Nacdlow

STAGE 3 REPORT

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Introduction

Overview

This document is a report detailing the smart home software, Iglü (stylised iglü), created by Nacdlow.

To start with, there is a section of the report dedicated to the marketing behind the application which includes a detailed and extensive marketing analysis as well as marketing strategies, goals and programs. The target market is also included there.

The section following on from this gives a full description of the final application design and implementation. This begins with a high-level overview before explaining the design methodology and rationale. From here, this section of the report then goes on to give details on the overall system architecture and database design to fully clarify how the system interacts with different components. There are also comparisons and analysis of the initial GUI design and the final GUI design. Various diagrams are presented here to round this section off.

The next segment is dedicated to the usability study which was intended to be completed. This will explain how the usability study would have been conducted, the reasoning as to why it was not carried out, and then some speculation about how the results would have been used.

An overall evaluation of the project follows on from this which firstly goes into depth evaluating how the group organised itself and planned to develop the application. This will then go on to review the initial schedule that was laid out at the start of the development process and refer to any problems encountered through the different stages. Moving on from the group, this section then looks at evaluating the application itself which contains details including completeness of functionality, key and additional features of the application and if there are any bugs remaining.

Technical, user, and maintenance guides are included in the latter stages of this report. This initially provides the user with information on the technical aspects of iglü - such as installation and setup. Further instructions on how different tasks on the application can be completed as well as further details about backups and administrative features are given. There is a small section after which looks at any future work that is planned.

The remaining two sections are an overall conclusion to this report and appendices. The conclusion ensures there are no loose ends and the report is nicely wrapped up whilst the appendices will contain any supporting documents that are referenced throughout the report and the project diary. This includes details that are not essential to the report but will help in giving background context to the material provided and aid in giving a better overall understanding.

Purpose

The aim of this document is to showcase the work that has been completed by Nacdlow over the last 6 months on the smart home application: iglü. It seeks to provide a final overview of the software which includes details of the finished design and implementation. There will also be an evaluation of the progress and goals initially set out at the beginning of the development process as well as providing evidence of marketing research to highlight how and why the company wants to enter the smart home market.

Marketing

Executive Summary

The new start-up company, Nacdlow, has been tasked with creating a piece of software that allows for control over a smart home. The team consisting of six Heriot-Watt University students have created an application called iglü to meet the requirements as set out by the client, Team Esteem. The purpose of the application is to allow for full control over a user's home through the tap of their phone or a click on their computer.

With the smart home market currently at its peak and expected to continually grow in coming years, Nacdlow believes this is an ideal opportunity to cement their place in the industry. More and more people are looking for software to power their smart homes and Nacdlow has created extensive marketing strategies which first and foremost consists of a clear and concise target market.

On top of the exhaustive background research which has been carried out, marketing analysis has also been completed using the three key frameworks of SWOT analysis, PESTLE analysis and Porter's 5 Forces. This has shown the current state of other companies in the market, highlighting what they have done well and where there are gaps with Nacdlow will look to exploit in order to become competitive.

Likewise, the unique selling point of security has been pinpointed which Nacdlow believes is a feature not currently focussed on within the market and therefore is a good way to attract potential consumers to the application.

In summary, the following marketing plan highlights the fact that there is a gap in the market that Nacdlow will look to fill with the iglü application. Not only that, but Nacdlow has thoroughly well planned marketing measures in place to do so.

Overall Objectives

Nacdlow were tasked with creating a smart home application for home-dwellers which was appropriate in design to consider a range of demographics from young children to the retired elderly. It was pivotal for the client that the application allowed home users to have remote control over devices in their house and that energy usage statistics were accessible. Through the software development process, and from the specification set out by the client – Team Esteem, Nacdlow has set some overall goals and objectives.

Customer Satisfaction

There must be a wide variety of features available to the user so that they have as much control as possible over their household. However, there is no point in having an extensive feature list if they either do not work or are so poorly designed that they cannot be used correctly. Therefore, Nacdlow are ensuring that everything works as expected on the application and the user interface is well created so that it can be used by anyone regardless of age or technical experience.

Employee Happiness And Safety

Nacdlow is lucky to have 6 hard working individuals working on the development and marketing of the smart home application but failing to keep employees happy and safe, could see this work ethic deteriorate very quickly. Health and safety training will be given to all employees so that all equipment is used correctly. A hazard free, safe environment will also be provided by Heriot-Watt University if required and Nacdlow will also ensure none of the employees are working unsociable hours or have too heavy a workload. A work-life balance is very important to the business. This should keep happiness and safety at a maximum which in turn will promote increased productivity. In the future if the company were to expand, hopefully reviews of working from employees will be exceptional allowing Nacdlow to attract the most talented individuals available.

Product and Market Background

Background

In order to meet requirements set out by Esteem, Nacdlow has created a fully functioning, user friendly smart home application that can be used by all ages of people within a household. Due to recent years seeing a considerable increase in phone usage and a slight decline in computer usage (Trifonova, 2018)[1], Nacdlow considered it to be pivotal that the software created was portable so that it can be used on a range of

[1] Viktoriya Trifonova, "How Device Usage Changed in 2018 and What it Means For 2019" globalwebindex, November 20, 2018, accessed April 04, 2020, https://blog.globalwebindex.com/trends/device-usage-2019/

operating systems across devices - and not just solely made to run on a computer. Furthermore, with security being of utmost importance, users will not need internet access in order to use the application.

Product

With hectic lifestyles becoming commonplace in modern society, Nacdlow wanted to create a piece of software that provided some calm and piece of mind by allowing users to maximise control over their home. The idea behind the software is that users can manage devices in and around their home– ranging from speakers to heating settings - via their phone or computer. On top of this, the application will also display a wide variety of statistics so users are able to keep on top of their power usage which can in turn, promote money saving.

Market

In 2017, the smart home market revenue sat at an approximate £2.2 billion with a home penetration rate of 13.4% (Statista, 2020)[2]. This percentage gives an idea of how many households are considered to be smart homes. In the last 3 years leading up to 2020, both the market revenue and household penetration rate have increased to a current standing of £3.9 billion and 25.0%, respectively. Whilst the revenue growth each year is declining, the market is still the biggest it has ever been which suggests it would be a good time to cement a place in the industry.

Moreover, as of 2019 in Britain alone, it has been reported there are approximately over 15 million smart homes - amassing a respectable 60%. Whilst the client, Esteem, is focussing on a smart home in Dubai, the market in the city specifically has some similar characteristics as the UK.

Whilst it is evident that thus far the smart home market has been on a continual upward spiral, the question arises as to whether this trajectory is expected to carry on in coming years. Between 2020 and 2024, it has been forecast that the market will see a compound annual growth rate (CAGR) of 11.7% which will see a market revenue value of roughly £6.1 billion - an increase of £2.2 billion across the 4 years. However, similarly to the years leading up to 2020, the revenue growth rate is expected to continually slow down. In terms of the household penetration rate, the predicted figures suggest that will reach its highest point in 2024 at 44.8%. It is worth noting that the projection of these figures in the smart home market do not detail further than 2024 and therefore it cannot be said whether or not the market will continue to grow past the years already presented.

What must also be considered here is any outside factors that may have influence over the smart home market. It has been suggested that one of the reasons for the market's

[2] Statista, "Smart Home - Worldwide" 2020, accessed April 04 2020, https://www.statista.com/outlook/283/100/smart-home/worldwide

rapid growth in recent years is due to the green initiative being carried out across the world when constructing buildings (Fortune Building Insights, 2020)[3]. It was also proposed in this report that if these green building policies continue to be implemented more and more, then this will inflate the smart home market. Additionally, the smart home market revenue will likely also see a great increase due to continuous development in smart city projects and data communication technology.

Main Competitors

There is not any one dominant company in the smart home market with a number of different businesses holding a similar stature. However, some of these large companies who are considered 'heavy-hitters', do not develop software for control over an entire home but rather specific devices. With that in mind, there are still applications which stand out and can be considered the main competitors of the iglü application.

In terms of a direct competitor, Belkin International, Inc. has a free application called WeMo which allows users to interact with different devices as well as control their heating and water. It also has a nice schedule feature allowing users to set specific times which devices are allowed to be on for. Similarly, an innovative feature called 'Away Mode' allows its customers to have lights come on in the household, if the user is away. This gives the impression that someone is currently in the house to deter people from trying to break in or steal things. It is likely that this is their unique selling point. However, it is clear from reviews that the application is not being maintained as the customers would like with the software not working after device updates. This application also requires the Internet to function which will hopefully allow for iglü to gain a competitive advantage with security being the number one priority and Internet access not being required.

Marketing Analysis

It is pivotal that companies looking to find their way into a market carry out extensive marketing analysis which generally focuses on their product, competitors and potential customers. When analysing competitors, there must be an equal focus on both strengths and weaknesses of the product(s) they offer. This is so companies can examine what is working in the current market and explore how different aspects of the product created can be considered superior. Having considered this, Nacdlow chose 3 key frameworks to aid in the marketing analysis: SWOT, PESTLE and Porter's FIve Forces.

Swot Analysis

Strengths

[3] Fortune Business Insights, "Smart Home Market Size, Share and Industry Analysis 2026" Jan 2020, accessed April 05 2020, https://www.fortunebusinessinsights.com/industry-reports/smart-home-market-101900

- The 6 members of the Nacdlow team all come from different backgrounds with different experiences which allows for a range of unique perspectives of the iglü application. Furthermore, although all members are currently receiving a first class education from Heriot Watt University in Edinburgh, one member of Nacdlow is currently living in Dubai - where the focus of the client is. This extra knowledge of the city and culture is of great use when developing the application.
- As the system would be installed locally, the users' security is maximised with data fully protected and outside access to the system prevented. Not only are there external measures taken to optimise security and privacy, but there are also permission features within the application which allows for certain users to be restricted in what options and data they have available to them.
- The application allows for full control over an entire household. There is no specific part of a home that the application focuses on, meaning users are given a variety of features to use ranging from turning off a light in the bedroom to monitoring energy usage.
- The branding of the smart home application is very unique in terms of name and design. The use of the letter 'ü' in the world iglü makes it stand out and ensures there is no other software available with the same - or even similar - name. The colour scheme and application logo is bold and very memorable - which could lead to brand association. The different aspects of branding mentioned here should also grab the attention of potential users which in turn may promote brand preference and therefore brand loyalty.

Weaknesses

- Being a small start-up company which is new to the market, both Nacdlow and the application severely lack any sort of reputation compared to competitors. Due to this, it may be a struggle to attract customers away from rival companies if a strong brand loyalty has already been created. Therefore, it is pivotal that Nacdlow makes good use of marketing campaigns to try and attract consumers.
- As a whole, the company does not have much support in terms of financial backing. Whilst this has not been a problem in the development stages of the application, issues may arise when it comes to marketing. This is because the company could struggle to run campaigns that reach a large enough audience which in turn could hinder the number of new customers to begin with.
- Similarly, as Nacdlow currently only consists of 6 members, the company may lack the manpower and resources to deal with an initial influx of customers. It may become a problem having to balance maintenance of the application and customer service. Customers may then become frustrated if either the application is not being maintained correctly i.e. not fixing bugs, not adding new features, or their questions and queries are not being answered. This could lead to them moving away from the iglü application and trying elsewhere. Generally, this is not an issue for other companies in the market as they have a large enough team to

deal with different operations in the organisation. It is worth noting that as the company grows, manpower will increase so these issues can be handled better.

Opportunities

- As previously mentioned, there are several countries across the world which are looking to implement green building policies for smart homes. Therefore, new homeowners in these countries will likely consider it vital that the application they choose allows users to monitor their energy usage - a prominent feature of iglü. This is a good opportunity to attract potential customers who have no previous loyalties to any other smart home software.
- With the popularity of gamification trending upwards, it would be a good time for Nacdlow to take advantage of this within the smart home software created. This is a feature that would have to be added at a later date as it is not part of the initial release but it could be a good way to gaining a competitive advantage over rivals.
- There is a big opportunity to increase online presence as currently, Nacdlow only has a basic company website and an Instagram business page. Looking to the future, it would be a good idea to have pages on all social media platforms to increase brand awareness and potentially look into revamping the company website with a further possibility of creating a website specifically for the iglü application.

Threats

- As many of the rival companies currently have an application which focuses on only one aspect of smart home management, there could be a potential issue if one of these businesses choose to make their application centre around the entire home. This is one of the major selling points of the iglü application and if other companies were to do the same, could see a loss of customers and potential customers.
- A potential threat to the application and therefore the company could occur if there is a shift in focus within the smart home market - for example, if there becomes a sudden demand for a specific feature that iglü does not currently have implemented. Whilst it may not be too much of an issue implementing the feature which the consumers want, there could be a problem in getting the message out that Nacdlow's smart home software now has this feature. This is mostly due to a lack of financial backing, especially if this shift in focus comes quickly after iglü initial marketing campaigns in which most of the finances would be used. It may not have too big an impact on current customers at the time, but could cause serious issues in attracting potential customers.
- There is another potential issue regarding the fact that all 6 Nacdlow members are about to enter their final year of study. Not only could an increase in workload from the university cause difficulties balancing the aforementioned and the application, but could also see group members headhunted by other companies

for a job after graduation. This would leave the application minimally maintained and could cause a serious overload of work on individuals in the group if other members were to leave.

A SWOT analysis diagram can be found in the supporting document section at the end of the marketing report.

PESTLE Analysis

Political

- All limited companies must pay corporation tax on their profits and this is something Nacdlow would have to do. The current corporation tax in Scotland sits at 20%, this is expected to drop to 17% by the end of 2020 but may be affected by the current pandemic.
- The UK formally left the European Union on the 31st January 2020 and entered an 11 month transition period. Due to this, there is a lot of uncertainty surrounding how application developers and their consumers will be affected. This may have an effect on how, or if, iglü will be able to penetrate the european market.

Economical

- Due to the global spread of COVID-19, there is once again a lot of uncertainty regarding the economy and how it will look after the pandemic is over. Many people have lost their jobs or are not receiving full pay so it is likely they will be spending less and unwilling to purchase such a smart home system for the foreseeable future.
- Prior to the COVID-19 outbreak, the UK had almost fully recovered from the recession of 2008 and is considered to have the 5th highest Gross Domestic Product (GDP) in the world and the 2nd highest in Europe.

Social

- Whilst it is generally considered that lifestyles are becoming more and more hectic each year, due to a number of different aspects but especially work pressures, many people are looking for a way to make the simple things a little bit easier. This is where people could turn to iglü to minimise stress as much as possible by having full control over their home wherever they go. The aim is to keep the hectic lifestyle outside the house as much as possible and inside the home can be a place for calm - this is where iglü comes in.
- There is a general conception that the elderly are completely inept when it comes to technology, however, research recently conducted provides evidence to suggest that isn't the case and that over 70% of people ages 65+ are now

connected to the world of digital information (Pew Research Centre, 2019)[4]. This is something that has been considered when designing the user interface of iglü ensuring it is as simple as it can be for increased ease-of-use. The hope here is that the application can be used by people of all ages and technical ability.

[4] Pew Research Centre, "Tech Adoption Climbs Among Older Adults" May 17 2017, accessed 07 April 2020, https://www.pewresearch.org/internet/2017/05/17/technology-use-among-seniors/

Technological

- Technology is constantly adapting and advancing with possibilities considered to be endless and automation is a big part of this. There are many manual tasks and jobs both within and outside the home that are being done at least semi-automatically thanks to the development in technology.
- Hardware is becoming more and more powerful allowing for processes to be completed quicker that ever and storage capacities continually growing. As the physical components of computers adapt and change, the software must do the same in order to keep up with these changes. This is something Nacdlow would need to keep an eye on when maintaining the application after release. Failing to do so could lead to poor application performance meaning customers may look elsewhere.

Legal

- The main law Nacdlow must consider is the Data Protection Act 2018. This states how data about customers should be stored and used correctly. There are a number of key points that come under this specific legislation and it is of utmost importance that Nacdlow abides by each and every one of them to ensure the organisation is not breaking the law in any way. It is worth noting that the smart home system by Nacdlow would be installed locally and privacy options are available to users giving them the choice of how much - if any - data is shared with the company.
- Amongst other laws as set out by the government that Nacdlow must adhere to, the Health and Safety at Work Act is one of the most important. The legislation ensures risk assessments are carried out and healthy and safety systems are in place. Nacdlow considers its employees' health and wellbeing to be of a critical nature and is vital the company does everything in their power to keep workers fit, well and happy.

Environmental

- Nacdlow will be striving to take a number of steps to reduce the carbon footprint of the company when developing the smart home application. The will mainly be in the form of reducing energy consumption wherever possible and disposing of electronics in the most environmentally friendly way. This must be done in order to help the environment and keep ethical at all times.

A PESTLE analysis diagram can be found in the supporting document section at the end of the marketing report.

Porter's Five Forces

Threats of New Entrants

The threat of new entrants into the market is thought to be medium to high. As there are many open-source and free resources available on the internet, new entrants do not need much - if any - financial backing in order to create a piece of software for smart homes. Only the technical know-how would be needed in order to physically code the piece of software. Whilst this can be difficult, then are many programming tutorials out there which would allow new entrants to gain the necessary skills. However, there are some companies in the market who have already built up quite the loyalty with consumers which may deter organisations trying to make their way in the market as they believe it is not profitable. The threat of new entrants is also increased due to the forecast upwards trajectory the marketing is going in which allows for more profits available to be spread around.

Power of Buyers

Buyer power refers to the pressure that consumers can place on organisations in order to make them lower prices and increase product quality. In general, buyer bargaining power in the market can be considered medium. Firstly, whilst there are a number of different applications available, very few of these offer complete control over an entire smart home. Due to this and the fact there are more and more people needing software to control their home, then buyer power is low. However, it is worth considering that customers could opt to not make use of their smart home and do everything manually. Likewise, as it would be difficult and unlikely for a consumer to create a piece of software for themselves, buying power is again low. However, as there are numerous other applications on the market - even if many specialise in certain areas of the home - substitute products are available and thus increases buyer bargaining power. It is also likely that the costs of changing software would not be too expensive again increasing buyer power.

Threat of Substitute Products

The threat of substitution refers to the likelihood of a consumer going outwith the market to find a product or service to meet their needs. In terms of the market Nacdlow intends to enter, it is a difficult one to analyse due to it being a rather niche market and there are not many products outside the market that customers could turn to. That being said, there are aspects of the iglü application that could be provided from outside the market. For example, in terms of energy usage and statistics, these details could be provided by whichever energy service the consumer is with. This would be considered outwith the market and therefore increasing the threat of substitutes but overall the level is considered to be low.

Power of Suppliers

Power of suppliers is the pressure that can be placed on organisations by suppliers by raising prices or reducing quality or availability of products needed. Whilst the software itself does not really need any supplies in order to be created or function, general hardware as provided by other organisations must be taken into account. As the application will look to be compatible with many different devices, if the suppliers of these devices were to increase their price or reduce the quality, customers in turn may seek to no longer maintain a smart home and therefore not need software. Whilst these supplies do not have a direct effect on the application created by Nacdlow, there may be knock on effects which leads supplier power to be of medium level.

Competitive Rivalry

This section of Porter's 5 Forces considers how intense the rivalry between organisations within an industry is. This is considered to be high for the market Nacdlow wishes to enter. Firstly, the market consists of numerous different companies all varying in size and capabilities with no clear market leader and thus increasing the level of rivalry. Furthermore, the products available all offer similar features with some focussing more on specific aspects and some focussing on a whole household. There are a couple of companies in the market who may not lead this particular industry but are considered to be conglomerates and thus have somewhat limitless resources available to them which may see them compete to try and break away and dominate.

A Porter's 5 Forces diagram can be found in the supporting document section at the end of the marketing report.

Marketing Strategies

Target Market(s)

Firstly, the main target market would be homeowners. However, Nacdlow believes this to be too broad and general a market to target and therefore will look to target a more specific group of people. This does not mean that groups who do not fit the criteria will be excluded but rather the marketing campaigns and messages delivered will be focussing on particular people that the company believes will be more likely to be interested in the iglü application.

Data has shown that the smart home market is used primarily by people aged between 25 and 44, which is over half of the market at approximately 57.6% (Statista Global Consumer Survey, 2019). This is the age of homeowners that Nacdlow will primarily be targeting. A big reason for this is that generally people in this age bracket will be the decision makers in their household - so will decide which software to opt for - and will

also have basic technological skills as a bare minimum. Whilst Nacdlow aims to target this demographic, it is thought that much of the marketing will still appeal to people of a slightly older age anyway. This is ideal as there are many people of the older demographic who will be looking to make life easier for themselves as they get older so this is a nice added bonus.

Nacdlow will also look at targeting people who fall into the intermediate and higher rate income bands in Scotland as detailed by the UK Government. The main reason for this is the price it can cost to turn a household into a smart home which would generally only be done by those who have disposable income. Nacdlow believes by targeting these two pay grades, they are potentially more likely to either already have a smart home system or looking to invest in one. Another big reason for this demographic specifically is that many of these people will likely be in high pressure, intense jobs which allows Nacdlow to really get across the message that iglü can bring some peace and calm to their home.

Whilst the client, Team Esteem, is looking for an application to use on a home in Dubai, Nacdlow has pinpointed two countries where they believe would be a good opportunity to target groups of people within the country. These two countries being the United Kingdom and the United States of America. The USA has the highest household penetration rate in the world whilst the United Kingdom is seeing one of the highest increase rates in house penetration.

Product Positioning

As Nacdlow is a new start-up company with a low reputation, it is an ideal scenario to be a market follower, meaning that the company is entering a market where firms already have considerable market share. Although this does mean that the ability to attract customers may be difficult at first and the iglü application will be constantly compared to the software created by the numerous larger organisations in the market, being a market follower does have a number of advantages which Nacdlow will look to make the best out of. This allows Nacdlow to scrutinise and analyse the major organisations to see how they have gone about their operations showing what worked well and what mistakes they made that must be avoided. Similarly, major companies have already attracted many consumers to the smart home industry through marketing which will have likely been through expensive campaigning. Nacdlow won't have to do this but are faced with another issue of other companies already having brand loyalty.

Strategic Intent

Nacdlow will be continually looking for ways to both develop the application - by adding new and improved features - and improve the branding of the organisation and the software. It is likely that Nacdlow will employ offensive and defensive strategies where needed and appropriate. For example, offensive strategies may include something simple such as cutting prices or trying to tap into countries the market has not focusses on thus

far. Nacdlow is also a strong advocate of low-cost guerilla marketing campaigns in order to attract attention if needed. Once established in the market, defensive strategies may need to be considered.

Stakeholders And Beneficiaries

There are a number of different groups which either have an interest in Nacdlow and iglü or will be benefited by the development of the application. These are listed below.

Team Esteem

Team Esteem are the client behind the application and Nacdlow have been, and will remain, in constant communication with them. Timely and honest updates have been given to the client ensuring that they are happy with the progress that has been made. receiving further details of features they would like as well as how they vision the overall look and feel of the application. Their satisfaction of iglü is of very high priority.

Heriot-Watt University

Heriot-Watt University has been the financial backing behind the organisation when developing iglü. They provided development tools where necessary whilst also allowing the members of Nacdlow to use meeting areas and rooms where required. The university also provided some of the technical expertise needed prior to the development of the application. It was also through the university that the opportunity to work with the client was made available.

Homeowners

Homeowners are the primary target market that Nacdlow is aiming to develop the smart home software for. Ultimately viewed as customers, it is vital that communication is kept to a maximum where possible to receive feedback on iglü and make changes where appropriate to keep them happy.

Residents

It is also important to consider that there will be potential customers who do not currently own the home they are living in - and therefore not homeowners - but are still in a position to have a smart home system installed. This group of people are also customers and should be communicated with on a regular basis just like homeowners.

Marketing Goals

These goals are specific objectives that Nacdlow would like to achieve through marketing. It is important that these are measured regularly to give an idea of how successful they are.

Increase Brand Awareness

As Nacdlow will be entering the market as a new start-up company with no reputation, it is important that measures are taken in order to gain the brand some exposure. This is something that can be done very well through social media channels in which the company can try and gain followers which will increase awareness of who Nacdlow is and the application that is offered. It is also of vital importance that the application is of a high standard when released as to begin with, much of the brand awareness will come through word of mouth. If the application is incomplete or of poor quality, people who try the software will not be wanting to recommend it to anyone which is very important in the early stages of increasing brand awareness.

Increase Number of Customers

Increasing the number of people aware of the brand is one thing, but Nacdlow must also turn these people into consumers of iglü. Once people know what the company is about, the message must be clear as to exactly what it offers and why they should use the product. The ideal scenario would be that everyone who has a look into the company then goes on to use the application. Unfortunately, that is never the case but Nacdlow aspires to create as high a turnover of people using the software as possible. This can in turn create brand engagement which is of great importance to any successful organisation.

Highlight Proactive and Reactive Nature of Business

Consumers demands and needs are constantly changing over time and businesses must do the same in order to satisfy what the customer wants. Nacdlow must ensure that the idea of customers being the number one priority is well marketed. So after an initial increase in customers, it is pivotal that the company shows it is reacting to feedback on the application and is making changes as requested. This highlights that Nacdlow cares about what the customers want from the application and is striving to achieve this. Also, it is a good idea to emphasise that iglü is constantly being developed with new and improved internal ideas so the customers can see how important the needs of the users are valued. The message here being that Nacdlow is going above and beyond for the customers.

Marketing Programs

Marketing Mix

Product
Both the client and customers are expecting a fully developed, well designed piece of software that provides users with a range of features in order to better interact with their home environment. On top of this, the application is expected to promote energy saving and efficiency and also continually be maintained to fix bugs and make improvements.

Price
The application itself will be entirely free to download but Nacdlow will look to its competitors to analyse any further prices - such as installation fees - that may need to occur in order to turn a profit. A marketplace will be available for the application in which users can pay extra for add-ons.

Promotion
Currently, there is only a company website which has been setup. However, as Nacdlow is a very distinct name, if people were to come across the organisation through one of its social media pages and then use a search engine to look the company up, this website will be at the top of the list. From here the message needs to be clear as to what the application offers and why they should give it a shot. The plan is to create a website for iglü, which again has a very distinct name, so will likely appear high up in the search results list.

An extensive marketing campaign will be carried out to try and attract people of the target market. It will have to be clear and concise showing the key features of the application and what great benefits it can bring to the customers. Much of this campaign will likely be adverts placed online for potential customers to see.

