order to fulfil a goal
3.6 Testing

Functional testing is a form of semi-automated testing that looks into the relations between the application and the user and the rest of the system. It only looks into what the application does. Functional testing can start with a function to test and go all the way up to first contact with customers. This type of testing takes into account how users would be using the application in real life scenarios. The application will be run on a system and most likely there will be other applications running simultaneously, meaning it will have to be tested under these circumstances to make sure it is crash-proof.

There are certain criteria that should be met during a functional test:
- Each functional test should be applicable throughout the entire project, and results from a functional test should be measurable against a standard output from an already validated output
- As much as it is possible, the functional test should be kept external to the application

Functional testing differs from non-functional testing, where non-functional testing would evaluate how ready an application is by checking the performance for instance, a functional test would only test what the application does. The internal workings of the application is unimportant in a functional test, thus making it a black box test. A functional testing encompasses the whole system, however, there are different types of functional testing and unit testing would only test a “unit”, a method in the case of an application.

There are different types of functional testing, each with their own benefits. The tests can also be split into negative and positive tests. A positive functional test would test with valid data if the application is functional. In the callback function of the application, a positive functional test could involve typing in a name in the name field and a phone number in the phone number field. A negative test on the other hand could involve adding special characters and letters into the phone number field, so as to test how the application handles unexpected data.

Unit testing is the testing of individual units or groups of related units. This type of testing isolates certain units of the code and exercise them. For projects written in C#, a unit can be looked upon as a method. A piece of code is written to test the code. The method being tested will be isolated, and then tested. A white box testing approach will be taken, and it will be done by the developer itself who has insights into the workings of the application. Test cases will be made based of this knowledge, and a list of legal and illegal inputs and values will be made, and the test will be ran against these.

TDD, also known as Test Driven Environment, is a code design technique where tests are written by a developer prior to production code. Traditionally it can be written after the production code, as will be the case in this project. Injecting input into a console application from a command line and test for the output is not unit testing, it is end to end system testing.

The first test will be made on a method that handles a digit-only input, a date input and a submit button so that customers can arrange for the company to reach out to the at a phone number of choice at a later time. The test will check if only allowed values are allowed into the phone number input box, and that the date picker only permits future dates, and only up to a certain point in the future.
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Another common testing method used that will also be integrated into this project is click testing. Learning about behaviour patterns such as where users click first, can provide

3.6.1 Unit testing

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This first test is narrow in scope, which is how unit tests are structured. They allow us to cover all cases. This is in contrast to integration tests which look into how different parts of the system work together in real life scenarios. The method that handles user requests for call backs will be isolated from all other methods, it verifies only a small portion of the application, and requires little resources to be set up, making it very time and cost effective, as opposed to integration tests which are more demanding in terms of setting up a real life environment to test in and testing the whole system.

There are certain properties that help make a good unit test, and a good unit test will be more valuable to the development of the application. A good unit test should be:
- Simple and quick to write, due to many unit tests being made for a project
- Independent of external factors, they should only test a method and check for bugs, since unreliable unit tests that are impacted by external factors can cause more damage since it can claim a bug has occurred even though none were introduced
- Fast and quick to deploy seeing as unit tests are run many times and valuable time can be lost if the unit tests are slow and a slow unit test could also be an indicator that more than just the method in question is being tested
Chapter 3. Design of the application

Figure 3.3: Table overview of the unit test

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Pass/Fail</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Create test data to inject project</td>
<td>Data needed to test functionality</td>
<td>Data injected</td>
<td>Pass</td>
<td>Success</td>
</tr>
<tr>
<td>2</td>
<td>Run test method</td>
<td>Run the test method only without touching other methods</td>
<td>Tests achieved</td>
<td>Pass</td>
<td>Success</td>
</tr>
<tr>
<td>3</td>
<td>Validate results</td>
<td>Validate data collected and go through results</td>
<td>No data collected</td>
<td>Fail</td>
<td>—</td>
</tr>
</tbody>
</table>

- Helpful and readable so that it is easy to know what is being tested and make it easy to address the problem

The unit test for the customer call-back request helped locate an error in the database connection, which was the result of an improper JSON structure and SRP violations (single responsibility principle). A class should be responsible for only one part of a software’s functionality. The class handling the customer call-back request was also handling the get request for products in inventory. By abiding the SRP, the class structure was streamlined, which in turn made the unit tests more effective as multiple functionality was not overlapping in the code and poisoning of the was fixed. The run speed of the application also improved due to correcting these errors.

In regard to conducting a unit test, there are multiple views within the industry on how they should be conducted. A study made by Per Runeson, professor of software engineering at Lund University in Sweden, found that there is no set standard on how often unit tests should be run [10]. While ideally unit tests should run quickly, some of the respondents reported that they had unit tests that could take them hours. This shows that leniency is acceptable in the industry in everything from one-man companies to large companies with upwards of 1000 employees.

The results of the unit test demonstrates the many advantages by including them in the development process, however, the method is not flawless. Based of finding from the aforementioned report, many of the companies expressed that there is an overreliance on the developers do structure the tests and run the tests. There were no systematic approaches to conducting the tests, but the companies relied on the developers’ expertise and judgement. A possible side effect of this is that there could be too many tests cases or too few. Depending on the project, it can also be hard to indentify units to test. As evident in this project, some methods broke SRP, making it hard to merely test “one unit”.