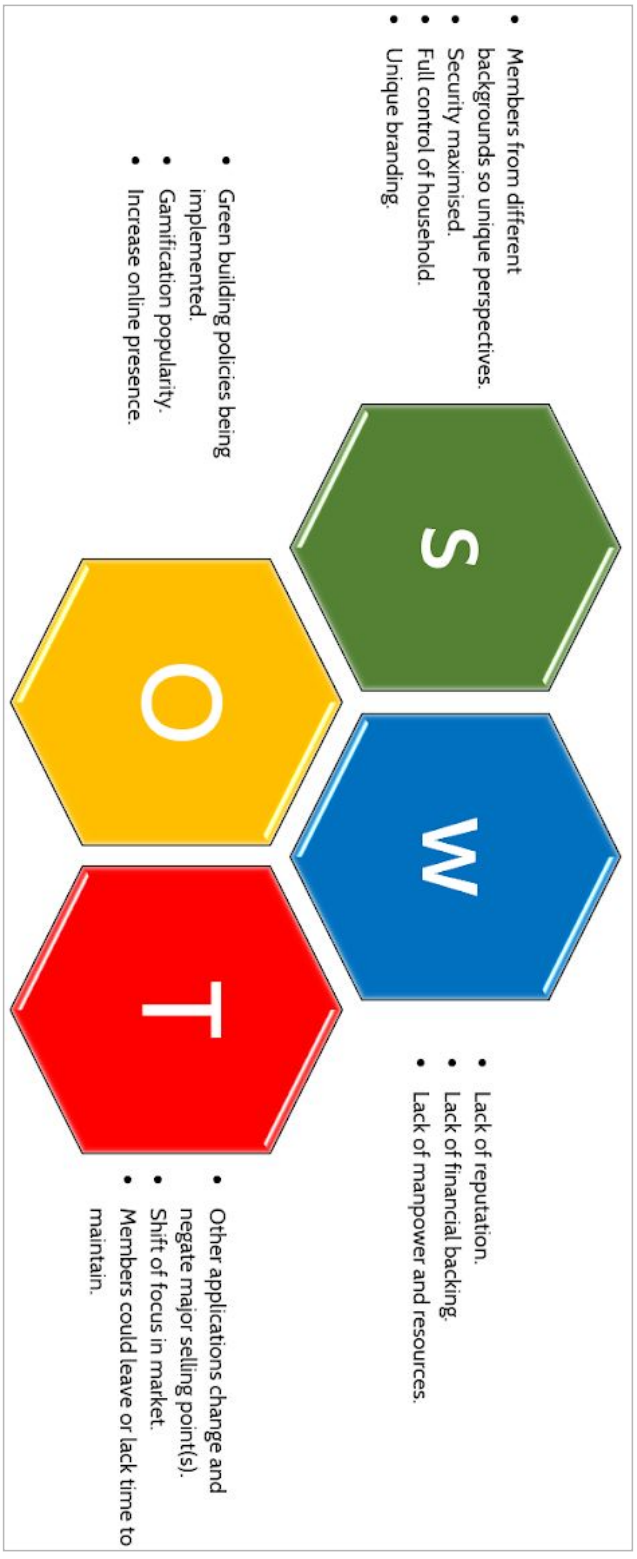
Place
As the server will be installed locally at a customer's household, the company will need to send out a technician to go and set this up. If a customer has any problems or issues with the system then Nacdlow will provide first-rate customer service remotely to help them out. If the issue cannot be fixed remotely, then they can pay for a technician callout. The software will be available to use on any computer, tablet or smartphone.

Unique Selling Point (USP)

iglü has a number of critical features which separates it from the other applications currently available on the market but there is one thing that stands out more than any other: security. The public are continually growing more concerned over data privacy and therefore security is of utmost importance to Nacdlow with the company striving to guarantee that all software created will have maximum security measures taken to protect customer's sensitive information. iglü is first and foremost centred around security, unlike many other smart home systems. This can be emphasised by the fact that everything would be stored locally to the customer and an opt-in service in place allowing full control over what data - if any - is shared with Nacdlow. Whilst users will have to connect to the Internet when setting up the system or for downloading system updates, a full offline mode is available so that the application still works even when not connected. This ensures that unauthorised, outside access cannot occur so users can have complete peace of mind when it comes to the safety and security of their home. Furthermore, there are further steps taken within the application - such as user permissions - to ensure that specific controls and data can only be used or seen by those who are given authorisation to.

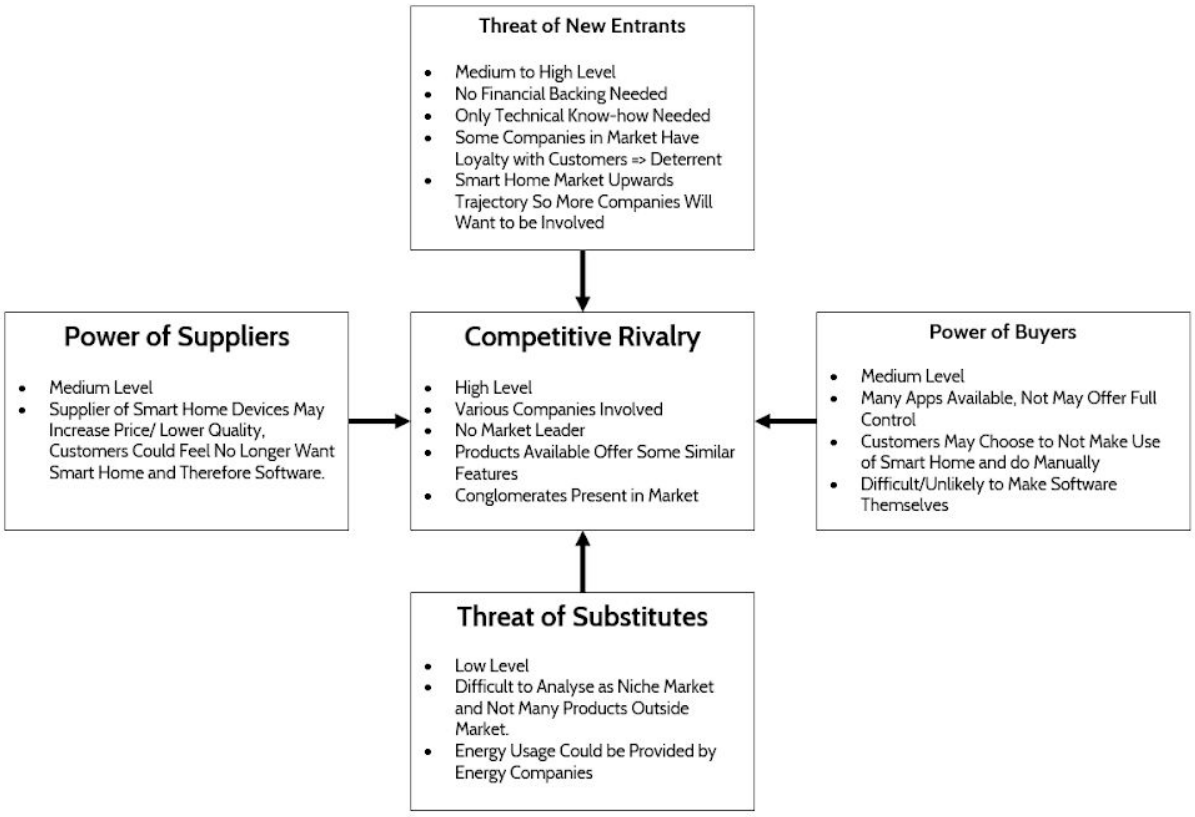
Supporting Documents

SWOT Analysis Diagram



PESTLE Analysis Diagram

Porter's 5 Forces Diagram



Application Design and Implementation

Introduction

Purpose

The purpose of this section of the document is to provide insight on what Nacdlow have achieved this past year in their implementation of what they believe is the smart home app of the future: iglü. This will allow any stakeholders to gain information about how and why everything was developed the way it was.

Overview

This section will first cover a high-level overview, going over the system as a whole and some initial decisions that are made in both the design of the front end and the implementation of the end. Proceeding this there will be in depth discussions about the system architecture and the database design of the system, showing how everything pieces together. After that UML diagrams will be presented to further give a visual insight into how the system works for all users clearly showing how everything fits together from a visual standpoint. Finally this section of the report will go over the history of our user interface design, starting from the mock up stage showing the progression to the initial implementation and eventually the final user interface design going over all the major points in the design, including the accessibility features and the reasoning behind Nacdlow's decisioning.

Scope and High-Level Overview

Design Methodology

Nacdlow developed their system using an adapted Agile methodology similar to the Kanban system. Every week the team would meet up to discuss what they have achieved in the past week, what they will achieve the following week and how long they expect to finish their task. Once every member agrees the task is relevant for completion it would get added to the Gantt chart and allocated to a member, sometimes multiple members. These sprint meeting took place throughout the development of iglü and its subsystems to insure Nacdlow stay on track and meet deadlines set by the customers.

Design Rationale

Architecture

The application has a modular structure, which allows developers to easily maintain each module of the project. This separation of concerns allows organisation of modeling and computing different aspects of the project. It also allows modules to be switched in the future. For example, the simulation module could later be replaced with an interface to a real-world physical home.

Framework

Two main frameworks were used to Implement iglü; for the frontend Material Design Bootstrap (MDB), and for the backend Macaron for routing and XORM for the relational database. The use of frameworks greatly increased productivity and lowered the time for development drastically.

Front-End Development

Material Design Bootstrap (MDB) is the front-end framework used to lay the foundation for a majority of the user interface elements in the web app. MDB was chosen over other front-end frameworks due to its Material Design design language and vast array of pre-built components, speeding up front end development significantly while keeping the look and feel of a native app, as well as giving the ability to create a powerful desktop solution. Using MDB allows the developers to make quick and drastic changes fitting in with Nacdlow's adopted Agile methodologies. As the free version of MDB is an open source[5], MIT licensed project, this allows Nacdlow to create products for commercial use.

Data Model

The application uses XORM (an Object-Relational Mapping library), which manages creating schemas from the structures (structs) and querying the database. In Nacdlow's case, the SQLite driver is used, which is reliable even for medium or high traffic websites.[6] Since this system would be running in homes, SQLite is a good choice. This reduces the time taken setting up a MySQL server, and getting it connected, then remotely managing this server. With this setup, the database driver and its configuration is shipped with the binary.

[5] "License - Material Design for Bootstrap." https://mdbootstrap.com/general/license/. Accessed 5 Feb. 2020.
[6] "Appropriate Uses For SQLite." https://www.sqlite.org/whentouse.html. Accessed 6 Feb. 2020.

Development Environment

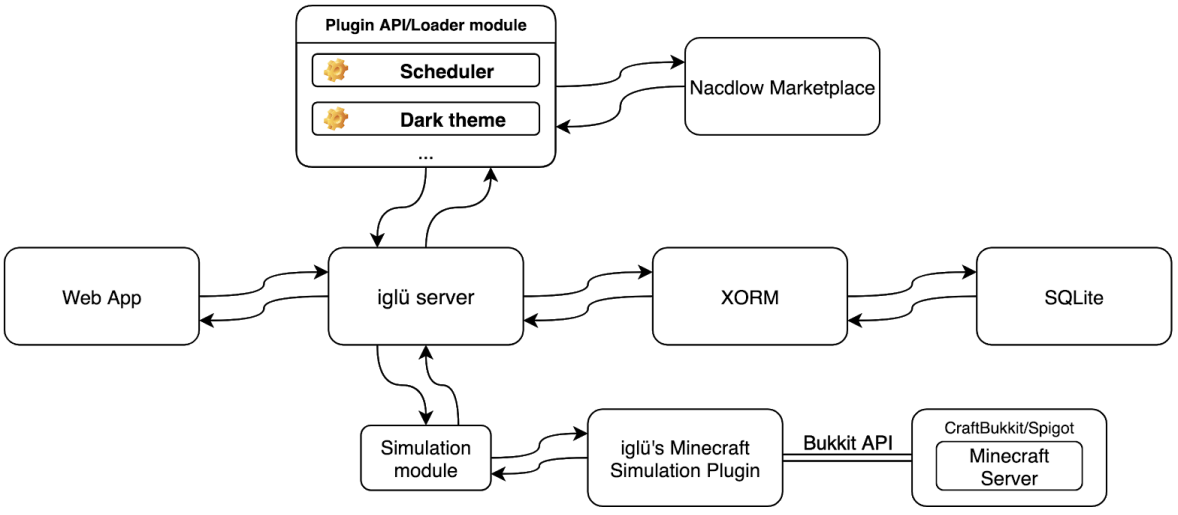
The development team has been using GitLab with the Git version control system. This allowed the developers to work on the same project and files at the same time, merging their changes at the end. Furthermore, the continuous integration provided by GitLab is used to automate testing and building the project.
Developers were not confined to specific development environments or operating systems, therefore a diverse range of IDEs, operating systems, and browsers were used with the benefit of a wider range of devices and ecosystems to test the implementation of one developer.
The application currently runs on a browser as a PWA allowing the user to natively use the app on whatever desired device, this is very important to create a seamless and intuitive installation process.

System Architecture

Client-Side

The user has a choice to interact with iglü using a mobile device via a PWA or on a desktop web browser, they will be greeted with a user interface allowing them to seamlessly interact with the underlying system without the need of having any external software or dependencies.

Application



This structure consists of a Progressive Web Application (PWA) rather than a native application due to the considerable reduction in 'duplication of effort', as there can be a single interface which works on both mobile devices and desktop computers. Another advantage of choosing to make the application web based is that it will be, effectively,

platform agnostic. A good example of this way of thinking would be to look at real world companies that are replacing their native applications with web apps.[7]

Database

For the backend database Nacdlow uses a Go based object relational mapping library called XORM, it allows the developers to easily create schemas and update the database without having to deal with sql queries saving time and allowing seamless development of new features. One of the features of iglü is the ability for it to work offline increasing the users privacy and reliability of the product, to do this iglü stores all the users data locally in an sqlite database rather than the cloud.

Simulation

There is an optional Minecraft Simulation Plugin, which mirrors the simulation on a Minecraft world, allowing you to interact with the simulated home. However, Minecraft (and the Minecraft simulation plugin) is optional for the operation of the simulation module. The reason for the existence of this optional plugin is to demonstrate to the clients that an operational interface has been created. The lights in Minecraft show up dynamically on the search devices page due to the iglü plugin API. It is important to note that there are two different plugins, one for the plugin API that has been developed, and one for the Bukkit API which is a free and open source Minecraft server extension (or modification) built by the community to provide an interface to the proprietary Minecraft server internals. This allows us to observe all sorts of in-game events and modify the state of the game world.

Plugins

The iglü server also supports loading custom plugins from the iglü marketplace, which is hosted centrally by Nacdlow. This feature introduces new functionality to the smart home, such as adding devices/software from third party companies. The plugins are pre-compiled binaries downloaded directly from iglü Marketplace's repository.

The plugins on the marketplace are stored in a format similar to popular Linux package managers' repositories, so there are binaries available for different CPU architectures and operating systems. This is because plugins are compiled binary applications and are compiled and linked to a specific architecture and operating system libraries. Before the plugins are uploaded on a repository, the plugins are compiled, binaries are stripped (removing debug information), checksummed (creating a SHA256 hash, used for automatic verification when a plugin is downloaded), and compressed (in xz format). A manifest file is also included with the description of the plugin, which is used for displaying information of the plugin to be installed on the confirmation screen on iglü.

[7] "LastPass is discontinuing its native Mac app and replacing it ...." 29 Jan. 2020, https://www.theverge.com/2020/1/29/21113505/lastpass-native-mac-app-store-replacement-web-safari-extension-update. Accessed 31 Jan. 2020.

Plugins currently provide a list of available devices, which are pulled when the “search devices” page is loaded. Also the plugins may have configuration fields, which are in a key-value format. Each key-value configuration pair a plugin has may be either user-specific or global, and it supports text, number, boolean, and selection value types.

Furthermore, plugins may provide web extensions, which are extra CSS and JavaScript snippets, and it can be limited to certain paths (using a RegEx match). This allows plugins to add extra components to be loaded with the page. These features allow plugins to implement anything they want, and since plugins are run as a separate binary, there is no limitation to what a plugin does.

Deployment Environment

The server is written in Go, which means the result is a compiled binary with all of the dependencies. This server would be running on a System-on-a-Chip (SoC) computer, which would be installed in the home’s network. This allows users to interact with the system instantaneously, even without Internet or if Nacdlow’s servers go down for any reason.

This system would not require any extra software to be installed (such as a database or web server, as this is bundled with the executable); not even Go is required to run the binary. This reduces setup time and allows Nacdlow to have greater control on the technology stack. For example, an update to the server’s binary will also update all of the dependencies, such as the SQLite driver, database engine, and/or the iglü custom-built web server.

The compiled server binary is bundled with all of the dependencies, and it does not require a runtime to be run (unlike other languages). Go would only be installed on the device if it is used for active development, and cross compiling with Go is trivial. The compiled iglü server binary can run on the most minimal Linux distribution without additional packages, software, or libraries installed.

Web Infrastructure

During the course of development, Nacdlow have created several different domains under the nacdlow.com domain.

- nacdlow.com
    - A marketing Wordpress website.
- blobs.nacdlow.com
    - The server which stores the help video files (help section of the settings).
- demo.nacdlow.com

    - Virtual expo demo login information and the Minecraft multiplayer server information.
- app.nacdlow.com
    - Virtual expo iglü app instance, linked from demo.nacdlow.com.
- local.nacdlow.com
    - Local testing domain, this is usually set on the developers machine to the loopback address. The website is up so an SSL certificate can be generated, and show a message when the hosts file or DNS server isn't set.
- market.nacdlow.com
    - The iglü marketplace, which hosts the plugin descriptions and the plugin repository.
- download.nacdlow.com
    - The site which contains the executable binary files for the iglü server, which is used in the group project submission.
- payment.nacdlow.com
    - The Stripe test payment gateway for the marketplace.
- wiki.nacdlow.com
    - The team's internal development wiki, which is password protected with GitLab.

A mail server has also been set up, and each member of the team has an email (such as numan@nacdlow.com or humaid@nacdlow.com). A general broadcast email address is available as contact@nacdlow.com. All emails are forwarded to our Heriot-Watt University-assigned emails.

Database Design

High Level

An Object-Relational Mapping library (XORM in this case) is used to convert data between a database and the objects in Go, providing developers an interface to the object database without worrying about writing SQL queries or caching. Transactions are also supported in XORM, which introduces atomicity and consistency, easily in the Go codebase.

SQLite is used as the database back-end instead of popular solutions such as PostgreSQL or MariaDB. These alternative database solutions run as a separate program on the system, which needs to be set up initially, and probably managed further on for each box. This increases the maintenance cost, as each box needs to be configured, and any issues need to be individually addressed. With SQLite, the entire database implementation is bundled with the iglü server binary, and no system package or library is required. This gives Nacdlow full control on the software stack. SQLite has been tested on relatively

high-load websites with large datasets, which it could handle without issues.[8] [9] Even though high loads are not expected in software deployed locally, the headroom adds flexibility.

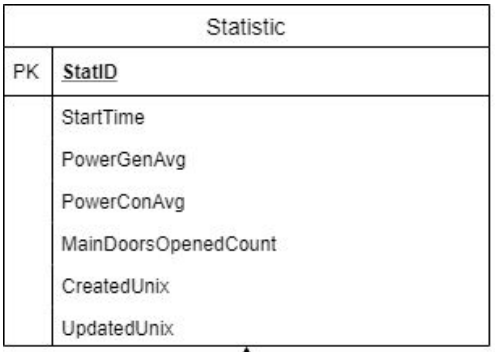
Querying

As the database is implemented through the use of XORM an object-relational mapping library, so no full SQL queries have been implemented, with the exception of prepared conditions.

Database Tables

There are 7 main tables implemented by nacdlow: Statistic, RoomStat, Room, Device, Alert, User and Schedule. All these tables have a key part in the implementation of iglü and all play a crucial role.

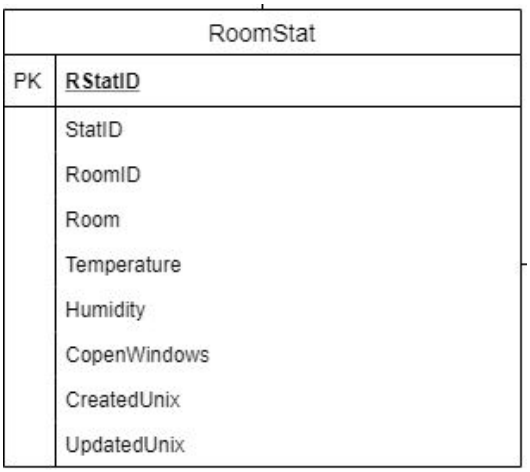
Statistic Table



This table is responsible for providing statistics for the smart home as a whole, main statistics such as the total power generation and consumption as well as missiciolanios information such as how many doors and windows are open to help give insight to the user on how to quickly save power.

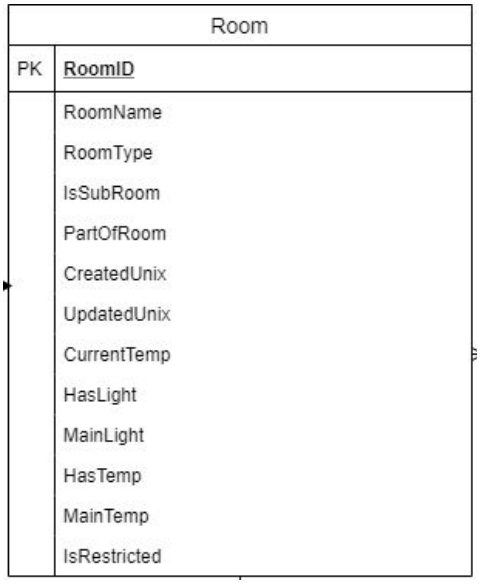
[8] "Implementation Limits For SQLite." https://www.sqlite.org/limits.html. Accessed 3 Feb. 2020.
[9] "SQLite FAQ." https://www.sqlite.org/faq.html#q19. Accessed 3 Feb. 2020.

RoomStat Table



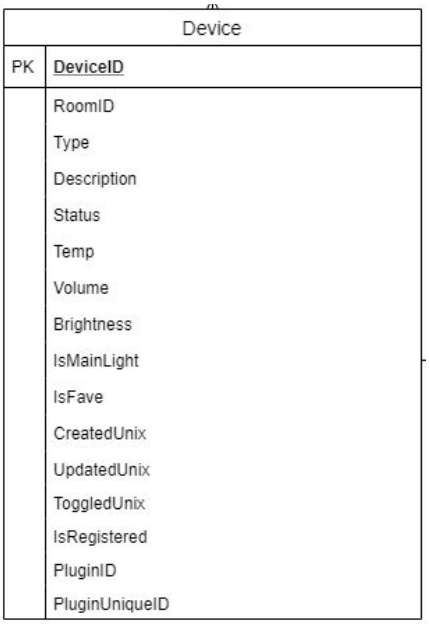
This table gives more in depth statistics about each specific room storing information about the rooms temperature, humidity, how many windows are open,

Room Table



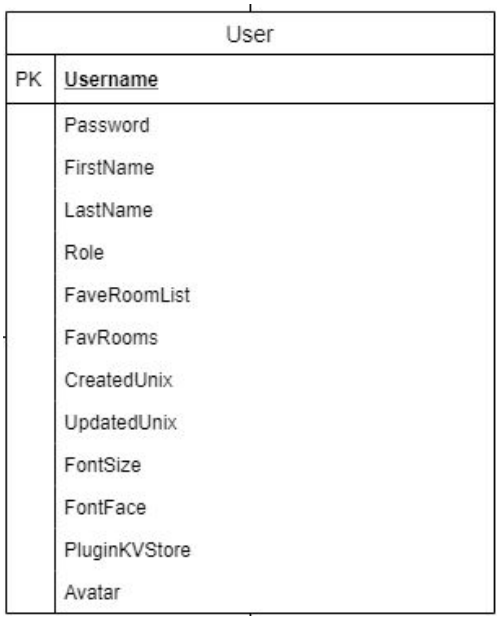
The room table stores all the key information about a specific room, things like; the room name, room type, the current temp of the room, the main lights and temp devices in the room as well as any rooms which are neighboring or connecting to itself. There's also a field to keep track if the room is restricted or not which can be set or changed by the admin.

Device Table



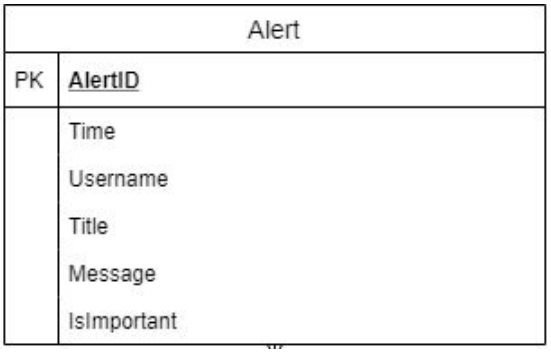
This table stores all the information about a specific device, information such as the device type, the status of the device, the temperature of the device (if its a temperature) device), the volume (if its a speaker/ audio device) and the brightness level (if its a light device). It also checks whether or not a device has been marked as a favorite by the user and whether or not it is a main device. Additional fields were added for the plugin system.

User Table



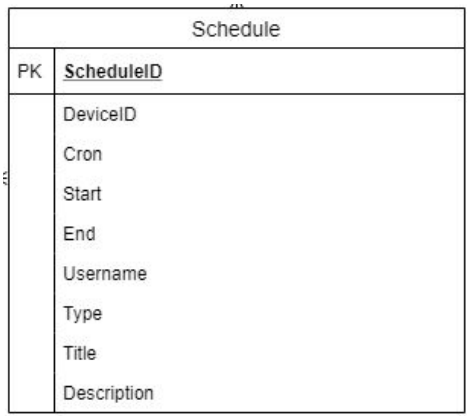
The user table stores all of the information regarding the user. It has fields for storing the passwords, names, the list of favorited rooms, the user permissions level as well as all the user configs such as the font size, font face and avatar.

Alert Table



This table was used to store all the alerts from a user, storing the time the alert was sent, the user it was intended for, the title and message of the alert and finally a field to keep track if the alert is important or not.

Schedule

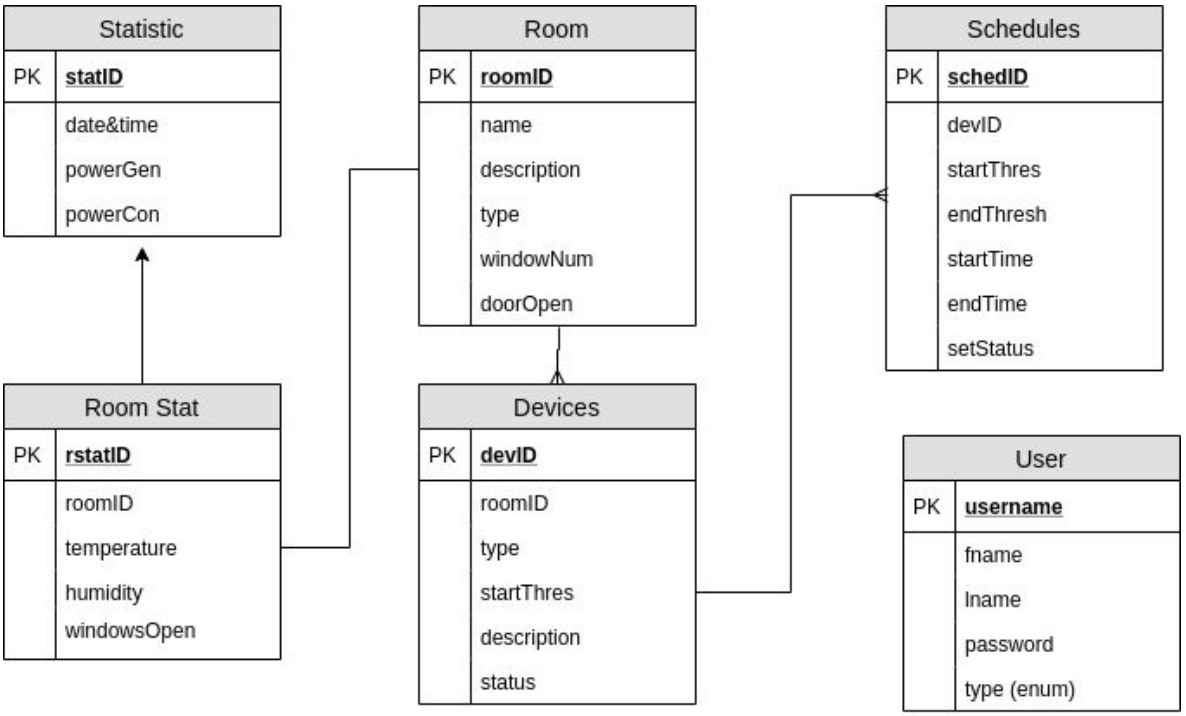


The schedule table was implemented to store and keep track of all the schedules a user would create in the app, it stores the start and end time of the schedule, keeps track of cron statistics, the user the schedule belongs to as well as any title or description the user chooses.