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Test Case ID: 123
Customer: Patrick Gislad
Test Type: Unit test
Test Description: Test customer call-back functionality
Chapter 4

Implementation of the application

In this chapter, we will take a look at the development process. Which software is being used, what programming languages and other technical aspects of this project will be brought up here. Some explanation of how the program matured through the project will also be made.

4.1 General information

The application itself is developed in Visual Studio community 2017 and is being written in C# and uses the Xamarin framework to handle cross platform support between Android and iOS. In the beginning of the project, a test application was made to test out the Xamarin framework, and get a feel of how the framework works. Once a functioning application was made, the code was moved over to what is going to become the actual application. As of February, the application can read text and extract image file paths and display images from said paths in the application alongside text. This will lay the ground work for later when the application will be reading off more information online, and the code will be altered so that it will get image files online rather than rely on them already existing at a specified path locally.

4.2 Initial startup phase

In the early phases of development, the application was tested towards a JSON file stored locally, where the json file contains a few strings and an image file, which is also stored locally. The test has proven to be a success, and more features will be added.

The application only has one page for the smartphone application, and while the current UI does not match the wireframes and do not contain the changes proposed by the focus group, this will be added at a later point. Currently, setting up all the pages and features are the main priority.

With the successful test of having the application extract information from a JSON file and display it in the application, the next natural step in regards to getting data is to having the application making HTTP request in terms of POST and GET with a database through a JSON restful API.
Figure 4.1: Early version of the application as seen in an Android Emulator
4.3 New Page

The application will feature multiple pages the users can navigate between, and there are a few ways to handle this. In this application it was decided that the best way of handling page navigation is through the async function Navigation. PushAsync and then push in a new xaml page, featuring a code-behind file just like the main page has

This form of navigation will exist in the form a bottom navigation bar which will be present on every page. Based on the information from the first focus group meeting, there will be 4 navigation elements present in this navigation bar, and reasonable icons have been selected. In some applications, it is important to keep in mind cultural differences and how different people interpret different icons, which has been kept in mind to some degree in this application, but some leniency exist due to the target audience of the application being predominantly of irish decent and within Ireland.

4.4 Inclusive programming

In the design chapter, disabilities were brought up, and in order to help people with disabilities use the application, certain elements have been implemented. To make the application friendly to deaf users, an email function is implemented so that users may contact the firm through an email rather than just through a phone call. So calling and sending emails are both options that exist within the application, which are handled by simply calling on system functions in Android and iOS. The phone number or email of the company is put into the default email or phone application on the user’s smartphone.

A web server has been created to create a connection between the application and database, as well as store certain files such as images. To facilitate the connection, a PHP script was made, which creates a mysql connection to the database and transfers data to the database as well as extracts data from it.

Due to the implementation of a database, the code for the application had to be changed to accomodate for this, seeing as it no longer dealt with a local JSON file. This change had unintended consequences, as demonstrated in the unit testing in ?? . It failed to retrieve the information from the database, which caused a fatal error. While the PHP file to begin with created the JSON object improperly, fixing this did not solve the application error. After reworking the code, the error was fixed, but a new albeit smaller error appeared, saying that a JSON array cannot be converted to a JSON object, which was solved by making sure that the correct JSON was passed down to the application.

4.5 Web Application and Database

The web application performs CRUD operations on the database, where it allows the user to create new rows in the database for products, read the rows based on user input, update rows for each product and delete rows in the database that the user choose. In the database, there are columns for product names, description of said product, the path to images for the product, how much a unit
of each product is, unit stock, condition of the product and a category to indicate whether there is new stock or not.

Beside the CRUD operations on the database, the C# application also makes GET requests to the database in order to display product information to the consumer. A PHP file acts as the middle on the web server to facilitate communication between the application and the database. The PHP file makes a get request as well, but this request is pointed at the database. As information is extracted from the database, it is put into an object and then serialised as a JSON object, making it very easy for the application to get the information, bind it to a listview and display it to the users.

All of the information that the applications get data from and push data to, is stored on a MYSQLi server. The database holds two tables, one being named inventory and other being named call requests. Both tables each contains a set of columns, with the inventory table holding 9 columns as mentioned in the previous paragraph, and the call requests holding 5 columns which contain data for people who wish to request a call back from the company.

Visual Studio Code was used to write the php scripts. The php scripts are structured according to the DRY principle (don’t repeat yourself).
Chapter 5

Evaluation and Testing

This chapter will be about the testing and evaluation of the project. Someone involved in the development of the project or a third party will test the project, and an evaluation will be made. Due to the nature of this project, a technical test will also be made.
Chapter 6

Discussion

In the discussion chapter the main focus will be on what was achieved, what did the group learn from the project and did the results reflect the goals originally set. What was good, and what could use improvement will also be talked about. How certain aspects of the project could have been done differently will be discussed as well.
Chapter 7

Conclusion

The conclusion will underscore the most important findings throughout the report. It will be an addition to the discussion chapter, and in a way summarise what was touched upon there.

[2] 'Steve Ciemcioch'. 'everything you need to know about inventory management'. '2018'.