ER Diagrams

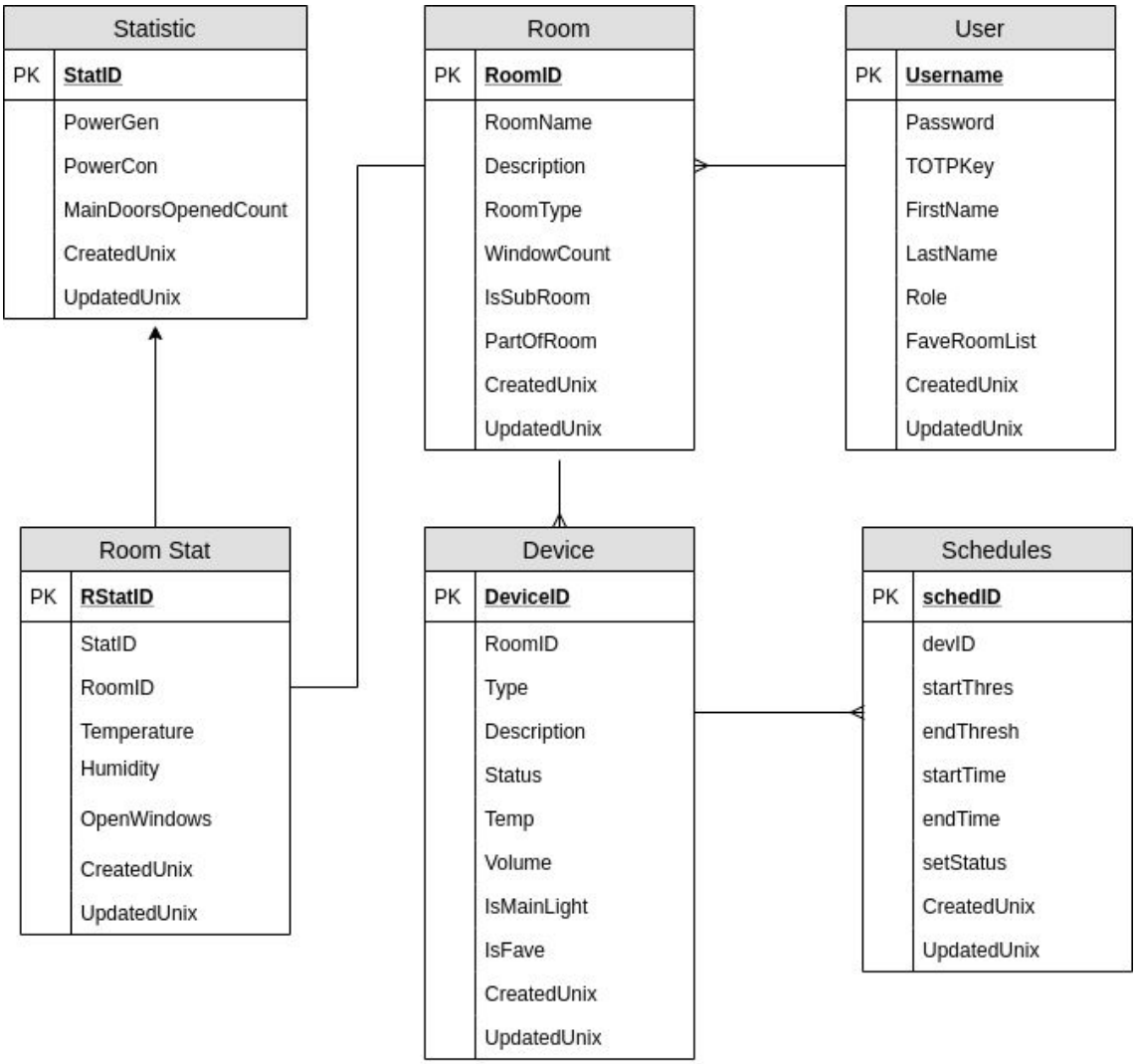
First Iteration

This was Nacdlow's first interpretation of how the database would be structured, it was the base of the implementation however many components were initially misplaced and even missing



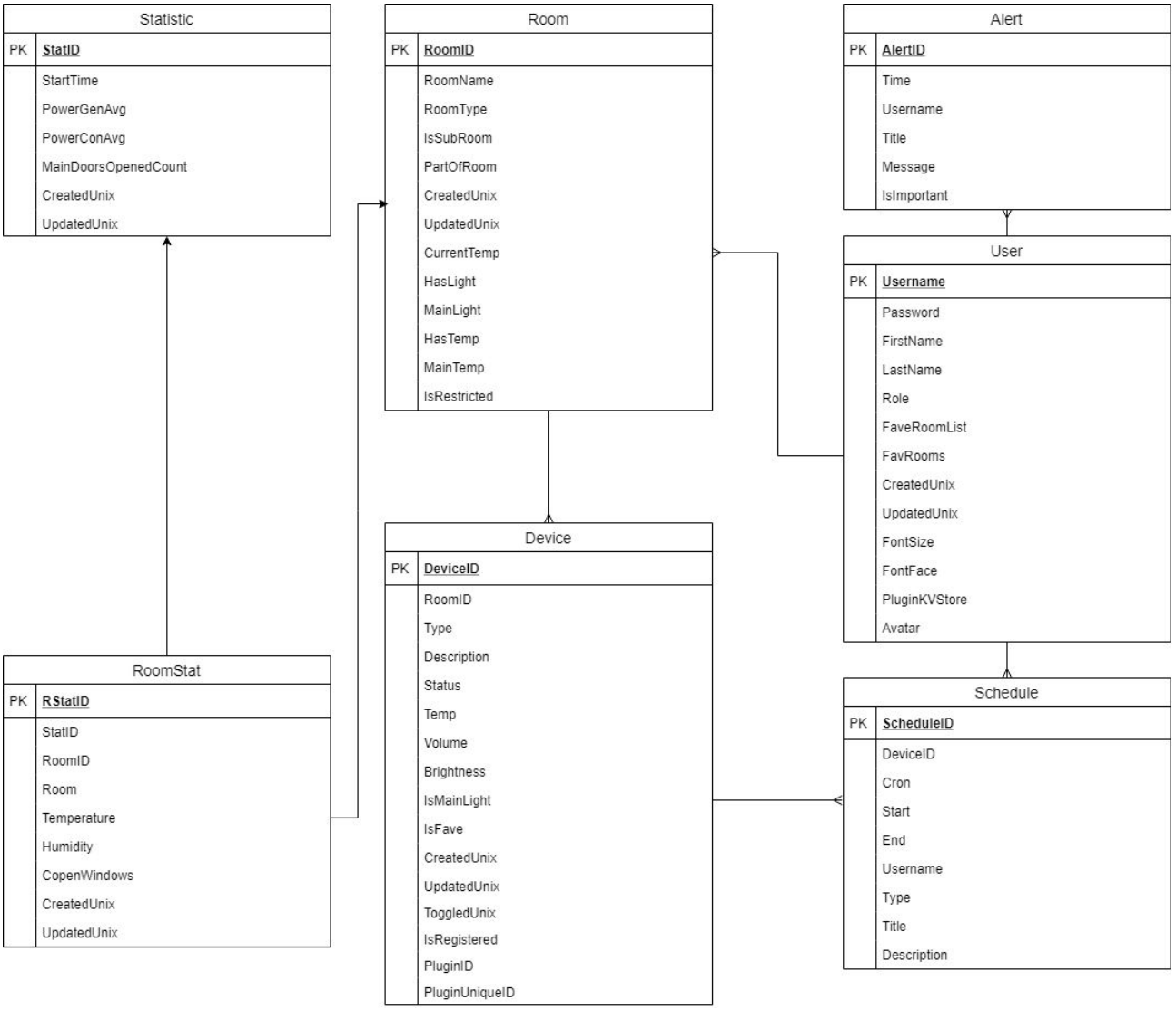
Stage Two Iteration

After the initial implementation and during early front-end development it was soon realised more depth was required for the database design, thus just at the end of the stage 2 Nacdlow designed the following:



Stage Three Iteration

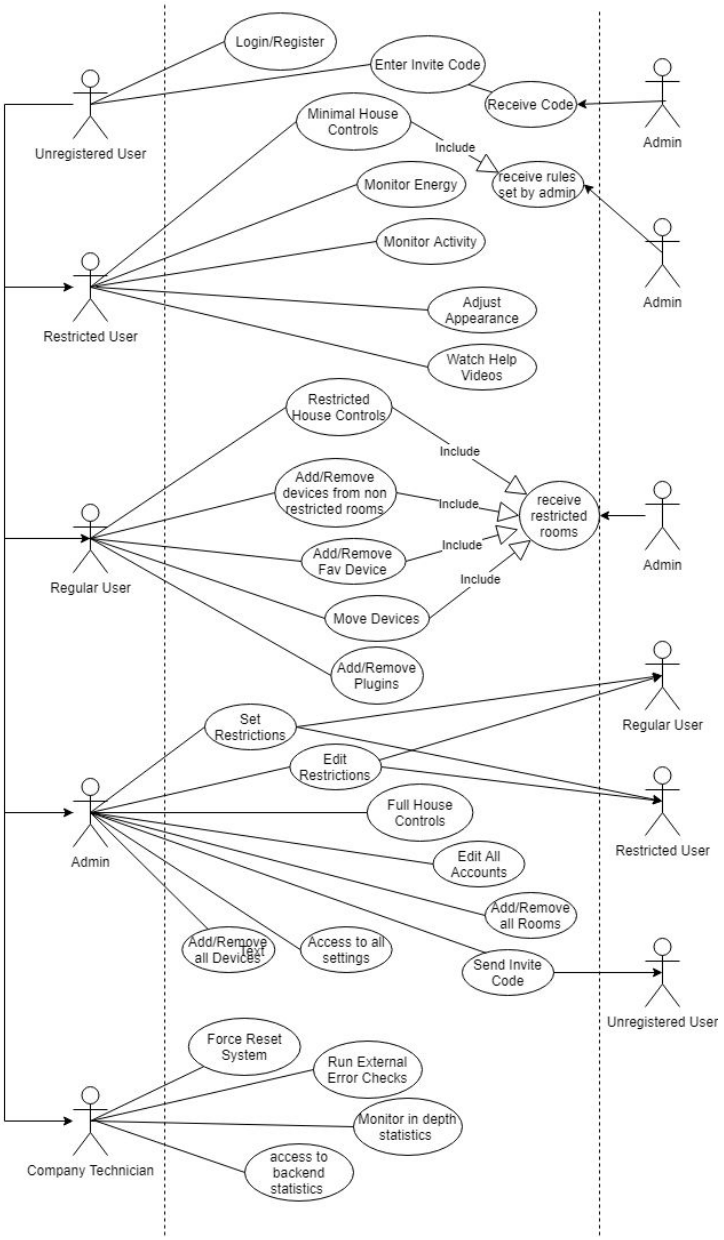
For stage 3, nacdlow set out to implement as many features as possible, and thus the database as a whole needed to be updated drastically, a new Alert table had to be added to allow for in app notifications and many new fields were required to be added:



UML Diagrams

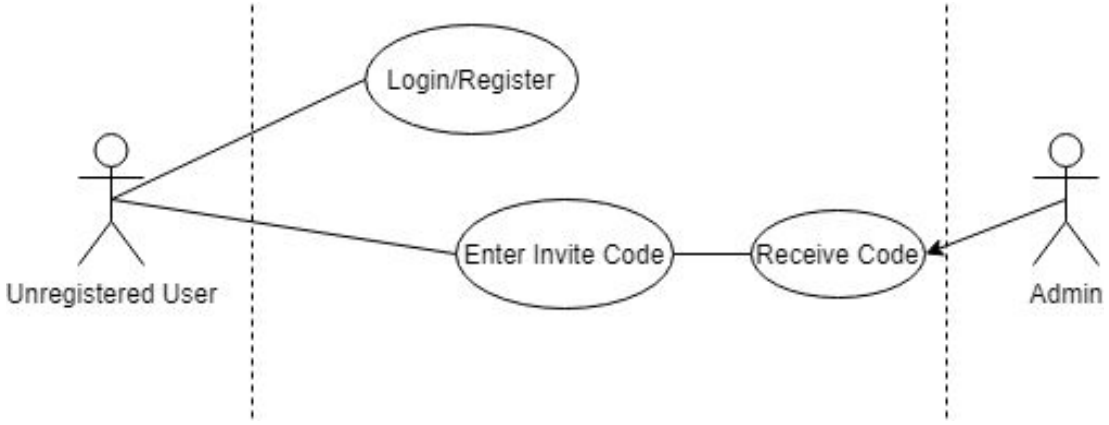
Full System Use Case

The target users of Nacdlow's software application are not presumed to be competent with PWAs nor to be tech savvy. Due to this presumption, the system must be well designed and have strong accessibility and help features. As a result of this, Nacdlow takes into account that all the functions of the system are explained clearly and laid out in a universal manner. Users of this application will interact via either:a smartphone, central control unit, another form of computer or all of the above. Because of this, Nacdlow made the assumption that the user is already comfortable completing tasks on a computerised interface, and has experience with creating accounts and accessing such accounts using usernames and passwords.



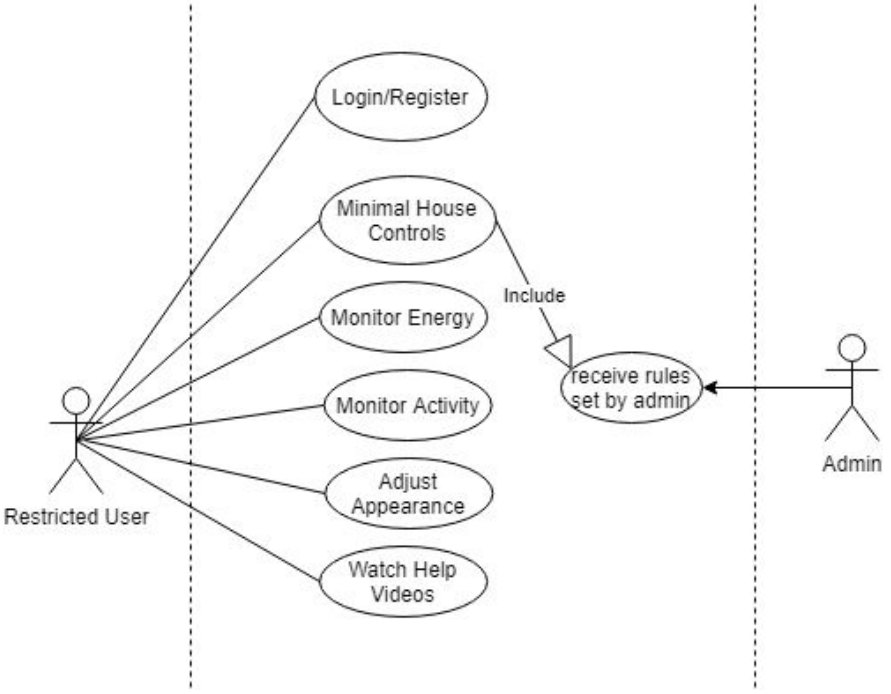
Unregistered User

iglü accounts for unregistered users who access the web application. Users browsing iglü will not have functionality until they have logged in. Hence, if they are an unregistered user, they will be either a potential customer therefore will be able to register, or they shall be a guest/family member of the home owner and therefore have the option to join an existing home using an invite code provided by the Amin user of that house.



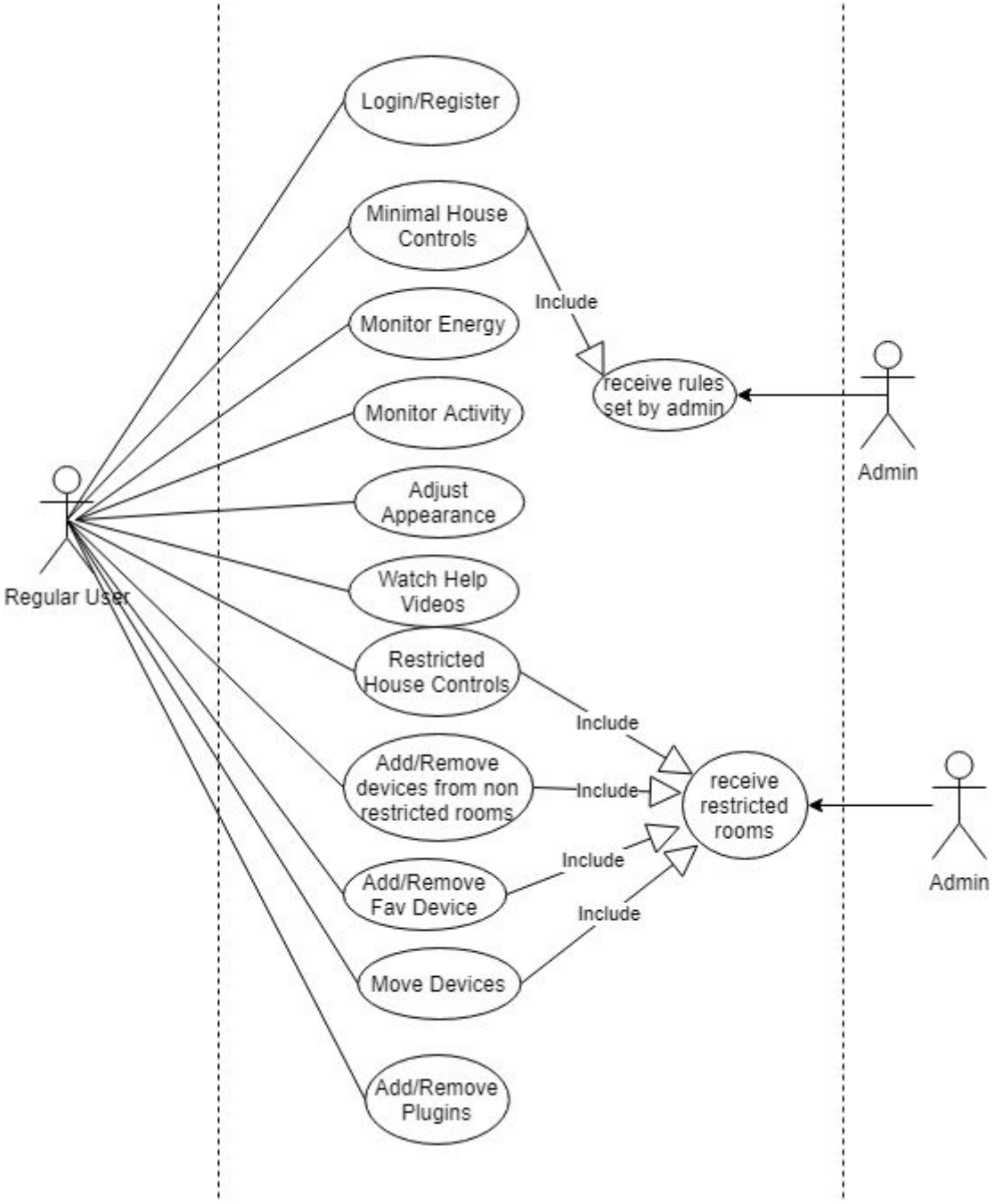
Restricted User

Restricted users have very limited control compared to regular users. The purpose of the restricted user is to give access to guest or non regular occupants of the smarthome giving them extremely limited functionality allowing them to still interact with the home but only specific rooms and devices the admin has set. Restricted Users also have access to the Monitoring of energy and activity, adjusting the appearance of the application and they are able to watch the provided help videos. This will help promote the application.



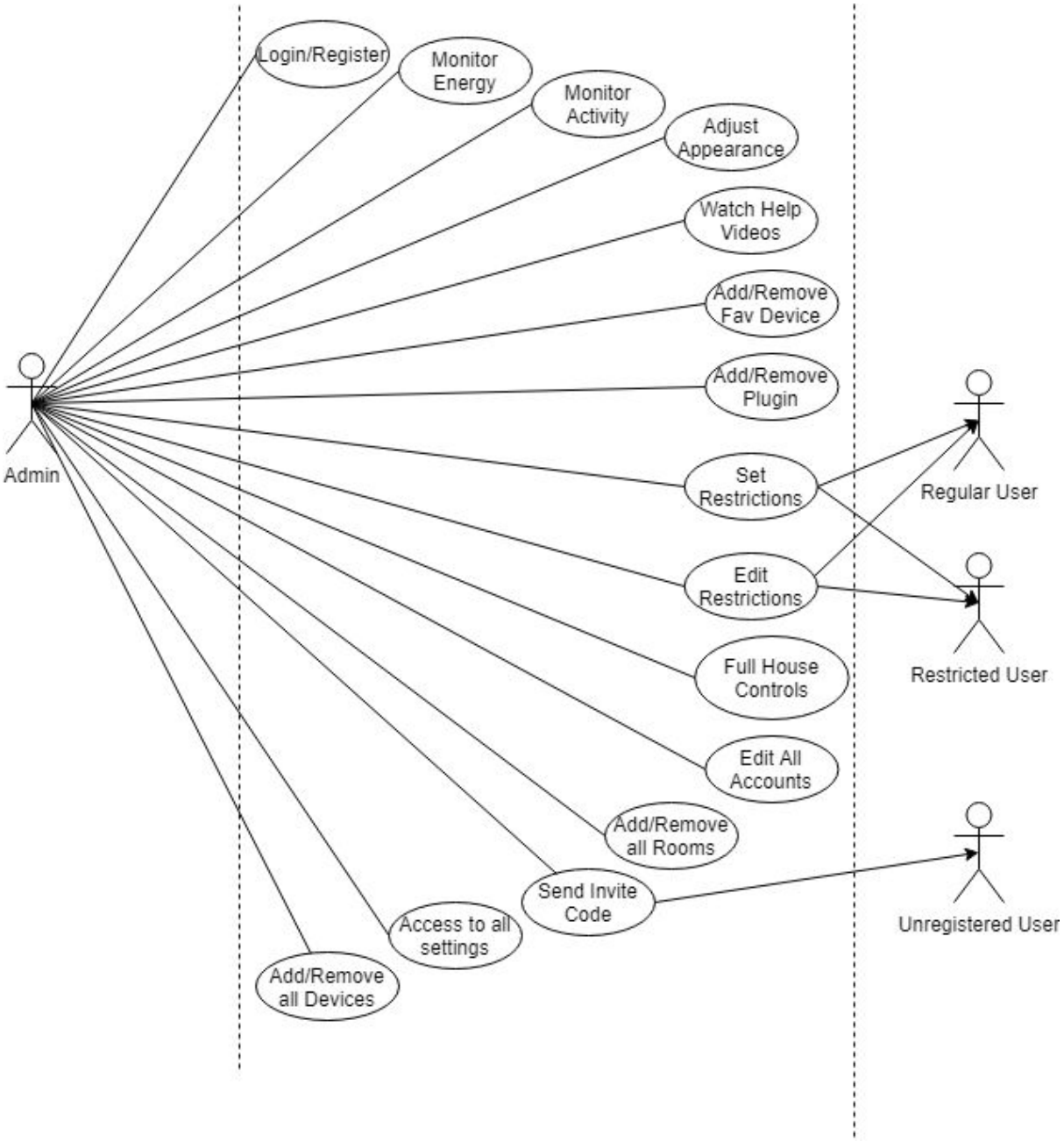
Regular User

A regular user has full control of the house, apart from the rooms and devices an admin has restricted, the difference between a Regular User and a Restricted User is by default the Restricted User has no control and requires an Admins permission to control a room whereas a Regular User has control over every room apart from ones that Admins have locked. A regular user can also add and remove devices, add or remove favorites, move devices to other rooms and finally interact with the plugin system and marketplace.



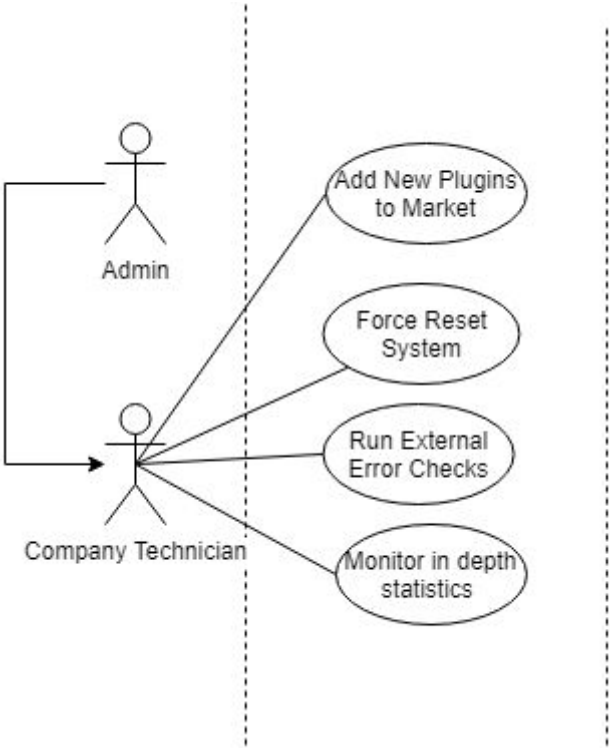
Admin

The Admin has the most control out of the whole user base. They set all the permissions and have access to all the settings allowing them to have full control of all accounts within the system. They can also request new invite codes to invite visitors. Admins may also edit existing accounts including the ability to change their name profile picture and even remove them from the system as a whole.



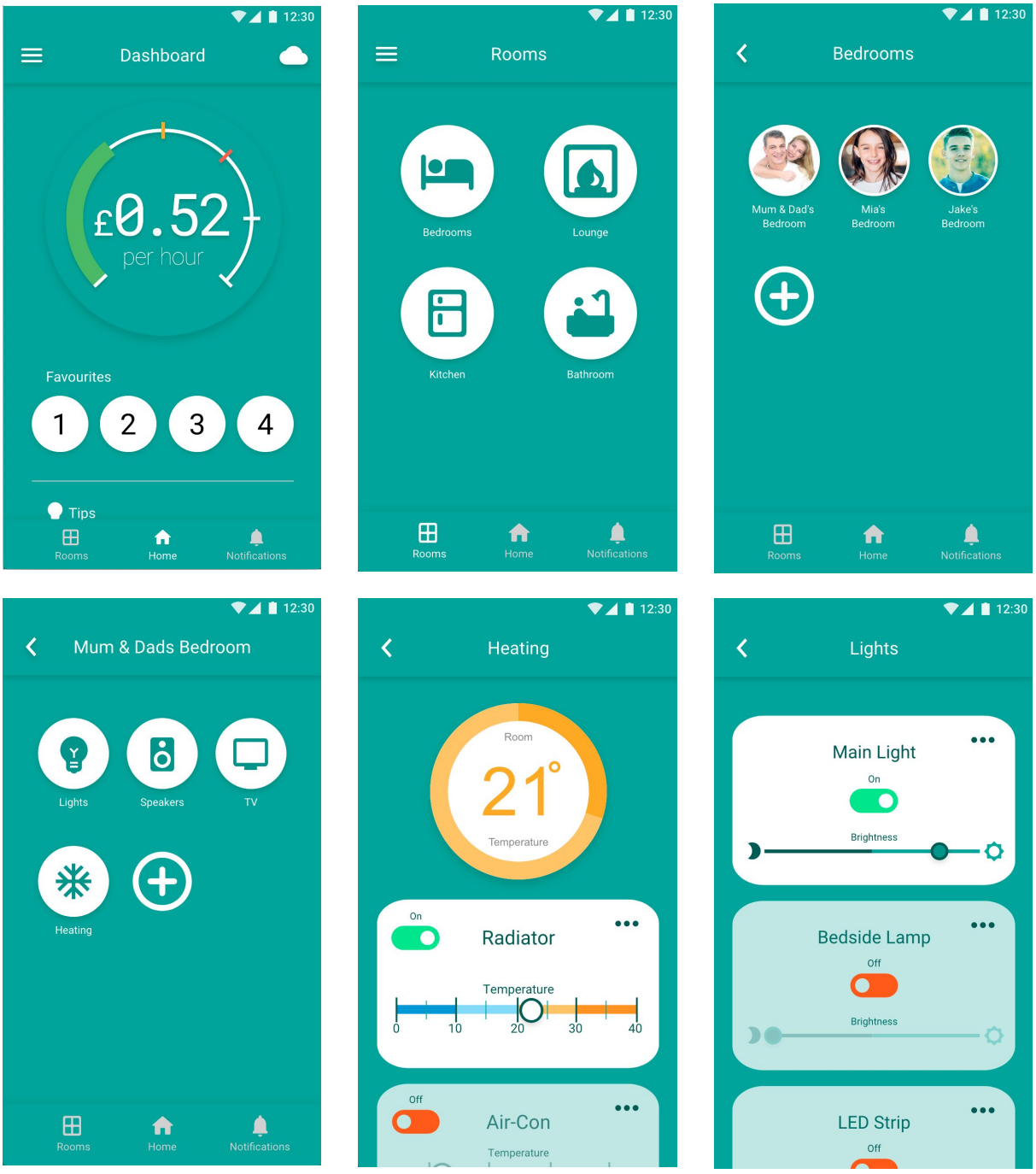
Company Technician

A Company Technician will be available upon an admins request if they require any assistance with their home. They will be able to troubleshoot for issues using in depth backend statistics unavailable to the user base. They can also run external error checks and even force system restarts as a last resort.



Initial GUI Design

First prototype design:



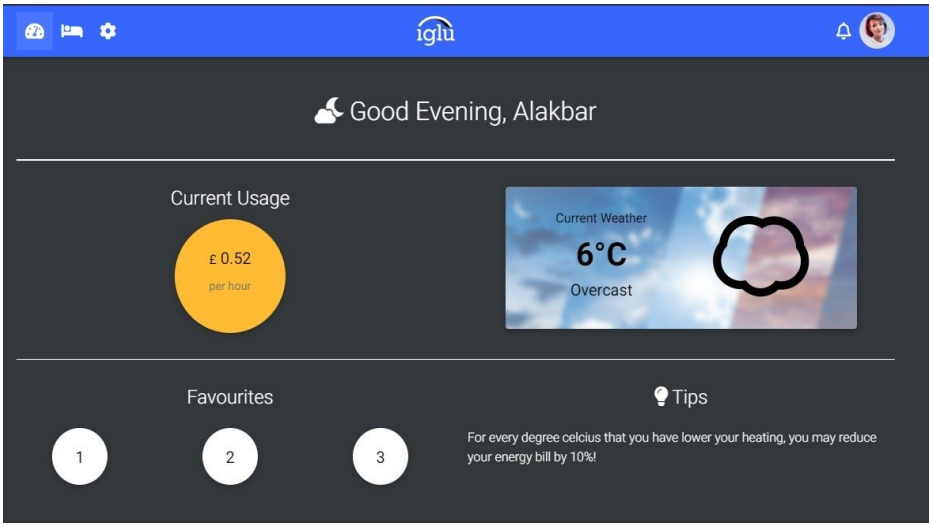
This prototype was punchy and when tested in a usability study it proved fairly well with only minor confusions about button functionality.

Initial Implemented Application design

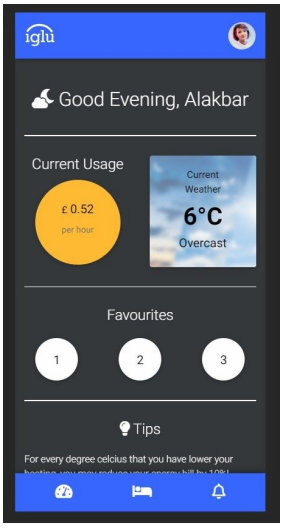
Initially Nacdlow tried to adopt the same colour scheme as the prototype other than a minor change in contrast. Nacdlow also kept the same page structuring/linking idea along with the layout of buttons and pages

This green colour scheme quickly developed to where blue was adopted, in theory representing the term iglü more closely. Labels were also added to the Nav bar and the logo had a complete redesign.

This blue and dark grey contrast was also adopted into the dashboard screen. The Nav bar labels had been removed again.

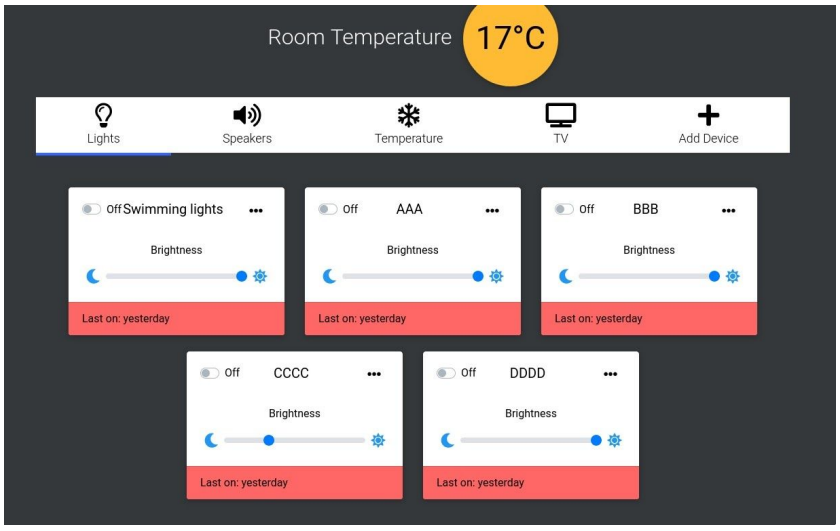


The £ph meter began to feel clunky and not fit the growing sleekness of the design, hence, an executive decision was made to remove this feature and come up with some replacement (this can be seen in the final GUI).



The initial design was strong and clean, but after deeper analysis and usability testing, it was realised there were too many clicks between each page and it was a long monotonous process to add a device or turn a device on.

Revision of devices

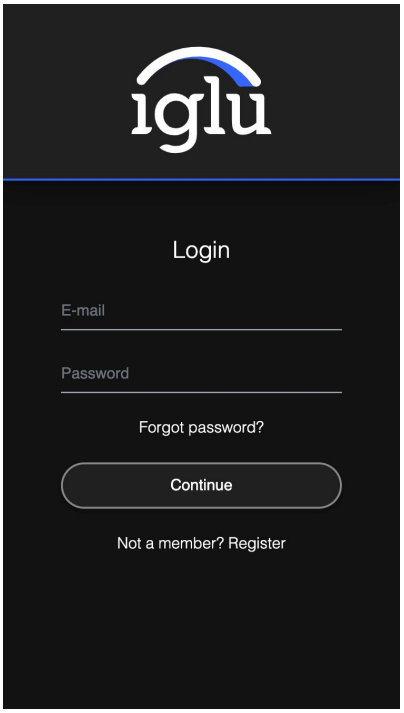


In order to reduce clicks, “Room Control” page was scrapped along with the individual device pages (seen in “Initial application design”) and instead moved to a system where each room has all the devices listed on one page. The devices could be swapped between using a simple selector emblazoned with the appropriate logo. This reduced average clicks immensely and improved overall navigation of the application as a whole.

The login page had a complete redesign and again adopted the blue colourway. Three of the primary goals of the application were added under the main iglü logo to further convey the purpose of the software to potential users.

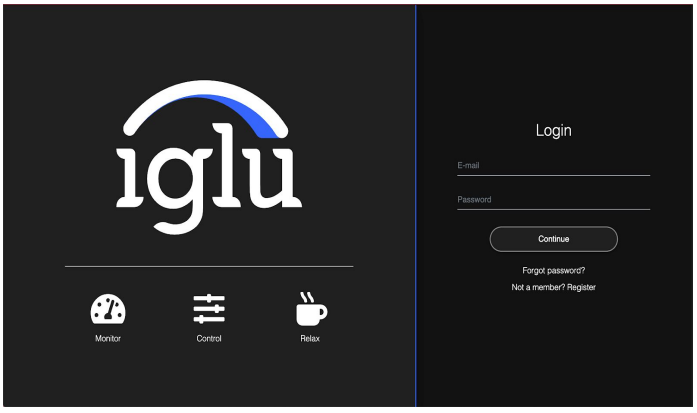
Final GUI Design

In the Final GUI the colour scheme was completely redesigned embracing the "Dark Theme" style. Dark Mode is an extremely popular colour scheme and is being used as the primary choice by many big companies. (there is a plugin on iglü's marketplace to download light mode if it is desired).

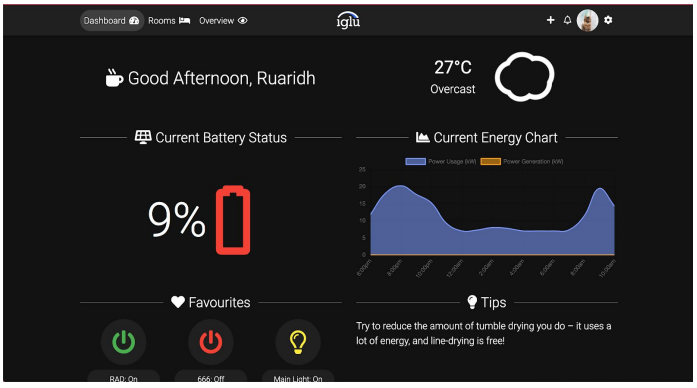


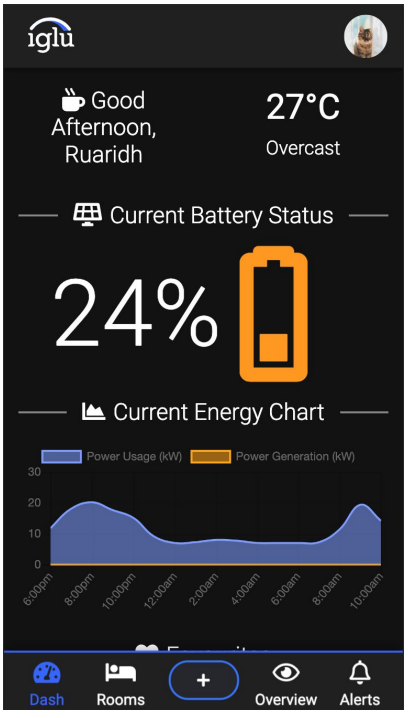
Login Screen

The GUI changes dynamically depending on the screen size - as shown by the mobile version on the right.



Dashboard



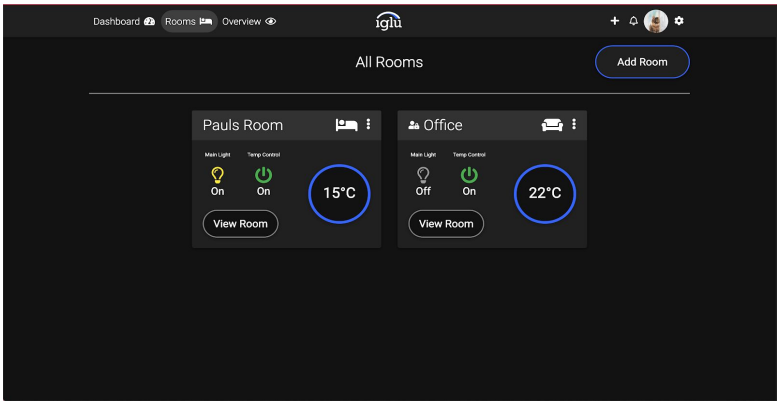


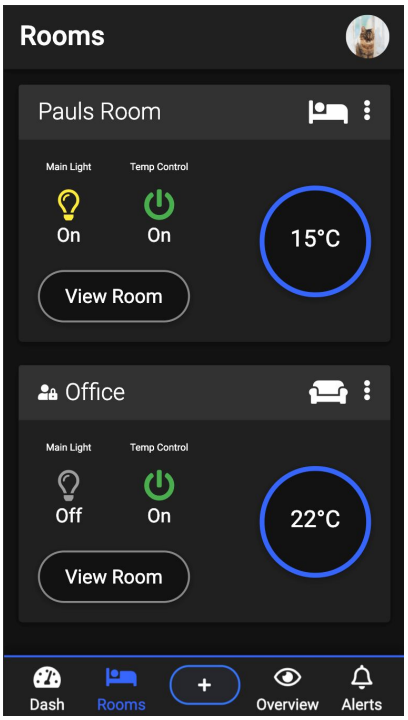
The £ph graph was replaced by an Energy Chart displaying the home's power generation (orange) and power consumption (blue) throughout the day.

The personal greeting had a change of icon and the weather data was tidied up in order to look cleaner and more seamless.

A battery icon and percentage has also been added in order to show the user the current charge of the home. Along with more features being added to the navbar in order to improve ease of performing tasks e.g. adding a device/room/schedule - denoted by the "+".

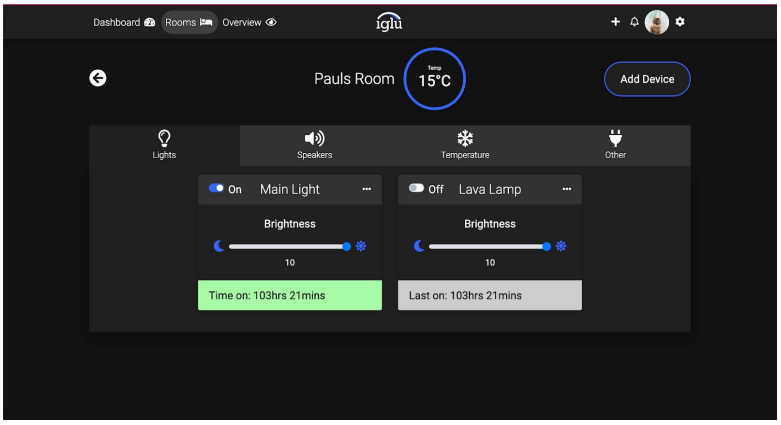
Rooms Page



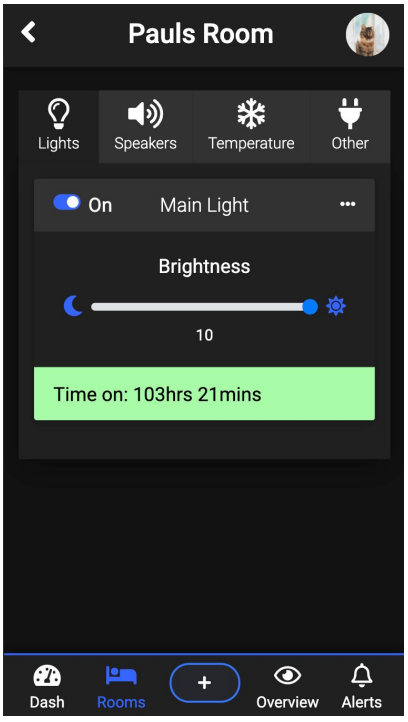


The rooms page had one of the biggest changes, you can now view the current room temperature, toggle the main light, and toggle the heating directly from the GUI. The sleek look that fits with the colour scheme and modern applications was carried across. Creating a more multi functional and useful tool than when it was just an icon (see Initial Implemented Application design).

Devices Page

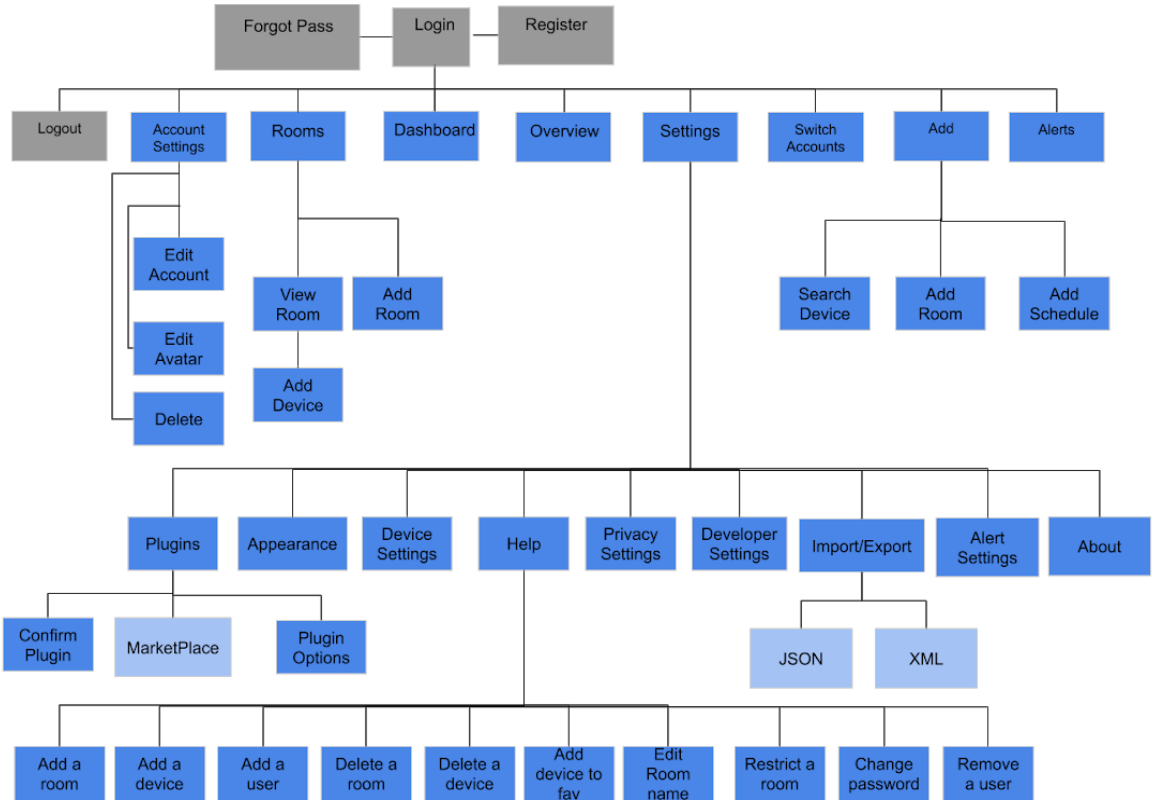


The devices tabs got cleaned up and the temp guage got a revamp to fit with the rest of the app. This allowed the page to look cleaner, more interactive and feel more native on mobile.



Software Interface Design

Site Map



This diagram is a site map of all the internal pages that Nacdlow have implemented and built into the iglü application. Note that the only way to return to the login screen after logging in is by logging out highlighted in grey. The dark blue represents all the internal iglü pages, and light blue represents pages that take you outside of the main application to an external page.

Design Decisions and Observations

After proceeding to the login screen the user is first greeted with the main dashboard, from there the user has quick access to all the important pages right from the get go.. This was an intentional design decision made by the developers of nacdlow to insure that the user doesn't have to dig to find the features they want. The maximum depth to get to anywhere in the application is three, meaning it will only take the user a maximum of three touches or clicks to get to where they need to go, regardless of the task. This excludes pages that take you to external sources (outside iglü, highlighted in light blue) and doesn't take into account the login portion of the app as that will only be required on setup or initial usage (highlighted in grey)

Technical Correctness

Testing took part continuously during development, every piece of code that was pushed into the repository was automatically tested via gitlabs pipeline. On top of this every piece of code that a group member completed was expected to be checked and proofed by another member in which they would notify them of any issues if they arose. This would ensure that the code created was robust and efficient allowing for a secure system.

Usability Report

Changes Made From Stage 1 Usability Study

In Stage 1, a usability study was completed with each member of the team receiving feedback from at least 1 participant. After the results had been collated, it was evident there were a few key areas that needed to be updated moving forward with the application. These included:

1. Modifying the cloud icon
2. Using more than one colour to differentiate items
3. Reducing steps required to do basic tasks such as toggling the lights

This feedback was strongly considered and the following steps were taken to address these issues:

1. The cloud icon itself was changed and accompanying text was made present. This text gave information such as the degrees at the user's location and the current weather. This ensured that the user's knew exactly what the icon was for.
2. Previously the entire interface was all the same colour making it difficult to differentiate between sections of the application. This has been changed so that the top navigation bar is a different colour to the central focus of the application. On mobile there is also a bottom bar present which has also been changed to match the colour of the top section of the app but again is different from the central focus. This should allow users to easily differentiate between the different aspects of the application.
3. Prior to the Stage 1 usability study, if starting at the dashboard page, it took approximately 5 clicks to do tasks in any bedroom such as turning off a light. This has now been changed so that the amount of clicks necessary to do basic tasks has been greatly reduced.

Usability Testing

Purpose of the Test

The Objective of this usability study is to allow the developers at Nacdlow to receive real-world feedback from a demographic of whom are likely to be users of iglü, the smart home application of the future. The benefits of having an external party testing the product will play a significant part in further improvements or changes to the user experience as a whole. Conducting control tests regarding the layout, design choices, button placements, ease of use and many other general design and functional decisions.

Participants

The main demographic of the application will be smart home owners or occupants looking for a way to improve their way of living and their ability to control smart devices. With this in mind, all participants must not be classed as a vulnerable user, i.e. they must not be elderly or younger than the age of 16 within Scotland and 18 outside of Scotland.

The ideal number of participants would be between 6-10 individuals that have a wide range of experience with technology ensuring a diverse group. Ideally participants will be selected from a wide range of backgrounds and disciplines. All participants will be expected to provide honest feedback.

Please note due to COVID-19 a conventional usability test was unable to take place.

Task Scenarios

Question	Description
1.Dashboard	Ask what the participant thinks each component of the dashboard does using their own words to describe
2.Navigation	Ask the participant what they expect each button on the navigation does
3.Rooms	Ask the participant to add, edit and remove a room. Ask the participant what all the icons and components mean to them.
4.Devices	Ask the participant to add a device of each type. Ask the participant to edit a device of their choice. Ask the participant to remove a device of their choice. Ask the participant about controlling the different devices. Ask the participant to move a device to another room Ask the participant to set a device as a favorite. Ask them what they think that does.
5.Overview	Ask the participant what they think the page is for. Ask the participant if they would find it useful.
6.Accounts	Ask the participant to switch accounts then delete the account they were just using. Ask the participant to set a new profile picture. Ask the participant to edit an account. Ask the participant how they would invite a new participant into their home system

7.Settings	Ask the participant to install a plugin. Ask how they feel about the marketplace Ask the participant to change the font size of the application Ask the participant what they would do if they required help.

Test scenarios will be graded from one of the following three values:

Success - The participant completed the task smoothly without any hints or tips.
Required Help - The participant completed the task however required some form of minimal help from the investigator.
Unsuccessful - The participant was unable to complete the task and the only way they could was by receiving an excess amount of help.

A scenario will be classed as 'finished' when the participant indicates they have completed the task or when the participant has received too much help from the investigator marking it as unsuccessful.

The investigator must also take notes during the test to keep track on how the user navigates through the interface and if any recurring patterns appear e.g. they do not complete the task in the simplest way or they keep ending up in a page that they don't desire or wasn't intentional.

At the end of the test subjective data will be collected via a questionnaire.

Structure of Test

The participant will first be introduced to the investigator, they will be given a quick talk about what will be required of them and how everything is going to proceed. Then the participant will be given a consent form in which they must sign to proceed with the testing. After this they will be given a demographic questionnaire at the start, this will be used to aid the analysation of results. After this the test will begin, the user will be given scenarios they have to complete and after the completion of each the investigator grades them from the three values above and the participant answers the questions related to the task. After the completion of all tasks and scenarios they user will finally be given a conclusive questionnaire about their experience of the system as a whole.

Usability Test

Consent Form

iglü USABILITY STUDY
1. Consent Form
Heriot-Watt University

CONSENT TO ACT AS A SUBJECT IN AN EXPERIMENTAL STUDY

PRINCIPAL INVESTIGATORS: [BIRD, MARK S.] , [ALI, NUMAN] , [ALQASSIMI, HUMAID] , [AKRAM, AMANULLAH] , [MOLLICA, RUARIDH] , [ZEYNALZADE, ALAKBAR]

DESCRIPTION: The purpose of this study is to acquire feedback from a range of participants about the general usability of the application.

PERSONAL DATA COLLECTED: Age, Gender
There are minimal risks for you to participate in this study. All personal information will be kept in accordance with the provisions of the GDPR. Your participation will not affect how well you do in your courses (if you are a student) or affect your relationship with the university in any way.

You are free to decline to participate in this study. Should you decide to participate, you are free to end your participation at any time. Such a decision by you will not adversely affect or alter your status with the university in any way. You are also free to withdraw 7 days after the study (please email contact@nacdlow.com). If you withdraw, your data will be removed and destroyed.

PARTICIPATION VOLUNTARY CONSENT: I certify that I have read the preceding and that I understand its contents. Any questions I have pertaining to the research have been answered satisfactorily by the team. My signature below means that I have freely agreed to participate in this study.

Date_____ Subject Signature_____
Investigator Initials_____ Participant Code [0 _ _ _]
✂.....

INVESTIGATOR'S CERTIFICATION: I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature.

Date_____ Subject Signature_____
Investigator Initials_____ Participant Code [0 _ _ _]

Demographic Questionnaire

iglü USABILITY STUDY

2. Participant Demographics Survey
Heriot-Watt University
Participant Code [0 _ _ _]

Please answer the following general questions, by selecting accordingly

1. What is your gender?
☐ Female ☐ Male ☐ Other ☐ Prefer not to say

2. What is your age?
☐ 18 to 24 ☐ 25 to 34 ☐ 35 to 44 ☐ 45 to 54
☐ 55 to 65 ☐ Prefer not to say

3. How often do you access the Internet?
☐ Never ☐ Once a month or less ☐ Once a week
☐ Several times a week ☐ Every day ☐ Several times a day

4. Which browser(s) do you use on a regular basis?
☐ Chrome ☐ Firefox ☐ Internet Explorer ☐ Safari ☐ None

☐ Other, please specify

Analysis

Due to COVID-19 the actual test data was unable to be gathered, however, an example of how the User Demographics Questionnaire data(MOCK DATA) would have been analysed is as follows:

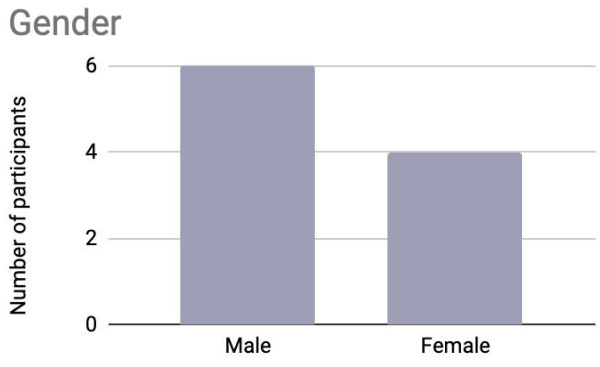


Figure 1: highlights the genders given by the participants of the Usability Study. This result shows that more males participated in the study in comparison to female participants. iglü's target market holds no gender bias and from this data it is evident that while more

males participated there is no drastic leap between genders of users.

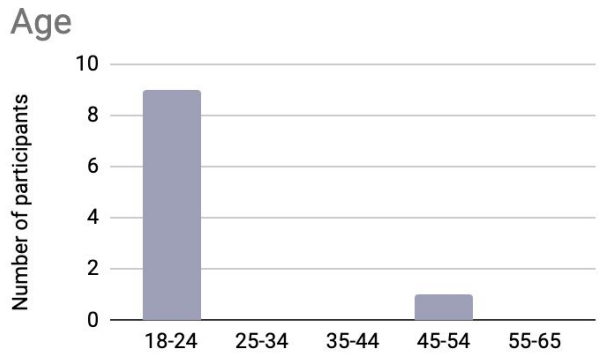


Figure 2: The results of the age question yielded an expected result stating that the majority of the participants were between the ages of 18 and 24. This data is based on the tests carried out in Stage 1 where participants were fellow students and friends. If COVID-19 had not ensued then Nacdlow would have had a much wider participant demographic and held large focus groups etc..

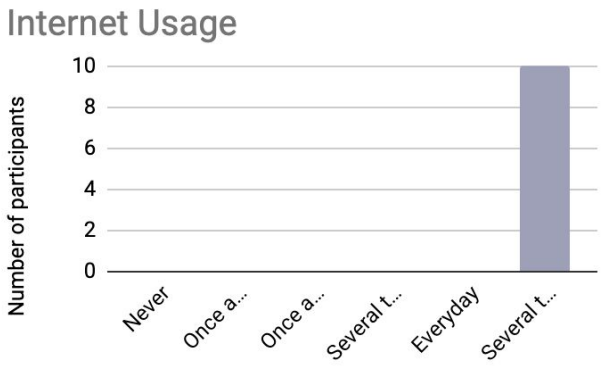


Figure 3: Upon analysis, it can be seen that every participant uses the internet several times a day. This statistic holds for the majority of the population due to living in a primarily technological society. iglü's target market is families and while they are not expected to be tech savvy - it is valid to assume that if purchasing the software, they have some basic knowledge and comfort using the internet and technology.

Test Scenarios

1.Dashboard
This is the Dashboard of iglü, the first screen you will be greeted with when you first login to the application, the purpose of the dashboard is to give the user all the information they require at a glance.

https://localhost:8080/dashboard

---

a) What do you think of the layout of the dashboard?

b) Are all the components of the dashboard easy and clear to understand? If not what components don't make sense to you?

c) Show me how you would check your current battery statistics

Successful Required Help Unsuccessful

2.Navigation
On every page you have one bar that remains constant no matter what page you are on. When using desktop it's at the top when on mobile at the bottom.

https://localhost:8080/dashboard

---

a) What do you think of the layout of the nav bar?

b) Do you think it's a good idea to have the navigation bar at the bottom when on mobile and at the top when on desktop?

c) Using the navigation bar show me how you would proceed to the rooms page

Successful Required Help Unsuccessful

3.Rooms
This is the rooms page, this page is where you will see all the rooms you have in your house, here you can edit delete and add new rooms, if you are an admin you can also restrict rooms from other users who don't have admin privileges.

https://localhost:8080/rooms

---

a) How do you think you would add a new room?

b) Add three new rooms; a living room and two bedrooms

Successful Required Help Unsuccessful

c) Rename one of the bedrooms and call it “daves room”

Successful Required Help Unsuccessful

c) Rename one of the bedrooms and call it “David’s bedroom”

Successful Required Help Unsuccessful

d) When you add a new room you can see a card appears, inside the card there are multiple icons and components, how clear did you find the components and what they stand for?

Not clear at all
Clear

1	2	3	4	5

e) Remove "David's bedroom"

Successful Required Help Unsuccessful

e) Proceed to the living room's devices

Successful Required Help Unsuccessful

4.Devices
The Devices page is the main page to view all the devices in a specific room, you can add remove and edit devices as well as control them all,

https://localhost:8080/room/1

Specific observations
1. Total time to complete task (a):

---

a) Add a device of each type: Light, Speaker, Temperature and Other
Successful Required Help Unsuccessful

b) Rename the light to "Bedside Lamp"
Successful Required Help Unsuccessful

c) Turn the Temperature device on and set it to 19 degrees
Successful Required Help Unsuccessful

d) Delete the speaker device you created
Successful Required Help Unsuccessful

e) Move the “Bedside Lamp” to your bedroom you created earlier

Successful Required Help Unsuccessful

f) Set the “Bedside Lamp” as a favorite device

Successful Required Help Unsuccessful

g) Show me what favorating the “Bedside Lamp” has done

Successful Required Help Unsuccessful

5.Overview

The overview page is still a work in progress

https://localhost:8080/overview

---

a) What do you think is the purpose of this page?

b)How useful would you find this page?

Not Useful at all

Useful

1	2	3	4	5

6.Accounts
iglü allows admins to control accounts inside your home system allowing you to give you full control.
https://localhost:8080/internal_accounts
https://localhost:8080/settings/accounts

---

a) Generate a new invite code so I can create an account for your smarthome

Successful Required Help Unsuccessful

b) Delete the account that was just created

Successful Required Help Unsuccessful

c) Change the avatar for your account

Successful Required Help Unsuccessful

d) Change the avatar for your account

Successful Required Help Unsuccessful

e) Change your name in your account

Successful Required Help Unsuccessful

7.Settings
The settings page on iglü give you quick access to all the settings you may require to control and make iglü an app for you.

https://localhost:8080/settings

---

a) How clear do you find the layout of the settings page?

Not clear at all
Clear

1	2	3	4	5

b) Load a plugin from the marketplace to change the appearance of iglü

Successful Required Help Unsuccessful

c) Show how you would change the font size of the application

Successful Required Help Unsuccessful

c) Watch a help video on how to add a new device

Successful Required Help Unsuccessful

d) How clear are all the help videos in the settings page?
Not clear at all
Clear

1	2	3	4	5

Ending Questionnaire

iglü USABILITY STUDY

8. Ending Questionnaire
Heriot-Watt University

1. What feature did you like most about the application?

2. If you were the application developer, what would be the first thing you would do to improve the website?

3. Please select your level of agreement with the statements below, with 1 being strongly disagree and 5 being strongly agree.

(please mark the respective box with an "x" or "✓")

	1	2	3	4	5
The application is easy to use					
The design & layout were clear and understandable					
The application is user-friendly					
The buttons were well organised and easy to find					
I immediately understood the function of each button					

All of the links I expected to find in the navigation were present					
The application layout is logical					
Some parts of the application are unclear					
The application is visually appealing					
It is difficult to navigate around the application					
	1	2	3	4	5

4. Do you have any additional comments?

5. Would you be interested in participating in another usability test for the development team?

☐ Yes ☐ No

6. If yes, do you have a smartphone or tablet which you could use to test the website?

☐ Yes ☐ No

How was your overall experience in this study?
(circle the emoticon that most resembles your mood after completion)

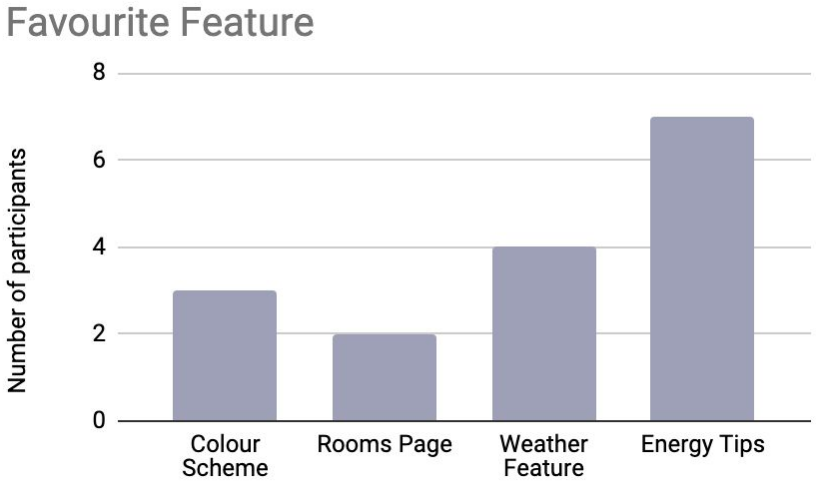
Analysis

The data gathered from the ending questionnaire would be analysed in different ways depending on whether the resulting data is qualitative or quantitative.
An example of how the above questionnaire would be analysed is shown below:

Question 1: what feature did you like most about the application?
Data Type: Qualitative

Since this data is qualitative it would not be possible to graph or chart it in the same way you can with quantitative data. In this case the qualitative data could be turned into a more quantitative style e.g. by totalling the responses and placing them into a bar chart. From there any commonalities between favourite features could be identified (i.e. if 4 people all said the same thing).

An example of how this could look is outlined below:



Upon retrieval of this data it would be of best interest to keep the Energy Tips feature in the software, if not make it a larger part of the system along with the weather feature. These stand-out features that the participants stated are favourites are something to focus on when marketing iglü.

Question 3: Likert scale stating level of agreement to given statements
Data Type: Quantitative

Likert scales being a numeric system means that their data is quantitative and hence can easily be analysed by converting all results to a graph. The data below shows the cumulative answers and the highest rated answer among the set highlighted.

	1	2	3	4	5
App easy to use			1	2	7
Design & layout clear			1	3	6
User friendly				3	7
Buttons easy to find			2	3	5
Understood button functionality		1	4	5	
Links were where I expected		2	3		7
Layout is logical				2	8
Parts unclear	1	4	4	1	
Visually appealing		2	1		7
Difficult navigation	8	1		1	

These results can then be used to discover where potential flaws with the system are. Ideally the system should not have extremely diverse results if the design and functionality has been refined to its best. This data above of course is just mock data for the purpose of analytical visualisation.

The table above clearly shows that the majority of participants found the system easy to use - 70% of them strongly agreeing with that statement.
Areas that may need improvement are perhaps the buttons, as the field “Understood Button Functionality” is fairly spread across columns - only 50% having a fairly strong agreement to the statement.
Upon these observations, a meeting would be held to discuss potential changes that could be made in order to improve these issues. Once improved, another usability study would take place to confirm that changes have been successful.

Project Evaluation

Introduction

This section aims to assess the project as a whole which has been completed by Nacdlow over the previous 7 months. Firstly, the overall organisation of the group will be evaluated giving details such as how the group was organised and how it worked together. The successfulness of this organisation will also be reviewed. Following on from this, the approach the group chose in the initial stages of development will be looked at as well as the tools used and problems encountered. Finally, an overall evaluation of the iglü application will be given showing key features of the software. It will also look to see how many requirements initially set out were met before detailing if there are any known bugs remaining.

Project diaries of each individual group member will also be available in the appendix at the very end of the document.

Organisation

Meetings

Nacdlow members met, at minimum, once a week. These meetings were organised through a WhatsApp group chat which had been created when the company was first formed. The group were averaging 9 or more hours a week at peak times. That being said, the only meetings that were necessary to attend were the weekly sprints, which lasted between 1 to 2 hours. Rooms would be booked 2 to 3 days in advance[10], though group members were informed that meetings would be taking place a week in advance in most cases.

Once the COVID-19 outbreak caused strict government sanctioned social distancing[11] measures to be enacted, group meetings were held on Discord[12] and Google Hangouts[13], with Hangouts being preferable due to one of Nacdlow's group members being unable to use Discord as it is blocked in the country in which they reside.

[10] Rooms could only be booked 3 days in advance due to Heriot-Watt room booking policy for some rooms
[11] Coronavirus: Strict new curbs on life in UK announced by PM - https://www.bbc.co.uk/news/uk-52012432
[12] https://discordapp.com/
[13] https://hangouts.google.com/

Online Tools

Gitlab
Nacdlow used GitLab for its version control, as it allows unlimited repositories in private groups. GitLab also allows sub-groups, which Nacdlow utilised to create an “Official Plugins” section to store the iglü plugins sources. GitHub was not used due to private repositories being a paid feature.

TeamGantt
TeamGantt was used to create the team’s Gantt charts, since other alternatives were either outdated, didn’t run on team member’s systems (such as GNOME Planner), or had some other serious problems.

WhatsApp
Whatsapp was used as Nacdlow’s main form of communication; all announcements, updates and development discussions took place on Whatsapp. As every group member was already using Whatsapp it was an easy decision to make as each member would frequently check its notifications, ensuring all messages that were sent would be read in a timely manner.

Google Drive
For all of the documentation, media production, diagrams, poster designs, presentations, meeting notes and meeting recordings google drive was used. Its shared cloud storage feature made it easy for group members to quickly stay updated and upload any work that was non code related.

Google Docs
Google docs was used to write up all of Nacdlows reports and documentation, it was also used to write notes about each meeting before storing them to the team's shared drive. Its live collaborate feature made it easy to work on a document at the same time while also keeping up to date with what other members were currently working on.

Discord
Discord was initially used to remotely collaborate with each other, it made sharing code easy and allowed the team to have remote group meetings via VOIP.

Google Hangouts
Google hangouts later used as the primary Tool used to communicate remotely as one of the team members were unable to access Discord in their country. Hangouts was used a lot in the teams late stage of development especially when COVID-19 caused countries to fall into lockdown.

Group Organisation

The first thing Nacdlow did was to find the strengths and weaknesses of each of the members, which helps us organise and know each other better. It was then listed in our internal wiki. Then a role to each of the members was assigned.

The roles didn't limit what each of the members were able to do, and it was used as a general label. For example, when it came to reporting anything, it was the job of the reporter but not limited to the reporter as they might have been busy during that day working on another task.

Due to this openness everyone in the team was generally involved in all aspects of the operation covering for one another in the event that they were unable..

Group Collaboration

Every meeting the group would make decisions together, taking a vote and going with the majority. During the sprint meetings when allocating tasks to each member, depending on the complexity of the task or the skill level of the developer, Nacdlow would sometimes allocate multiple members per task giving an opportunity to problem solve as a team and even do pair coding sessions.

When a member pushes their code another team member would be expected to look over the implementation and test the given solution, if problems arise they would directly consult the member(s) in charge of that task and formally describe their concerns. This constant method of testing and proofreading an implementation insures the creation of robust code and thus a robust system.

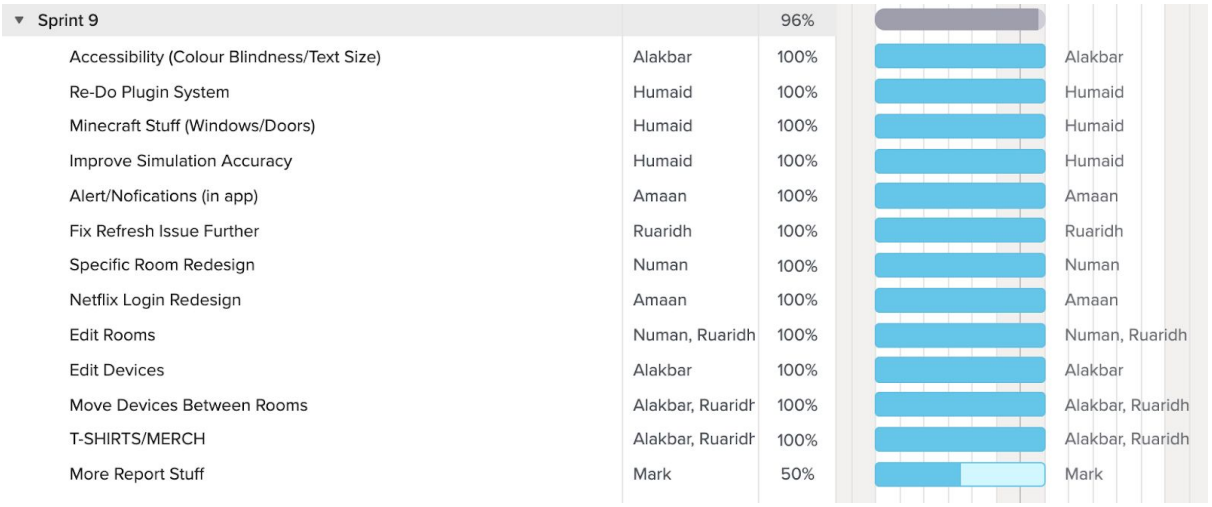
Remote collaboration was a big part of the development of Iglü, especially since many countries have gone into lockdown due to COVID-19. This happened during a crucial point in the development cycle and thus remote collaborating was required via Discord and Google Hangouts. Features like screenshare were heavily used to help aid to convey ideas and solutions remotely.

Implementation

Planning Approach

An Agile planning approach was taken throughout the implementation of the system. The application development was broken down into sprints, where each sprint covered 5-10 coding tasks(usually being related to one another - but not always) and was to be completed by the start of the following week.

An example of a sprint, detailed using TeamGantt software is shown below:



Sprint 9		96%	
Accessibility (Colour Blindness/Text Size)	Alakbar	100%	Alakbar
Re-Do Plugin System	Humaid	100%	Humaid
Minecraft Stuff (Windows/Doors)	Humaid	100%	Humaid
Improve Simulation Accuracy	Humaid	100%	Humaid
Alert/Nofications (in app)	Amaan	100%	Amaan
Fix Refresh Issue Further	Ruaridh	100%	Ruaridh
Specific Room Redesign	Numan	100%	Numan
Netflix Login Redesign	Amaan	100%	Amaan
Edit Rooms	Numan, Ruaridh	100%	Numan, Ruaridh
Edit Devices	Alakbar	100%	Alakbar
Move Devices Between Rooms	Alakbar, Ruaridh	100%	Alakbar, Ruaridh
T-SHIRTS/MERCH	Alakbar, Ruaridh	100%	Alakbar, Ruaridh
More Report Stuff	Mark	50%	Mark

Each task in the sprint was assigned to a member of Nacdlow (this member was likely to volunteer for the task or be chosen by vote during one of the bi-weekly meetings)
Sprints made the project more manageable, and allowed the team to generate high quality features of the system quickly in bite sized segments. Creating more flexibility and the tools to adapt better to unexpected changes.

Schedule

During development of the system Nacdlow followed a consistent work/meeting schedule in order to complete tasks and finish the implementation. The sample below depicts how Nacdlow went about a typical week of development. (weekends are not included in the model, however tasks were carried out by members through the weekend if needed.)

Monday:	- Finish up tasks that were assigned to be completed by Monday. - Discuss who will be able to attend the meeting on Tuesday. - Update Gantt chart sprints with completed tasks.
Tuesday:	- Hold a meeting - typically 2 hours long. - Each member will discuss what they have completed and show their work to the rest of the team. - Discuss any difficulties encountered last week if there were any. - Assign tasks for group members to complete by next Tuesday - Perform any updates/ making sure each member has the most current version of the code.
Wednesday:	- Individual members begin planning their workload and coming up with ideas on how to complete their task
Thursday:	- Members should have started to complete their task. - General updates to the Nacdlow Group chat on progress will be sent by each member - Incremental progress should by marked in % on the Gantt Chart
Friday:	- A “mid way” check on tasks will be taken to estimate whether more time is needed or not. - In times of large work load or strict time constraints a second meeting is held. - Members should have completed the majority of their task in line with finishing on monday.

Full sprint details of Stage 2 and Stage 3 are available to view in the appendix.:

- Stage 2 Schedule
- Stage 3 Schedule

Tools

For the implementation of Iglüü many development tools were used among the team.

Go

Go is the primary backend language that was used to create iglü. This was because of the great toolset which comes provided with the language, which enforces a strict format. Also language is simple to learn and fast when running as it is a compiled language. The strict typing of the language prevents issues with function typing.

Macaron

Macaron was used for routing for the HTTP server, and it was also used for creating our middlewares, handling sessions, flash error, form binding, and more. This saved a lot of development time.

XORM

The application uses XORM (an Object-Relational Mapping library), which manages creating schemas from the structures (structs) and querying the database. XORM is used to convert data between a database and the objects in Go. These objects are things such as "User.go" which holds the go code outlining the User database table schema.

SQLite

SQLite was used to host the database that includes all of the schemas generated by XORM. SQLite is reliable even for medium or high traffic websites.[14] Since this system would be running in homes, SQLite is a good choice. This reduces the time taken setting up a MySQL server, and getting it connected, then remotely managing this server.

HTML/CSS

HTML5 was used to create all of the pages of the application. HTML5 allowed Nacdlow to create the complete structure of each page and implement all web and mobile features to the application. CSS3 was used in conjunction with HTML5 to write and attach style sheets that made all elements of the application look and behave more optimally. CSS3 and HTML5 were used together to manipulate the shape of elements, align elements and create an overall more eye-pleasing and neat application.

Javascript

Javascript helps to create a more responsive and multifunctional application by providing the ability to create functions that work seamlessly with HTML and CSS.
It had multiple applications, such as:

- Showing and hiding elements upon toggling a switch or button.

[14] "Appropriate Uses For SQLite." https://www.sqlite.org/whentouse.html. Accessed 6 Feb. 2020.

- Refreshing elements periodically in order to dynamically update data - for things like the temperature or the light status.
- Sending data from multiple elements to Go functions via variables passed through a URL (this was done in conjunction with go macaron and go routes) .

MDB

Material Design Bootstrap (MDB) is a CSS and Javascript framework that allows a developer to use pre-made templates, components, animations and effects via simple pieces of code. MDB was used throughout the whole application and played a key part in the majority of the aesthetics that make the UI so sleek. MDB provided a simple way to align data into grids or tables and also came with features such as “data modals”, modern buttons, toggles, data cards, and interactive graphs.

Problems

During stage 3 the biggest problem the group faced was working around COVID-19 and the country's lockdown, however it was easily overcome through the use of the online tools as stated earlier in this report.

Review of Original Plan

Overall the original plan initially created during stage 1 was not drastically changed. However many new features were implemented that were not initially planned for, but this was to be expected due to our agile development methodology.

Product Evaluation

Overview

This section of the report will focus on Iglü itself, the product that Nacdlow have developed over the last few months, it will go over all the functions, any additional functions, all the outstanding or known bugs as well as an overall system usability evaluation.

Functionality Assessment

Bellow is a list of all the functionality of Iglü and a ranking of how complete each functional requirement is:

FR ID	Description	Completion
FR1	The web app must permit the user to interact with the smart home.	100%
FR2	The user must be able to monitor energy consumption, generation and view general statistics about the smart home.	90%
FR3	The web app must have a unique account system that provides a tailored experience depending on the users.	100%
FR4	The web app must have an authentication system to provide a secure login/register service.	100%
FR5	The user must be able to control individual smart devices.	100%
FR6	The user must be able to add and remove devices at their leisure.	100%
FR7	The user must be able to add and remove rooms at their leisure.	100%
FR8	The user must have the correct permissions in order to add or remove devices.	100%
FR9	The web app must be fully functional across all types of devices and platforms	100%
FR10	An authorised user shall be able to install (or uninstall) modules from the marketplace, if they have permission to do so.	100%
FR11	A user is able to set a schedule and create macros to automate tasks and functions.	50%
FR12	The home system shall give tailored suggestions to the users on ways to conserve energy.	30%

FR13	The app must function as a PWA, e.g. works offline, can “add to homepage” on mobile devices, etc.	100%
FR14	The web app must have accessibility options for those with visual impairments, i.e. screen readers, font size, deuteranomaly/tritanopia/achromatomaly etc. (compliance with WCAG)	100%

Most of the functional requirements have been fully implemented and are working as expected, however, a few are still unfinished due to their priority being lower compared to the other functional requirements:

FR2 - All the main stats are available including a power storage statistic, and a graph of power consumption vs power generation however the developers of nacdlow intended to implement more graphs allowing more advanced users to keep tabs on their energy, the statistics are available via the simulation just not implemented in the app itself.

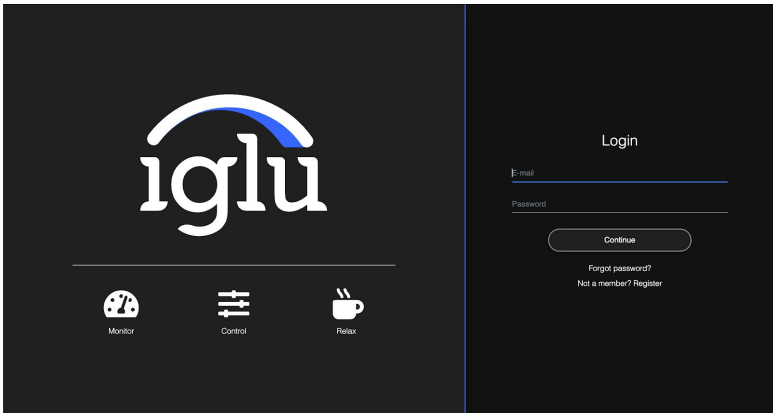
FR11 - Schedules are available for users to create, store and edit however right now they don't affect devices and thus functionally are currently not working.

FR12 - Suggestions are given to the user via the dashboard however are not tailored to the user dependent on statistics, they simply cycle through a finite list of tips stored offline within the application itself.

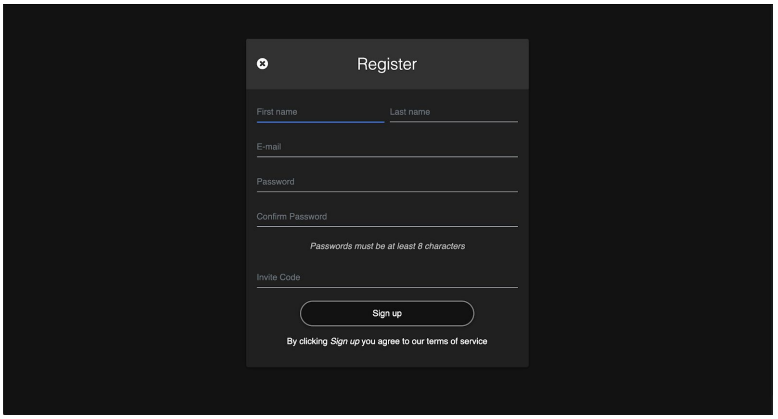
Key and Additional Features

This segment of the report details some of the key features and additional features(not detailed in requirements) that have been implemented in the iglü Smart Home System. The features will be accompanied by a brief summary of what they do and how they improved the iglü application as a whole. Additional features will be marked with "ADDITIONAL" in order to distinguish between Key Features.

Login and Registration pages (using an admin generated code)

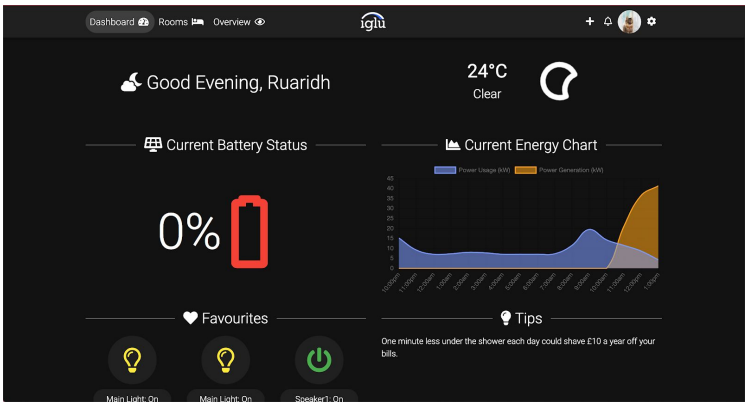


The login page allows home users to login to their smart home system. It has iglü's tagline "Monitor, Control, Relax".



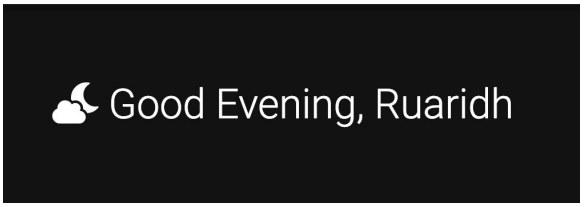
The registration page allows home members or guests to create their own account. The only requirement is that they need an invite code.

Dashboard



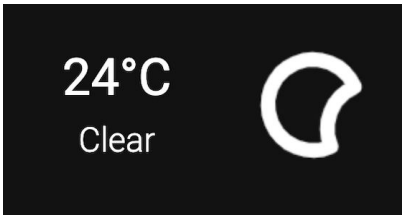
The dashboard shows a summary of the smart home system. It contains the outdoor weather, battery status and energy usage chart. Also it shows the user's favourite devices and tips on reducing energy consumption.

- **Personalised Welcome Login** ADDITIONAL



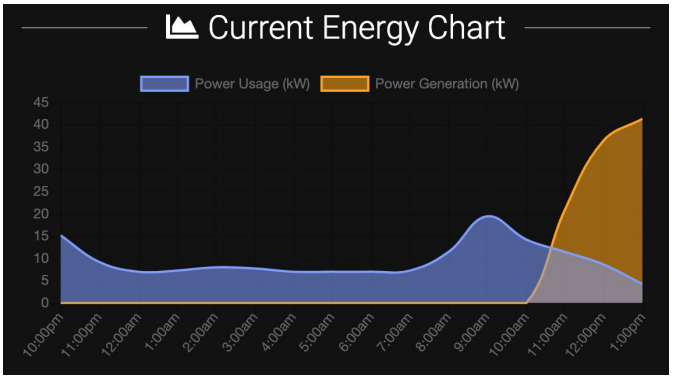
There is a personalised welcome message for every user, greeting them depending on the time of day.

- **Weather Feature** ADDITIONAL



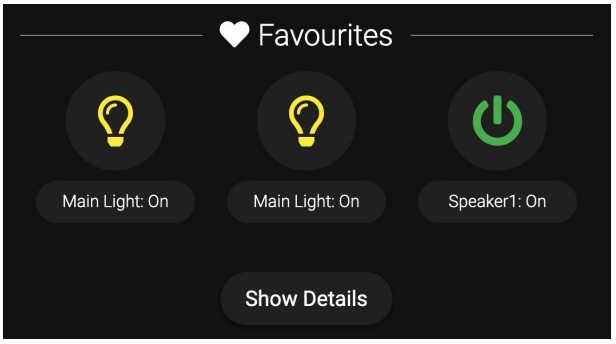
A weather widget is also available, which shows the outdoor temperature and weather status. An animated glyph changes depending on the weather.

- **Energy Consumption/Generation Chart**



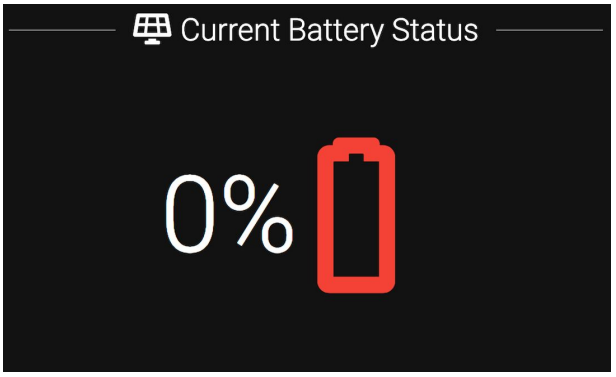
The energy consumption and generation chart is a simple way for everyone to understand how much electricity is used and generated without a concrete knowledge in the power units. FR2

- **Favourited Devices** ADDITIONAL



Devices may be favourited, and it will be listed on the user's dashboard for ease of toggling their devices.

- **Battery Percentage (power monitoring)**

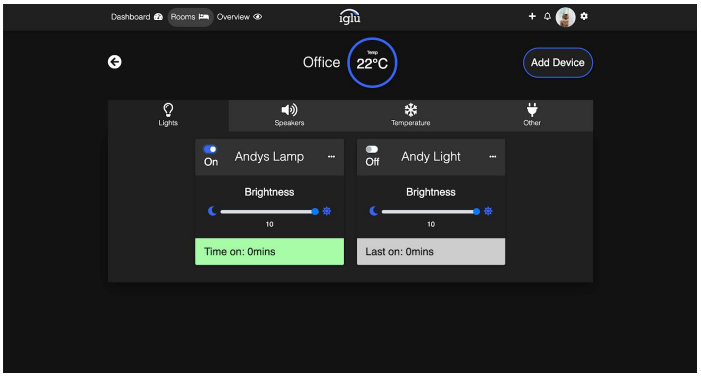


Everyone understands power storage in the terms of a percentage and an icon. This brings a familiar concept to understand how much power is stored in the home's power bank.

- **User Tips for Energy Saving**

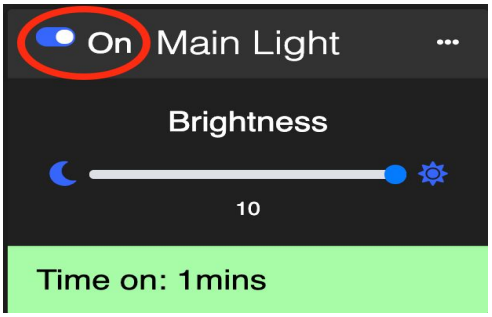
The tips feature provides random tips on how the users can save power, and raising awareness on how a simple change of habit can save you money.

Devices Page



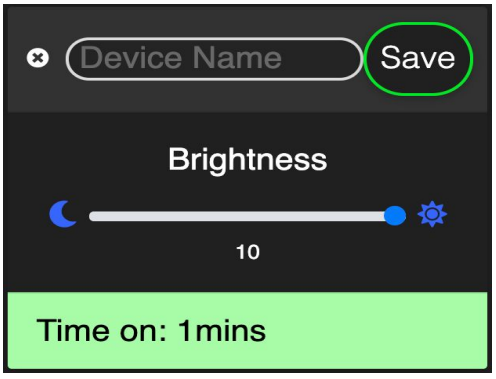
The devices page is made to be as intuitive as possible. The temperature shows next to the room, and categories of devices are split into their tabs. A quick shortcut to add a device to the current room is also available.

- **Toggle Devices On and Off**



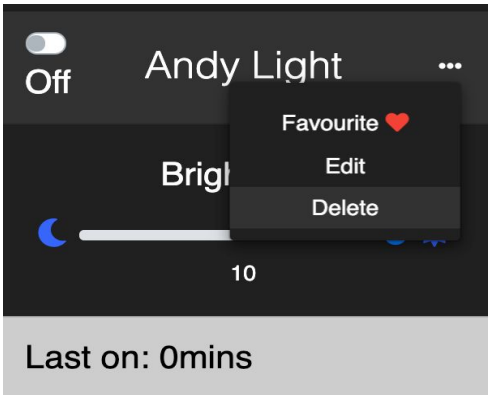
Devices may be turned on and off using the simple toggle icon. Toggles are universally recognised. This feature is a key feature that was highlighted by FR5

- **Rename Devices** ADDITIONAL



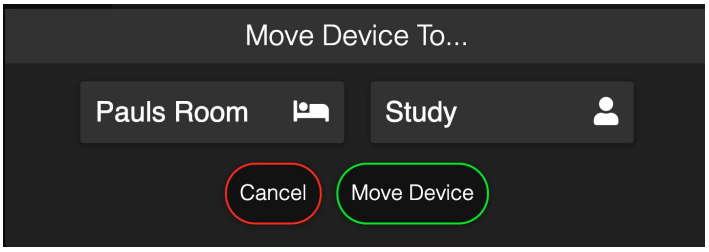
Devices may be renamed easily within the card, and is updated dynamically.
This feature was implemented to improve the customizability of the application.

- **Delete Devices**



Devices may be deleted using the dropdown menu, which would display a confirmation. This feature was explained in FR8

- **Move Devices Between Rooms** ADDITIONAL

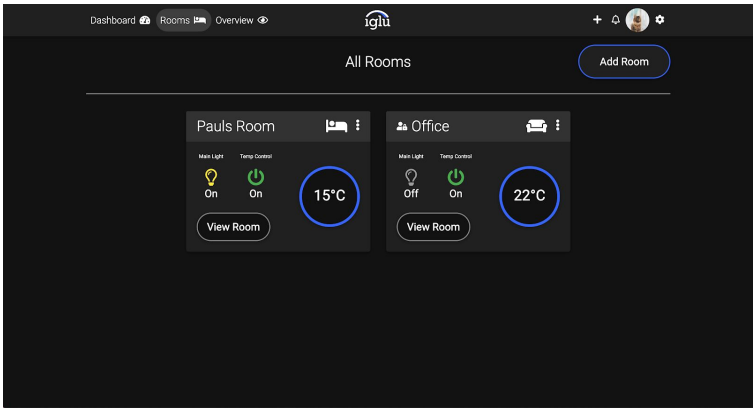


Some devices can be portable, and move from room to room. So it is important that users can do this easily.

- **Device Running Time** ADDITIONAL

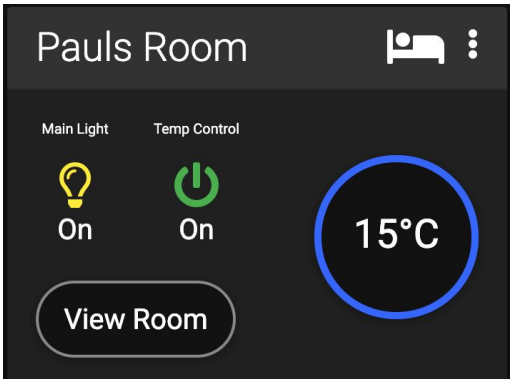
Each device has a running time, this lets the home users be aware of how long the device has been running.

Rooms Page



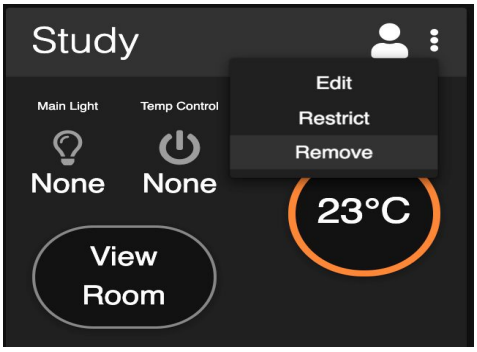
The rooms page has been designed to reduce the number of clicks (or taps), so you can toggle the heating (or cooling) and the lights right from the rooms page.

- **View Current Room Temp** ADDITIONAL



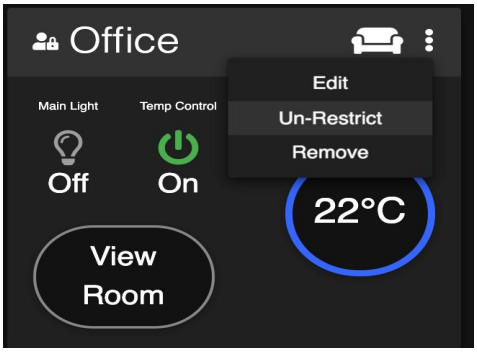
The room temperature can be viewed on the card to reduce the number of clicks and increase the user experience.

- **Remove Rooms**



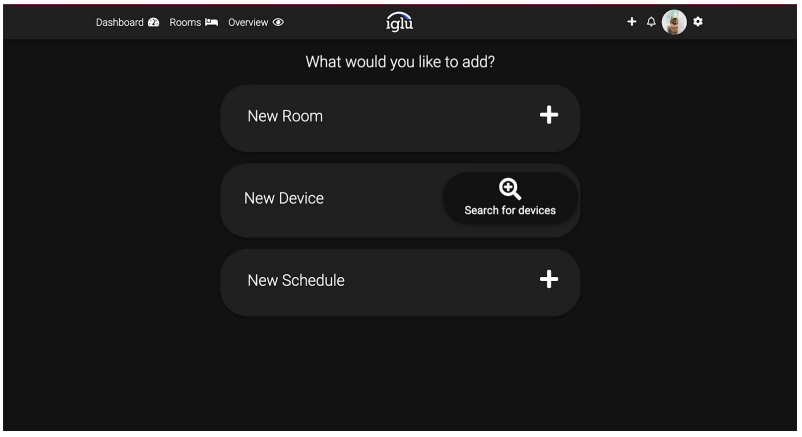
When a device is no longer a part of the home, it may be removed using the dropdown. This key feature was highlighted in FR7.

- **Restrict Rooms** ADDITIONAL



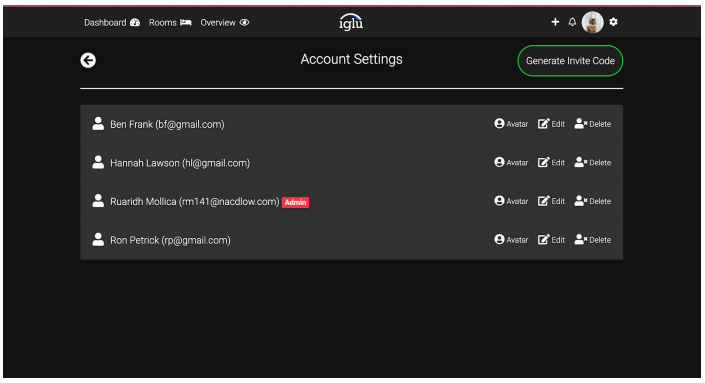
Rooms may be restricted, this prevents restricted users from controlling devices in that room. This is to prevent the kids, for example, to toggle the devices in the parents' room.

Add Rooms, Devices and Schedules



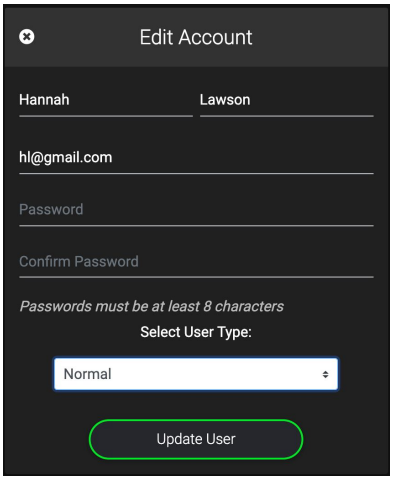
There is a '+' symbol on every page, which allows you to add either a room, device, or a schedule. This provides a simple and friendly interface. Stated in FR6

Account Settings



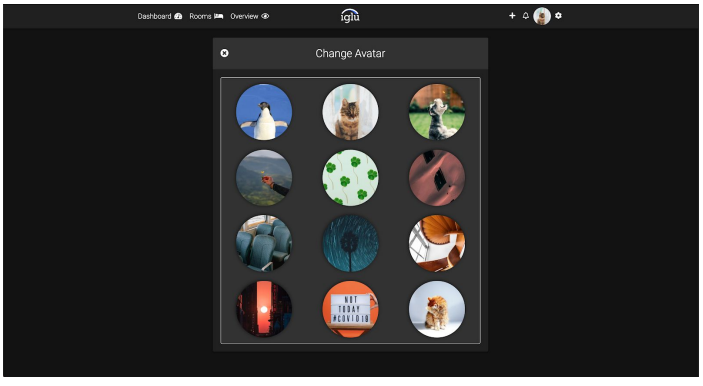
The accounts settings page allows you to see the users registered on the system, and you may modify their attributes, change their avatars, or delete them. This makes it easier to know who has access to the system. A button to generate an invitation code is available for users willing to register a new account.

- **Edit User (Change Password, Email, Role etc)**



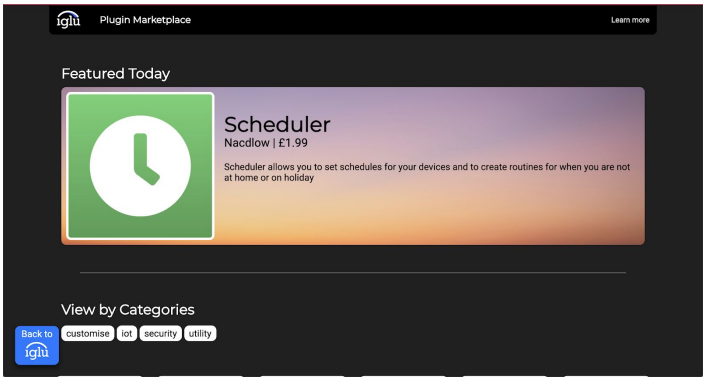
An edit account form is available so administrators can reset emails, change the name or role of the user.
FR3 (role)highlights this.

- **Change User Avatar** ADDITIONAL



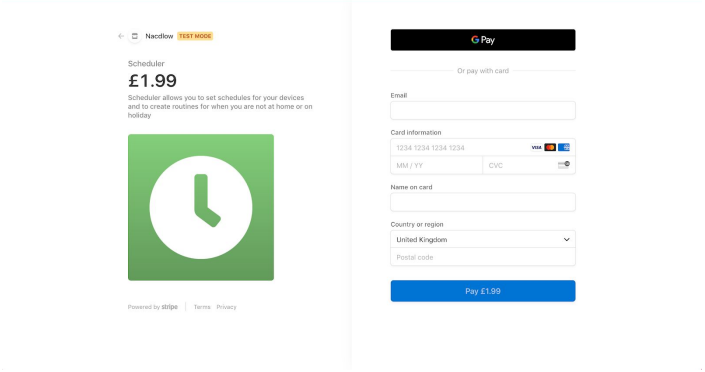
Avatars add a level of customisability and personalisation to the product. This product is supposed to be a part of the home, hence it should be made personal.

Plugin Marketplace



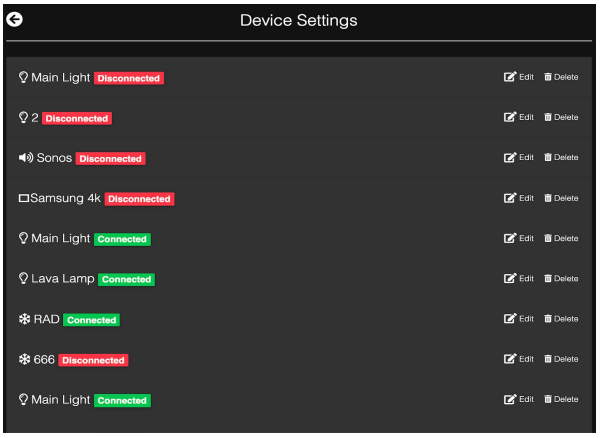
The marketplace allows smart home owners to search and install plugins. The plugins are also categorised. A learn more page is available, which contains information on how to develop plugins with our plugin SDK. (FR10)

- **Real Payment method using STRIPE** ADDITIONAL



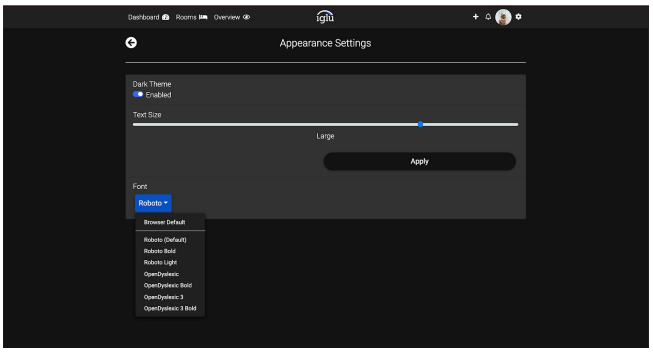
Plugins may be paid products, which we utilise Stripe for payment processing. Once the payment is processed, they will be redirected to their local iglü instance to confirm the installation.

Device Settings (via settings page) ADDITIONAL



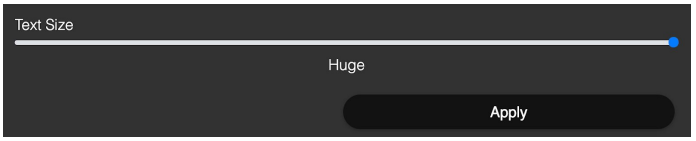
The device settings page shows you a summary of all the devices connected in the smart home. It allows you to see whether the devices are connected or not.

Appearance Settings



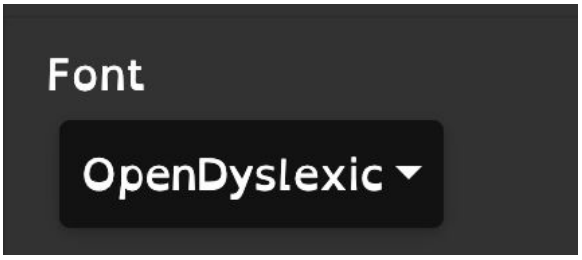
The appearance setting page allows users to change the text size and font, this is to increase accessibility with people with vision impairments or reading disorders.

- **Text Size Changer (For accessibility)**



FR14
The system's font size may be changed individually for each user.

- **Font Changer (For accessibility)**



A selection of fonts are available which users may select, such as the OpenDyslexic font. This is a key component in making the system accessible to all. FR14

Download data in both XML and JSON ADDITIONAL

Data may be downloaded and exported as an XML or JSON format. This is used for backing up the system or for analysis.

Minecraft Simulation ADDITIONAL

The Minecraft simulation plugin allows us to demonstrate the smart home system in a virtual environment.

Bugs and Robustness Evaluation

Overall the system is robust and secure, however, some issues arise in regards to scalability and its responsiveness. The team observed that if a large amount of rooms are added the system starts becoming jittery and slightly less attractive to use. Also when removing rooms there is a 15-20 second delay due to the method on which it was implemented (via auto periodic auto refresh). Both of these issues however are easily mendable.

System Usability Overview

Overall the system is fully usable, both in the real world with a real device and via a simulation visually represented in minecraft. In terms of the real world we have shown the ability to control smart devices by installing the correct extensions from the market is possible, however, only support for one device is currently available; lifx smart bulbs. This however should be enough for a proof of concept that the application works and can easily be extended for further support of other devices.

Within the simulation all our main features are shown to work. This includes all of the data generation statistics and how each device affects the power usage and thus using up all the power that has been stored.

In terms of the app itself all implemented features are usable and robust enough for daily use with the only exception being the features that are unfinished as stated in the functionality assessment above.

Guides

Technical Guide

Installation

Overview

The iglü system software comes with iglüOS and is set up to display information on the e-ink display. iglüOS can be built using the build script provided in the iglüOS repository, the resulting image file may be burned into an 128GB microSD (providing enough space for storing statistics). This microSD card should be inserted in the iglü device, which houses the Raspberry Pi Zero W with an e-ink display and a real-time clock soldered, which is supported by a custom operating system.

For development purposes, the iglü server software may be run on a development machine. The iglü supports any machine which Go compiles to and the program has been tested and confirmed to run on: Linux, macOS, OpenBSD, and Windows.

Running make on the iglü server repository will create a build for your current system. Running the binary will display the command-line interface help menu. Usually, you would want to run the binary as:

```
$ ./nacdlow-server run --dev
```

This would run the server, it would use port 8080 by default, unless overridden by the --port flag.

iglüOS Installation

With the iglüOS repository cloned, you will have to obtain the latest Raspbian Buster Lite .img file. Also all required packages have to be installed before running the build script, these include: bash, go, kpartx, proot, qemu-user-static. Qemu was used with proot as there is a need to emulate ARM to customise Raspbian to match needs in a chroot environment.

The ./build.sh script can then simply be run,, which would take a few minutes and would generate a iglüOS-$DATE.img file. This can be burned to an microSD card by running the following command as a superuser:

```
# dd if=iglüOS-$DATE.img of=/dev/$DEVICE bs=4M
```

Make sure to replace $DATE and $DEVICE with correct identifiers, otherwise you risk overwriting your system partition!

After you complete burning the image to the microSD card, it may be inserted into the iglü's Raspberry Pi Zero W testing unit.

Setup

To add a new iglü user to the system, you can run iglü with the useradd command-line option, as follows:

```
$ nacdlow-server useradd
```

This will prompt you for the email and password of the user you are adding. By default the user will be an admin (unless specified otherwise, using --isadmin false).

Dumping fake data for testing

Fake data may be dumped to the database for testing purposes. This is automated using the dumpfakedata option.

```
$ nacdlow-server dumpfakedata
```

User Guide

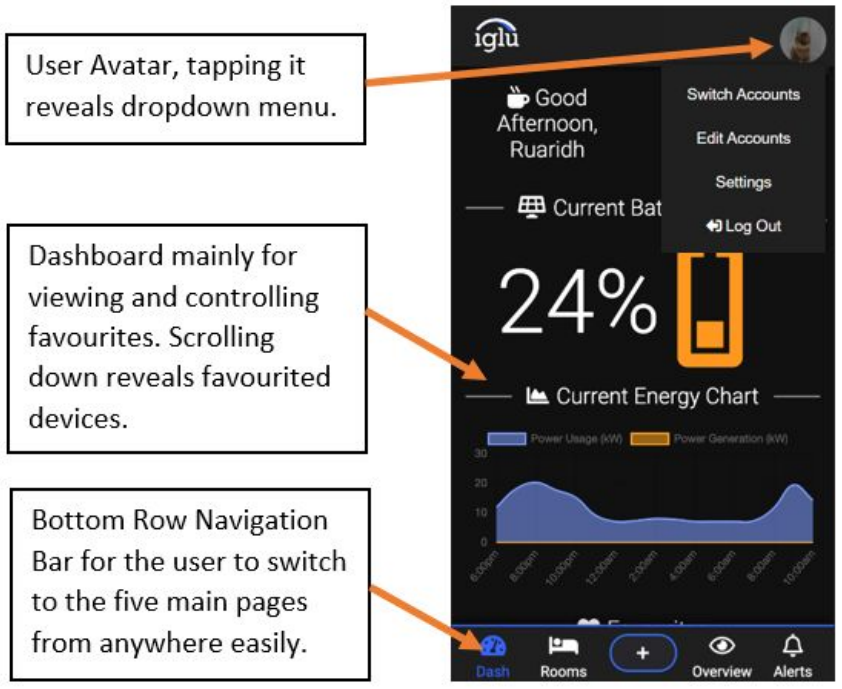
Purpose & Scope

This part of the report gives an explanation of the common features a user will interact with and how to use them. Not every feature will be covered in the user guide as the most will not be the primary use case of the user. It can be mentioned that the other features have been designed to be user friendly and self-explanatory, not requiring a great learning curve by the user.

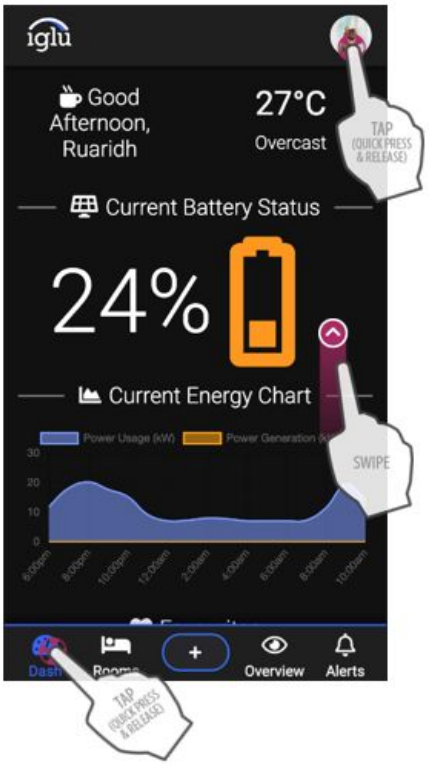
Getting Started

When iglü is first run on the users device of choice, it is assumed that the iglü server mentioned in the above technical guide, is installed successfully and an admin account has been created for the homeowner. Once the admin is logged in the first page they are presented with is the dashboard. For this user guide a primary focus will be set on the mobile layout and the mobile interactions as this will most likely be the users main method through which they will use iglü.

Mobile Layout:



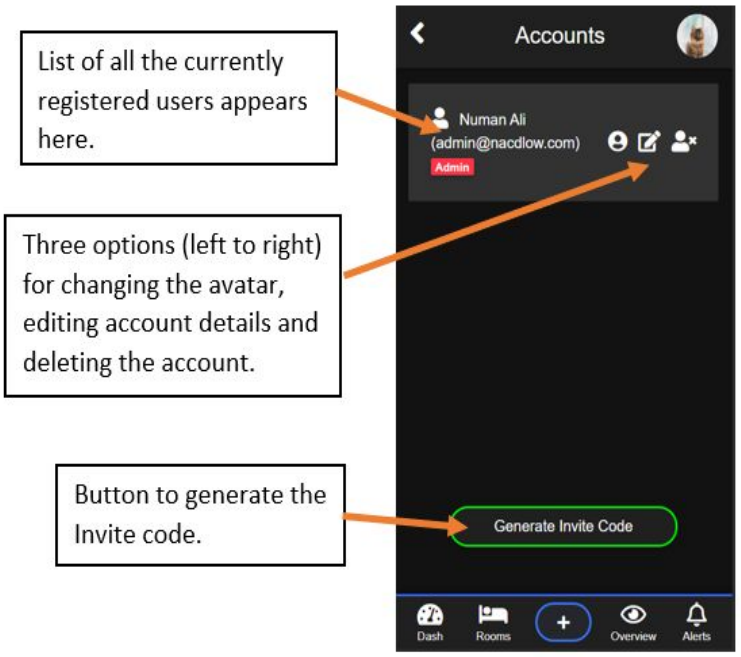
Mobile interactions:



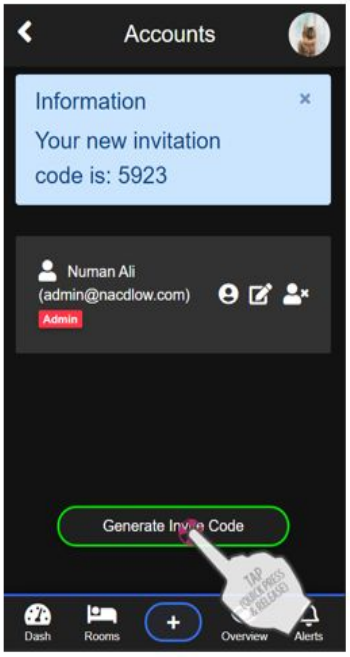
Creating an Account

In this scenario an admin user is going to create another account. From the avatar dropdown menu shown above the user presses the edit accounts option. The following page is then presented:

Mobile Layout:



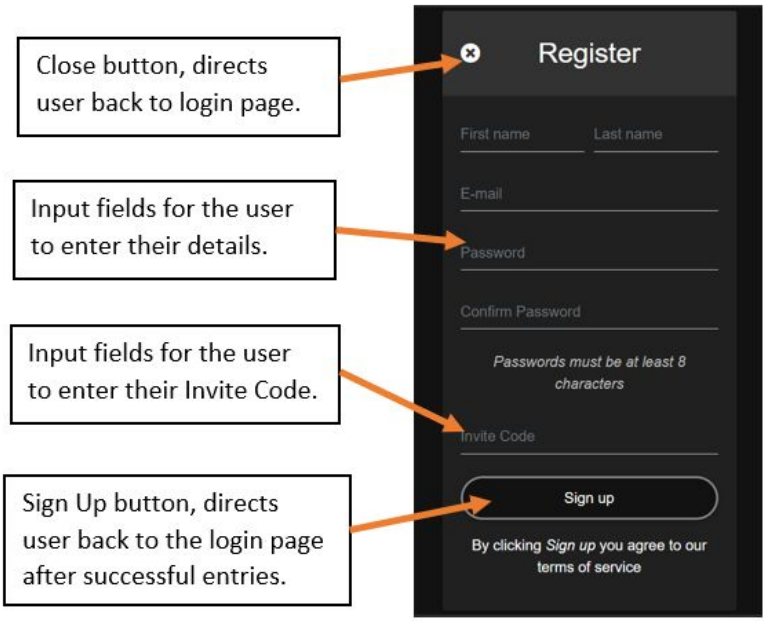
Mobile interactions:



Registering

Once the user presses the generate invite code button and the code is generated the new user can then register. From the register page the user can enter their details and the invite code generated by the admin user. The register page looks like this and is fairly self explanatory:

Mobile Layout:

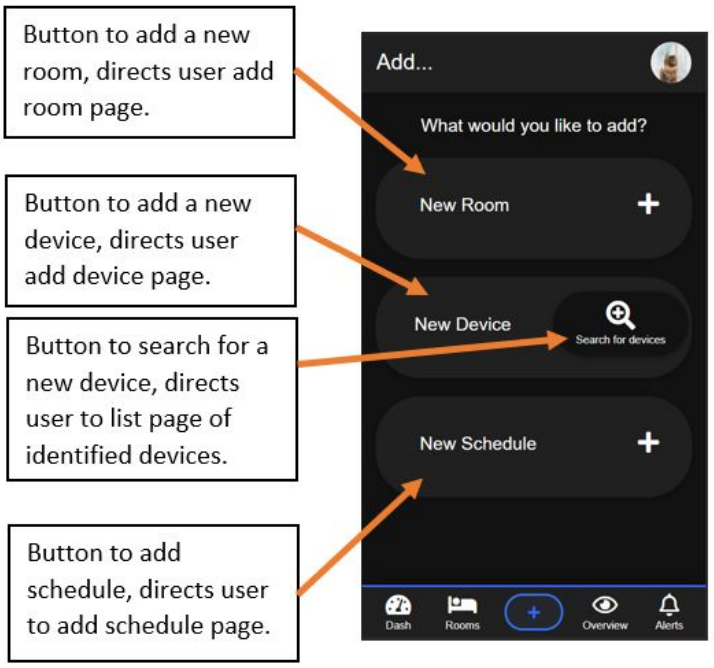


Mobile interactions:

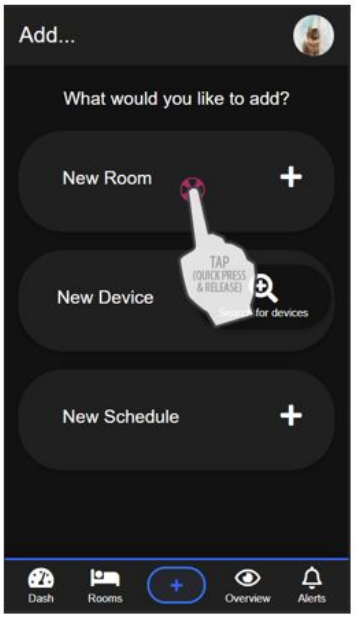
Adding/Removing Rooms

Once the user has completed their registration, the first thing they are going to do is set up a room. To do this the user should tap the plus button in the bottom row navigation bar and the following page will be presented:

Mobile Layout:

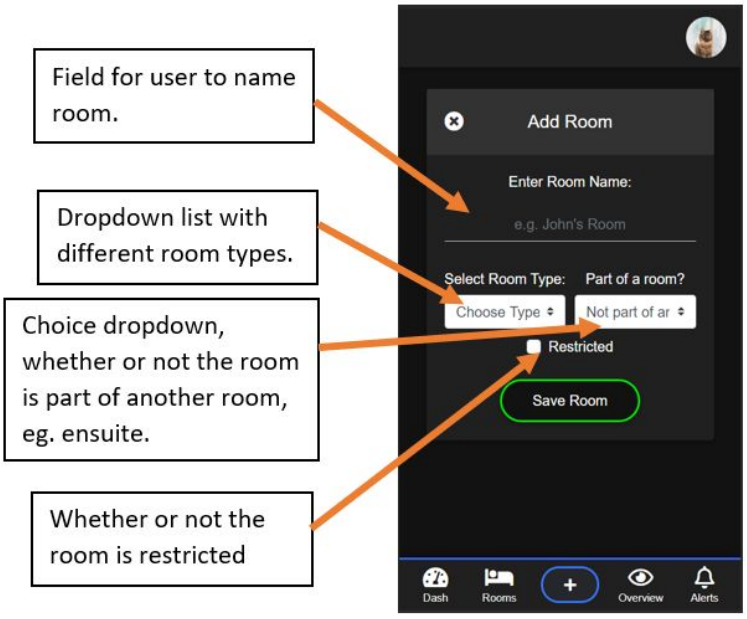


Mobile interactions:

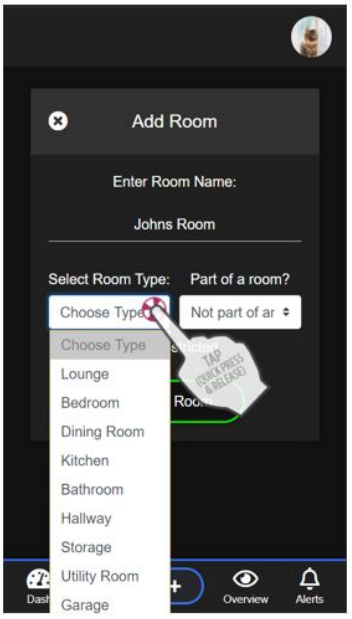


Following this page the user can add the room by filling in the details:

Mobile Layout:

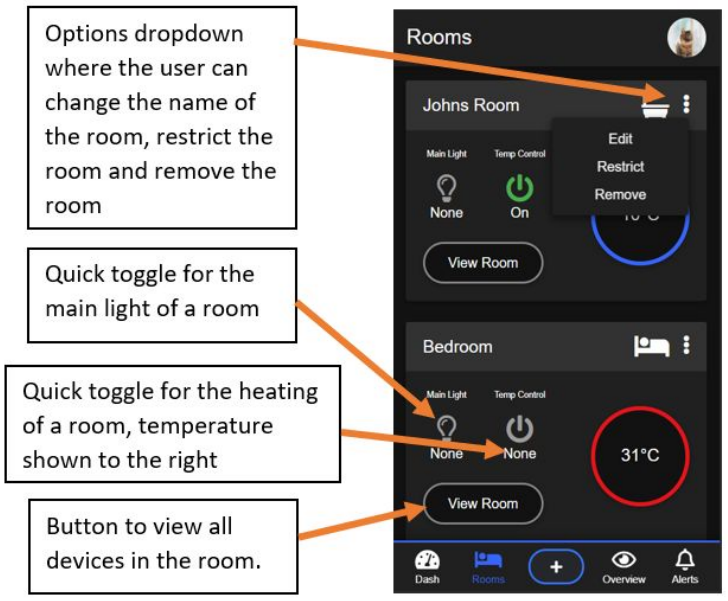


Mobile Interactions:



Removing the room is simple, after the user presses rooms on the bottom navigation bar all the rooms are shown, the user can simply press the options button on the room and then press remove, the full layout of the rooms is show here as well as the remove modal:

Mobile Layout:

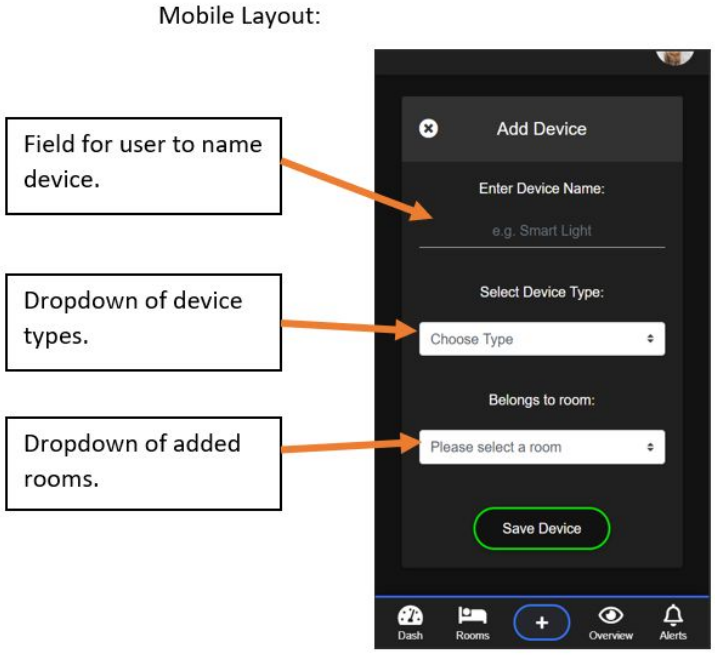


Mobile Interactions:

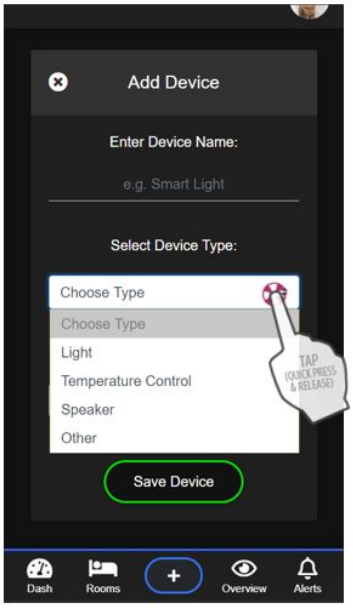
Adding/Removing Devices

To add a device the user should tap the plus button in the bottom row navigation bar and then tap the add device button and the following page will be presented:

Mobile Layout:

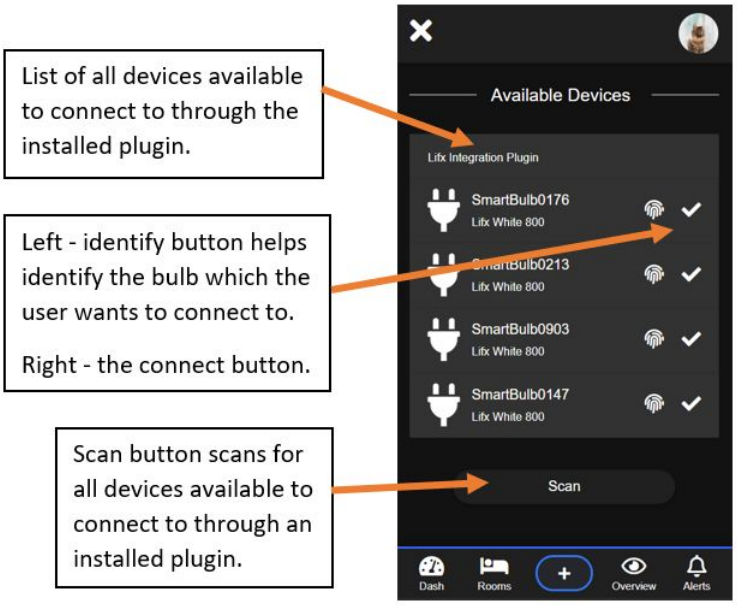


Mobile Interactions:

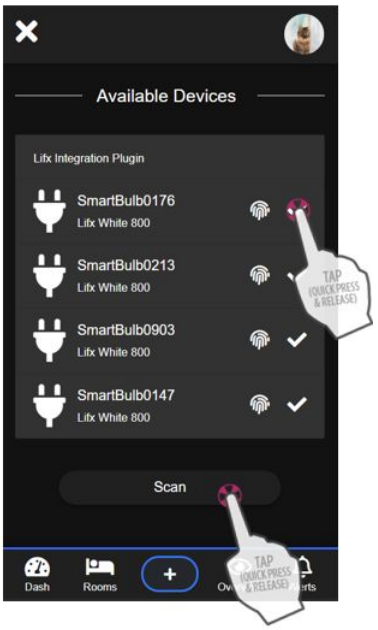


If the user wants to search for their device, with the relevant supported devices listed on the Iglü marketplace as plugins, the following page will appear:

Mobile Layout:

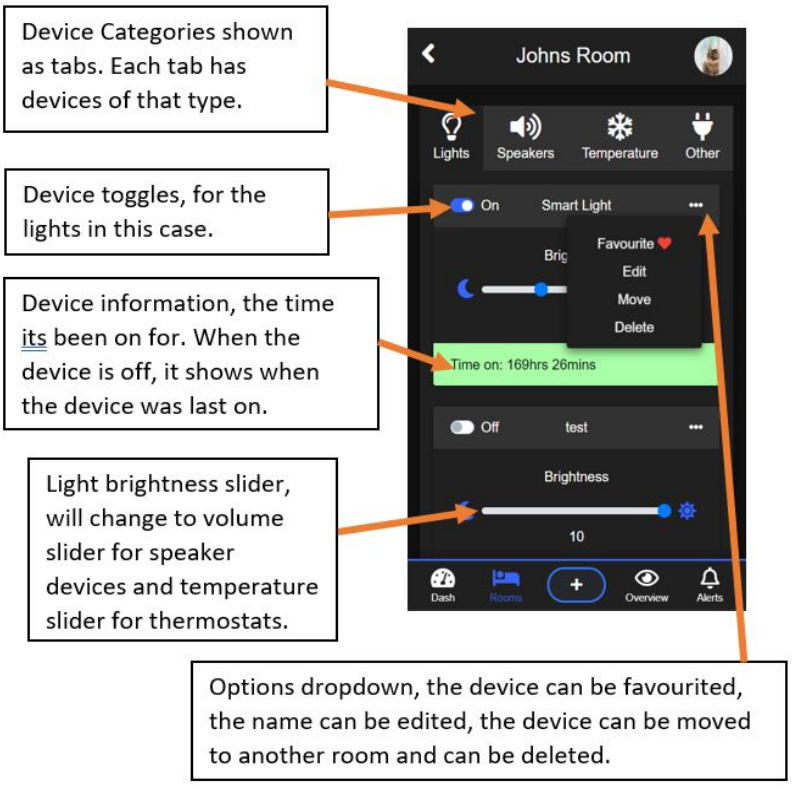


Mobile Interaction:

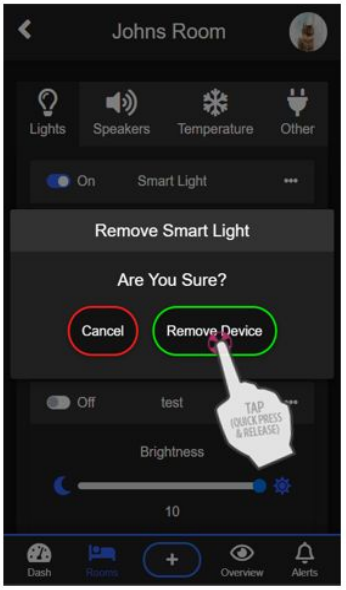


Removing the device is simple, after the user presses rooms on the bottom navigation bar then the “view rooms” button on one of the rooms, the user can view all devices by category. The options button on each device has the remove option. The full layout of the devices page is shown here as well as the remove modal:

Mobile Layout:



Mobile Interaction:



Maintenance Guide

Purpose

The purpose of this document is to provide a guide on maintaining iglü. This document contains instructions on how a user may maintain, backup, and perform other administrative functions on the system.

Scope

The scope of this document is limited to functions available on the system's UI. Other lower-level system operations may not be done without a Nacdlow technician.

Requirements

The user performing the maintenance must be an administrator, otherwise you will not be able to perform maintenance functions on the system settings. Regular, restricted, or guest users will not have administrative options visible on their settings page.

Maintenance

The system is self-containing, at an unlikely event that the system or a plugin crashes, the system will automatically and seamlessly restart. The usual maintenance actions such as renaming, adding and deleting room, or renaming, deleting and adding devices are all available from the user interface, guides for which can be found in our user guide.

Backup

The system may be backed up by exporting the database in XML or JSON format from the settings Import/Export feature. These exports may be used by data scientists or computer hobbyists to further analyse the data.

Admin Features

The admin has full control of the application, including the ability to restrict rooms and devices from other users of the application. They also have full control of all the accounts registered to their home allowing them to edit their details and even change their permissions.

Future Work

If Nacdlow were to continue the development of Iglü, the following features would be added/completed first:

Fix scalability and responsiveness issues
First thing Nacdlow would do is fix all of the bugs and issues regarding its scalability and responsiveness. To achieve this a new method would be implemented that is required to auto refresh the application allowing it to change dynamically rather than periodically.

Overview Page
The overview page needs to be fully implemented, more graphs and statistics should be on this page as well as a functioning live floorplan of the home to allow the user to quickly see what devices are where, and what devices are currently active. The floor plan can also be color coordinated to show different temperature levels similar to a heat map. The overview page as a whole should be a place where Nacdlow developers are free to be creative and implement what they think would be a good idea.

Schedules
Schedules need to be fully implemented to allow users to easily pick the time day and duration of when smart devices should be activated. Also other features like AI based schedules which can learn based on how the user uses the smart home application.

Notifications
Notifications and alerts need to be fully implemented to allow users to quickly gain relevant information and warnings about their smart home and smart devices.

More Device Support
Right now in terms of real world usage Iglü only works with LifX bulbs, but Nacdlow must develop more support for other popular brands such as philips hue, targeting the main brands first will allow Iglü to become more relevant and usable at a faster pace.

Account System
Nacdlow has to redesign the account system to support internalised accounts for each house, this design choice was only discussed later on during development and due to it being such a large and drastic change Nacdlow were unable to adapt the system to support it..

More Plugins for the Market
The marketplace needs to be populated with more plugins and features, this directly correlates to supporting more devices as each device brand should have its own plugin in

the market. Again this is an area in which Nacdlow developers are free to be creative and implement what they want within reason.

Appendix

Project Diary

Meeting Minutes

Meeting 1 - 27 September 2019
Members Present: Humaid AlQassimi, Alakbar Zeynalzadye and Ruaridh Mollica
Members Not Present: Numan Ali, Mark Bird and Amaan Akram

Notes From Meeting:

- Choice of programming language(s) discussed. Humaid gives his reasons for wanting to use Go suggesting he can help teach others.
- A tour of GitLab also given
- No decisions were made due to only half of the group attending

Meeting 2 - 01 October 2019
All Members Present

Notes From Meeting:

- Crash course of GitLab given by Humaid for members not present at last meeting
- Primary roles assigned
- Humaid further elaborates case for using Go for members not present at last meeting
- Brainstorm all ideas that could possibly be included in the application

To-Do Before Next Meeting:

- Rough mock-ups for the app
- Research existing solutions
- Take note of things around the house that could be improved.

Manager Meeting - 08 October 2019
All Members Present

Notes From Manager Meeting:

- Natural Language Processing is the managers field.
- Encouraging using actual hardware (Raspberry Pi).
- Think about retrofitting older homes.
- Others in the group may not know about some technologies, so keep in mind about not creating too many things to learn.
- Don't wait till semester 2 to start writing code.
- Do not underestimate the backend.
- Biggest issue with Amazon Alexa is human error ("switch off the light... no the other one"). Recommend to leave as a want to have.
- Market research is important, even though it is down the line. Focus groups, surveys, etc.
- Think about data. It is very important.

Meeting 3 - 08 October 2019
All Members Present

Notes From Meeting:

- Discussion took place regarding existing solutions
- Begin to look at requirements specification
- Assign section of the specification to each team member
- Manager emailed to arrange first meeting
- App naming and other naming took place

To-Do Before Next Meeting:

- Familiarise ourselves with sections given

Meeting 4 - 11 October 2019
Members Present: Humaid AlQassimi, Numan Ali, Amaan Akram and Ruaridh Mollica
Members Not Present: Mark Bird and Alakbar Zeynalzade

Notes From Meeting:

- Ruaridh showed TeamGantt and explained some of key features
- Humaid discussed a tool set that is going to be used for Go development. GoDoc and Git Merging also discussed.
- Looked at buying a domain and how to set up a website.
- First Gantt chart also created

Meeting 5 - 18 October 2019
All Members Present

Notes From Meeting:

- Mark discusses his reasons for wanting to use WordPress to create the company website in stage 2.
- Discussion also to place as to how project should be kept at the end i.e. release project open-source, keep domain going so can link to portfolios/CV

To-Do For Next Meeting:

- Look at Gantt chart for task to be completed next week

Meeting 6 - 22 October 2019
Members Present: Ruaridh Mollica, Humaid AlQassimi, Numan Ali, Alakbar Zeynalzade
Members Not Present: Mark Bird and Amaan Akram

Notes From Meeting:

- Brief summary given by each present members on what they have completed
- Evident some members finished their sections and willing to work on something else

Meeting 7 - 05 November 2019
Members Present: Ruaridh Mollica, Humaid AlQassimi, Numan Ali, Alakbar Zeynalzade and Amaan Akram
Members Not Present: Mark Bird (shoulder dislocation)

Notes From Meeting:

- Updates given on how much progress has been made since last meeting
- Discussion on how to conduct usability study

To-Do For Next Meeting

- Looking for parts still needing done in report and try and complete them
- Start thinking about creating a mockup of PWA

Manager Meeting - 15 November 2019
All Members Present

Notes From Meeting:

- Assign tasks of usability study
- Manager willing to read over report before deadline

Meeting 8 - 19 November 2019
All Members Present

Notes From Meeting

- Further discussion of usability including all forms that will need to be given to participants and how the results will be stored.

Meeting 9 - 15 January 2020
All Members Present

Notes From Meeting:

- Went over feedback from Stage 1 report as a group
- Humaid discussed structure of the web server
- Numan presented idea of Material-Design Bootstrap
- Date set for 17 Jan when front-end development will begin
- ER Diagram and DB Implementation occurred

Meeting 10 - 30 January 2020
All Members Present

Notes From Meeting:

- Discuss a game plan for the next meeting with the manager - what to show him etc.
- Started to think about the demo to manager (room, time etc)
- Ask manager if he wants to look over report
- Query about student equipment fund

Manager Meeting - 31 January 2020
Members Present: Ruaridh Mollica, Humaid AlQassimi, Numan Ali, Alakbar Zeynalzade and Amaan Akram
Members Not Present: Mark Bird (Mumps)

Notes From Meeting:

- Changes needed on homepage of website
- Changes needed on Team page of website
- Feedback on application given

Meeting 11 - 17 February 2020
All Members Present

Notes From Meeting:

- Discussed how should organise meeting: assign tasks and work individually in meeting to complete or everyone just does their own thing
- Further discussion on marketplace of application
- Continued work on application
- Notifications also considered extensively

Meeting 12 - 21 February 2020
All Members Present

Notes From Meeting:

- Organised some of the remaining tasks into what was absolutely critical (i.e. be completed in the next few days) and what was else was of high priority
- The decision was made to work through the to-do list on Gitlab
- We discussed new ideas such as the a floor plan and moving devices between rooms
- The Student Equipment Fund was brought up and how it could be used to pay for a Raspberry Pi that the server could be hosted on
- Some questions regarding Ron arose about demos and an email was compiled

Meeting 13 - 03 March 2020
All Members Present

Notes From Meeting:

- As the Expo Neared closer a list was made of all the features that should be working by the Expo.
- Email responses from the Tshirt Printing company were read aloud as to update the team on their estimated completion.
- A large list of items that needed re-designed was created and members were assigned these design tasks.
- A complete colour redesign from blues to greys was decided and the Dark Mode was fully embraced

--- COVID-19 Begins to take effect --

Meeting 14 - 10 March 2020
All Members Present

Notes From Meeting:

- After being informed that the Expo was moving to a video presentation we reevaluated what needed to be completed and what how this task would be completed
- A story board was made and the Expo video idea began to take shape
- The team agreed that just because of COVID-19, the quality of our expo should not lessen, and all the merchandise that had been purchased should not go to waste.
- A meetup date was organised to begin the Expo video
- The new updated specification (due to COVID-19) was discussed

Meeting 15 - 23 March 2020
Members Present: Ruaridh Mollica, Numan Ali, Alakbar Zeynalzade and Amaan Akram
Unfortunately Due to COVID-19 Humaid AlQassimi had returned to Dubai so was unable to attend this Meeting. Mark S Bird was also taking the recommended precautions and was unable to attend.

Notes From Meeting:

- The story board was followed closely and interviews were filmed.
- Group members spoke about their roles and what iglü is as an application.
- Alakbar showed the team the newly printed banner
- B-ROLL was filmed to create transitions when making the Expo video

- Our original storyboard had to be deviated from due to 2 members being unable to attend further meetings.

Meeting 16 - 02 April 2020
VIRTUAL MEETING (video call)
All Member Present.

Notes From Meeting:

- Due to the initiation of a national lockdown as a result of COVID-19 new ideas about the expo video were shared.
- An idea was shared by Alakbar about incorporating a “fake skype call” that transitions to videos of Humaid and Mark introducing themselves.
- The gantt chart was updated with people completed work and 3 final sprints were made dictating the final tasks to complete.
- Roles were assigned to each task.

Meeting 17 - 10 April 2020
VIRTUAL MEETING (video call)
All Member Present.

Notes From Meeting:

- All coding sprints had been completed.
- Discussions on what was to be submitted were had
- The complete Expo video plan was shown to all members
- Members assigned themselves tasks for the Expo video
- The current status of the report was shown to the group
- The gantt chart was updated.

Meeting 18 - 17 April 2020
VIRTUAL MEETING (video call)
All Member Present.

Notes From Meeting:

- Members had completed their expo parts and sent them to Alakbar for editing
- The report was discussed in detail in terms of what still needs to be included
- Each member selected portions of the report they wished to complete
- Report work continued during the call where sections that some confusion existed were discussed in detail. E.g. the project diary
- Alakbar showed the team a rough cut of the Expo video intro - we all approved :)

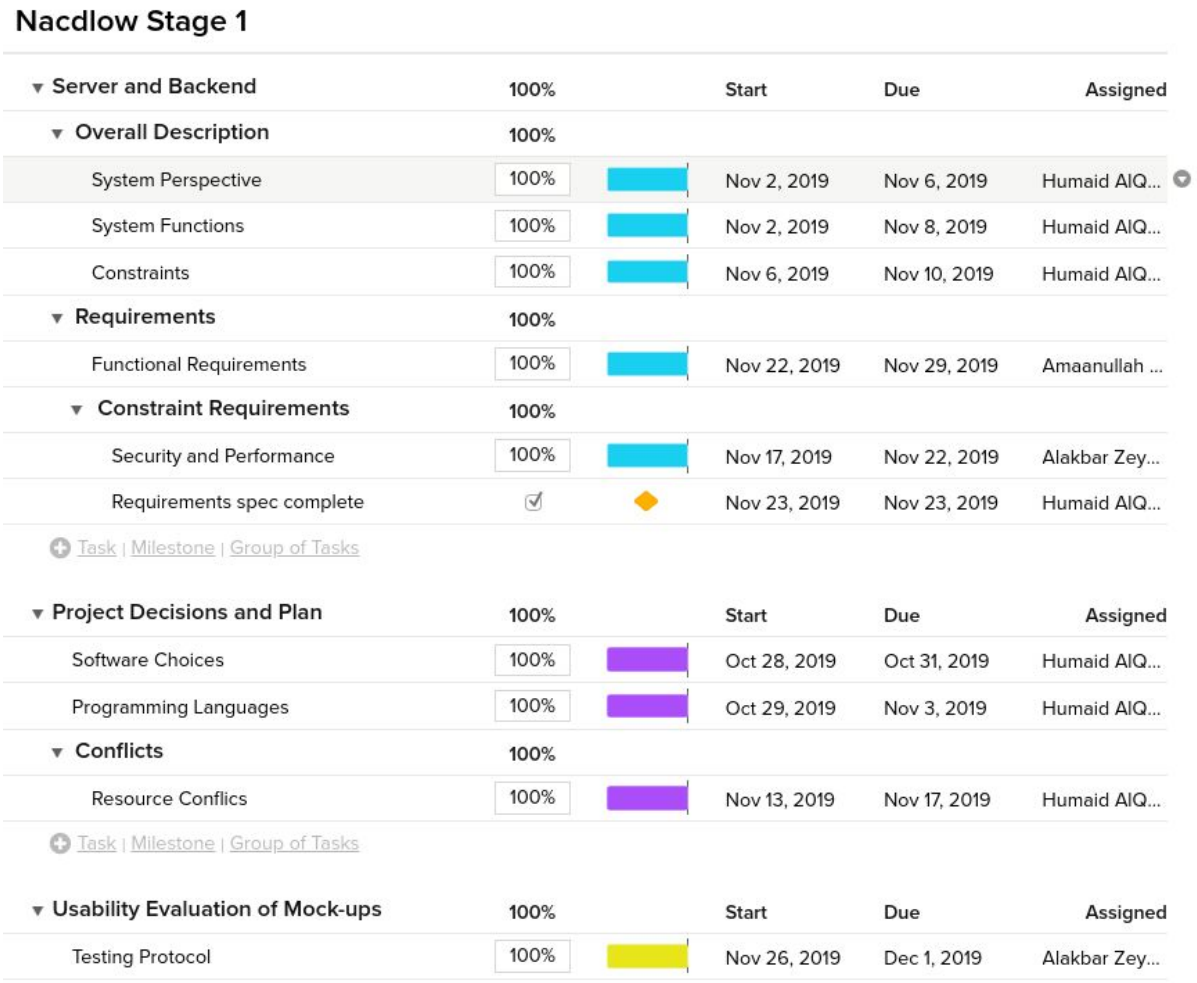
Humaid

The first thing I did when starting the project is creating a style guide which lists our practices, and how we organise meetings and take decisions. We later made a decision on which language we would use. I have persuaded the group on choosing the Go programming language by debating the difference between similar programming languages such as Python and NodeJS.

Then I have taught the developers how to write Go code and the structure of the project. I helped guide the group through tough decisions with technical concepts.

I also created tools which assisted the group with development such as godoc2markdown, iglüOS, Plugin Packager, the Plugin SDK, the Waveshare driver, and much more.

Stage 1



Stage 2

Stage 2

▼ Nacdlow Company Website	100%		Start	Due	Assigned
Deployment	100%		Dec 27, 2019	Dec 29, 2019	Humaid, Mark S bird
Task | Milestone | Group of Tasks					
▼ Application Implementation	75%		Start	Due	Assigned
▼ Sprint 1 - Database	94%				
Database Impementation	100%		Dec 19, 2019	Dec 30, 2019	Humaid, Mark S bird, Numan ...
Server Set-up	100%		Dec 24, 2019	Dec 31, 2019	Amaan, Humaid
▼ Sprint 3 - Back-end Authentication System	50%				
Code Design choices and allocation	100%		Jan 3, 2020	Jan 5, 2020	Amaan, Humaid, Ruaridh Molli...
Authentication system	100%		Jan 6, 2020	Jan 12, 2020	Alakbar, Amaan, Humaid
Two-Factor Authenticaion	0%		Jan 13, 2020	Jan 17, 2020	Humaid
▼ Sprint 5 - Administrator capabilities	0%				
User removal/addition	0%		Jan 23, 2020	Jan 28, 2020	Humaid
▼ Sprint 6 - Backend Routing Finalisation	99%				
Continuous Routing Integration	100%		Jan 1, 2020	Feb 1, 2020	Humaid
▼ Sprint 7 - Testing Phase	65%				
Stress test databse	90%		Feb 2, 2020	Feb 3, 2020	Humaid, Mark S bird
Backend	60%		Feb 2, 2020	Feb 3, 2020	Amaan, Humaid
Task | Milestone | Group of Tasks					
▼ Mid-Stage Changed	100%		Start	Due	Assigned
Coding changes	100%		Feb 3, 2020	Feb 5, 2020	Humaid
Security Changes	100%		Feb 3, 2020	Feb 5, 2020	Amaan, Humaid

Stage 3

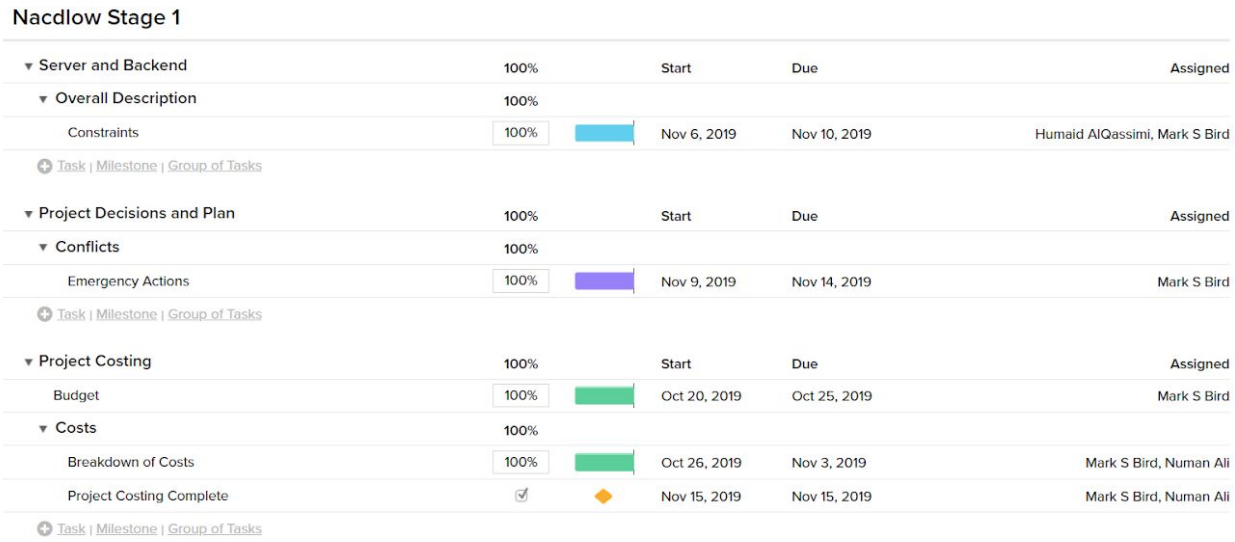
▼ **Sprint 8**	**98%**		**Start**	**Due**	**Assigned**
▼ **Marketplace**	**100%**				
Stripe Demo Purchase	100%		Feb 17, 2020	Feb 23, 2020	Humaid
Accounts/Privileges	100%		Feb 17, 2020	Feb 23, 2020	Humaid
"Time On Since"	100%		Feb 17, 2020	Feb 23, 2020	Alakbar, Humaid, Nu...
Task | Milestone | Group of Tasks					
▼ **Sprint 9**	**96%**		**Start**	**Due**	**Assigned**
Re-Do Plugin System	100%		Feb 24, 2020	Mar 1, 2020	Humaid
Minecraft Stuff (Windows/Doors)	100%		Feb 24, 2020	Mar 1, 2020	Humaid
Improve Simulation Accuracy	100%		Feb 24, 2020	Mar 1, 2020	Humaid
Task | Milestone | Group of Tasks					
▼ **Sprint 10 - Nearly There**	**69%**		**Start**	**Due**	**Assigned**
Minecraft As A Plugin	100%		Mar 2, 2020	Mar 7, 2020	Humaid
General Cleanup (check meeting notes and gitlab	100%		Mar 2, 2020	Mar 7, 2020	Alakbar, Amaan, Hum...
Task | Milestone | Group of Tasks					
▼ **Sprint 11 - Final Stretch**	**68%**		**Start**	**Due**	**Assigned**
Only Show Past 24hrs for Graph	100%		Feb 24, 2020	Mar 1, 2020	Humaid
System Update Functionality	100%		Feb 24, 2020	Mar 1, 2020	Humaid
Only one main light	100%		Feb 24, 2020	Mar 1, 2020	Humaid
▼ **Week 1 of 3**	**60%**		**Start**	**Due**	**Assigned**
Documentation/Set Up Guide (deliverable)	100%		Apr 1, 2020	Apr 5, 2020	Humaid, Numan
Task | Milestone | Group of Tasks					
▼ **Profile Picture Picker**	**93%**		**Start**	**Due**	**Assigned**
Image Encoding	100%		Apr 1, 2020	Apr 5, 2020	Humaid
Task | Milestone | Group of Tasks					
▼ **Week 3 of 3**	**0%**		**Start**	**Due**	**Assigned**
Future Work	100%		set date	set date	Humaid, Ruaridh
Project Diary Paragraph	100%		set date	set date	Alakbar, Amaan, Hum...

Mark

Here I aim to highlight the work that I have completed over the last 7 months. The Gantt chart has been filtered to show the tasks I completed in each of the 3 stages. It is worth nothing that these are not 100% accurate. There will also be a brief bullet pointed list to give a further overview of tasks completed in each stage.

It is worth noting that since I am an Information Systems student that most of my focus was away from the application. However, I still gave opinions on the design of the software when required.

Stage 1



Nacdlow Stage 1

▾ Server and Backend	100%		Start	Due	Assigned
▾ Overall Description	100%				
Constraints	100%		Nov 6, 2019	Nov 10, 2019	Humaid AlQassimi, Mark S Bird
⊕ Task | Milestone | Group of Tasks					
▾ Project Decisions and Plan	100%		Start	Due	Assigned
▾ Conflicts	100%				
Emergency Actions	100%		Nov 9, 2019	Nov 14, 2019	Mark S Bird
⊕ Task | Milestone | Group of Tasks					
▾ Project Costing	100%		Start	Due	Assigned
Budget	100%		Oct 20, 2019	Oct 25, 2019	Mark S Bird
▾ Costs	100%				
Breakdown of Costs	100%		Oct 26, 2019	Nov 3, 2019	Mark S Bird, Numan Ali
Project Costing Complete	☑	◆	Nov 15, 2019	Nov 15, 2019	Mark S Bird, Numan Ali
⊕ Task | Milestone | Group of Tasks					

- I worked with Numan to complete the project costing section of the report
- Made initial contact with our manager (Yannis) and arranged numerous meetings with him
- Helped with the overall editing and completion of the Stage 1 report
- Detailed actions to be taken if conflicts arose in the team
- Began to research ways of creating the company website due in Stage 2
- Worked with Humaid on constraints in the requirements specification

Stage 2

Stage 2

▾ Nacdlow Company Website	100%		Start	Due	Assigned
Website structure and plan	100%		Dec 20, 2019	Dec 25, 2019	Mark S bird
Website design and implementation of plan	100%		Dec 20, 2019	Dec 28, 2019	Mark S bird
UI refinement	100%		Dec 20, 2019	Dec 29, 2019	Alakbar, Mark S bird, Ruaridh Mollica
Deployment	100%		Dec 27, 2019	Dec 29, 2019	Humaid, Mark S bird
⊕ Task | Milestone | Group of Tasks					
▾ Application Implementation	75%		Start	Due	Assigned
▾ Sprint 1 - Database	94%				
Database Impementation	100%		Dec 19, 2019	Dec 30, 2019	Humaid, Mark S bird, Numan ALi
▾ Sprint 4 - Smart Controls Interface	73%				
Testing and Documentation	50%		Jan 23, 2020	Jan 24, 2020	Alakbar, Mark S bird, Ruaridh Mollica
▾ Sprint 7 - Testing Phase	65%				
Company website	100%		Feb 2, 2020	Feb 3, 2020	Mark S bird
Stress test databse	90%		Feb 2, 2020	Feb 3, 2020	Humaid, Mark S bird
⊕ Task | Milestone | Group of Tasks					
▾ Mid-Stage Changed	100%		Start	Due	Assigned
Documentation Changes	50%		set date	set date	Mark S bird, Numan ALi

- Further researched how to create website required with help of Humaid
- Created website
- Continued to test and redesign elements of website after manager feedback
- Wrote sections of the Stage 2 report
- Gave general help where required in Stage 2 report
- Gave demonstration of final website design to manager

Stage 3

Nacdlow Stage 3

▾ Sprint 8	98%		Start	Due	Assigned
Getting Started On Report	90%		Feb 17, 2020	Feb 23, 2020	Mark
⊕ Task | Milestone | Group of Tasks					
▾ Sprint 9	96%		Start	Due	Assigned
More Report Stuff	50%		Feb 24, 2020	Mar 1, 2020	Mark
⊕ Task | Milestone | Group of Tasks					
▾ Sprint 10 - Nearly There	69%		Start	Due	Assigned
Design Usability Study (POSTPONED)	15%		Mar 2, 2020	Mar 7, 2020	Alakbar, Mark
General Cleanup (check meeting notes and gitlab issues)	100%		Mar 2, 2020	Mar 7, 2020	Alakbar, Amaan, Humaid, Mark, Numan, Ruaridh
⊕ Task | Milestone | Group of Tasks					
▾ Sprint 11 - Final Stretch	68%		Start	Due	Assigned
Marketing Stuff	25%		Feb 24, 2020	Mar 1, 2020	Mark
Test Application	0%		Feb 24, 2020	Mar 1, 2020	Mark
⊕ Task | Milestone | Group of Tasks					
▾ Week 1 of 3	60%		Start	Due	Assigned

▾ Week 1 of 3	60%		Start	Due	Assigned
Report	50%		Apr 1, 2020	Apr 5, 2020	Alakbar, Amaan, Mark
Marketing & Analysis	15%		Apr 1, 2020	Apr 5, 2020	Mark
⊕ Task | Milestone | Group of Tasks					
▾ Marketing Section In Report	100%		Start	Due	Assigned
Introduction	100%		Apr 1, 2020	Apr 1, 2020	Mark
Product and Market Background	100%		Apr 1, 2020	Apr 3, 2020	Mark
SWOT Analysis	100%		Apr 4, 2020	Apr 6, 2020	Mark
PESTLE Analysis	100%		Apr 7, 2020	Apr 8, 2020	Mark
Porter's 5 Forces	100%		Apr 9, 2020	Apr 11, 2020	Mark
Marketing Strategies	100%		Apr 9, 2020	Apr 12, 2020	Mark
Marketing Goals	100%		Apr 12, 2020	Apr 12, 2020	Mark
Marketing Mix	100%		Apr 13, 2020	Apr 13, 2020	Mark
Unique Selling Point	100%		Apr 13, 2020	Apr 13, 2020	Mark
⊕ Task | Milestone | Group of Tasks					
▾ Week 3 of 3	0%		Start	Due	Assigned
Project Diary (List View, Filter to your name)	100%		set date	set date	Mark, Ruaridh
Project Diary Paragraph	100%		set date	set date	Alakbar, Amaan, Humaid, Mark, Numan, Ruaridh
▾ Project Evaluation	0%		Start	Due	Assigned
Introduction	100%		set date	set date	Mark

- I started to piece together an outline of what was required in the report
- I wrote the introduction of the report
- Extensive research into the market conducted
- The marketing section of the report was then completed
- Me and Alakbar began working on the usability testing that was to be done prior to the COVID-19 outbreak - this was then postponed
- With the help of Ruaridh, I compiled all the notes that had been taken at each of our meetings
- I provided help wherever necessary in the report
- Also wrote the introduction to the project evaluation
- I helped to proof read the entire document for spelling, grammar etc. prior to submission

Ruaridh

In this section I aim to demonstrate the areas that I worked on in the development of the project. For the duration of the development I worked as an organisational manager, front end, and backend programmer.
To show what areas i worked on, I have included a filtered version of our Gantt chart showing what tasks I completed in each sprint in stage 2 and 3(the gantt chart is not 100% accurate and does not show all the work each member did, hence i will include further data).
I have also included my commit history from the gitlab project.
Further detail of my role in development is also highlighted in a bullet point list.

Stage 1

- Worked with Alakbar to design the prototype of the application GUI
- Worked with Alakbar to create the Usability study to test the GUI
- Completed the Risk Analysis and Mitigation document with Amaan
- Managed the Gantt charts
- Created and managed the Nacdlow instagram page
- Took meeting minutes for the first half of stage 1
- Wrote the User Characteristics section
- Wrote the Interface Constraint Requirements

Stage 2

Gantt Tasks

Stage 2

▾ Nacdlow Company Website	100%		Start	Due	Assigned
UI refinement	100%		Dec 20, 2019	Dec 29, 2019	Alakbar, Mark S bird, Ruaridh Mollica
Task | Milestone | Group of Tasks					
▾ Application Implementation	75%		Start	Due	Assigned
▾ Sprint 2 - Basic Application Interface	97%				
Web Application Interface design	100%		Dec 20, 2019	Dec 25, 2019	Alakbar, Numan ALI, Ruaridh Mollica
Interface Implementation	100%		Dec 22, 2019	Jan 4, 2020	Alakbar, Numan ALI, Ruaridh Mollica
Testing and Documentation	75%		Jan 6, 2020	Jan 8, 2020	Alakbar, Numan ALI, Ruaridh Mollica
▾ Sprint 3 - Back-end Authentication System	50%				
Code Design choices and allocation	100%		Jan 3, 2020	Jan 5, 2020	Amaan, Humaid, Ruaridh Mollica
Password Reset Capabilities	30%		Jan 18, 2020	Jan 20, 2020	Ruaridh Mollica
▾ Sprint 4 - Smart Controls Interface	73%				
Devices	100%		Jan 16, 2020	Jan 21, 2020	Ruaridh Mollica
Statistics	50%		Jan 18, 2020	Jan 22, 2020	Alakbar, Ruaridh Mollica
Testing and Documentation	50%		Jan 23, 2020	Jan 24, 2020	Alakbar, Mark S bird, Ruaridh Mollica
▾ Sprint 7 - Testing Phase	65%				
Web application	100%		Feb 2, 2020	Feb 3, 2020	Alakbar, Numan ALI, Ruaridh Mollica
Task | Milestone | Group of Tasks					
▾ Mid-Stage Changed	100%		Start	Due	Assigned
UI changes	100%		Feb 3, 2020	Feb 5, 2020	Alakbar, Ruaridh Mollica

A Cumulative List of Tasks Performed

- created Room Statistics table schema (.go)
- Added “specific rooms” page
- Added Devices Pages (lights, heating, speakers)
- Added options to devices (ellipses drop down)
- Added initial functionality on devices
- Added auto generated room icons
- Made Device toggles and brightness sliders post data to DB
- Added auto-updating divs so elements refresh and dynamically update their data
- General help across the report

Stage 3

Gantt Tasks

Nacdlow Stage 3

▾ **Sprint 8**	**98%**		**Start**	**Due**	**Assigned**
Fix Refresh Issue	90%		Feb 17, 2020	Feb 23, 2020	Ruaridh
▾ **Sprint 9**	**96%**		**Start**	**Due**	**Assigned**
Fix Refresh Issue Further	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Edit Rooms	100%		Feb 24, 2020	Mar 1, 2020	Numa...
Move Devices Between Rooms	100%		Feb 24, 2020	Mar 1, 2020	Alakba...
T-SHIRTS/MERCH	100%		Feb 24, 2020	Mar 1, 2020	Alakba...
▾ **Sprint 10 - Nearly There**	**69%**		**Start**	**Due**	**Assigned**
Move Devices Between Rooms	100%		Mar 2, 2020	Mar 7, 2020	Numa...
T-Shirts	100%		Mar 2, 2020	Mar 7, 2020	Ruaridh
General Cleanup (check meeting	100%		Mar 2, 2020	Mar 7, 2020	Alakba...
Add option to restrict a room	100%		Mar 2, 2020	Mar 7, 2020	Ruaridh

▾ **Sprint 11 - Final Stretch**	**68%**		**Start**	**Due**	**Assigned**
Replace TV with Other for adding	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Admin Only Settings	100%		Feb 24, 2020	Mar 1, 2020	Numa...
Remove Description on Room	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Add close button on renaming	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Make "main light" option just for	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Error when trying to move a main	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
▾ **Week 1 of 3**	**60%**		**Start**	**Due**	**Assigned**
Help/How-To In App	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
▾ **Profile Picture Picker**	**93%**		**Start**	**Due**	**Assigned**
Image Viewing (Database)	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
▾ **Week 2 of 3**	**70%**		**Start**	**Due**	**Assigned**
Voice Over Recordings	90%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Add "User Role" option in edit	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Make it so restricted users have little	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Restricted rooms dont show on "add	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Remove "Guest" as a role from	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh

▾ **Week 3 of 3**	**0%**		**Start**	**Due**	**Assigned**
Usability	100%		set date	set date	Alakbar, Amaan, Ruaridh
Future Work	100%		set date	set date	Humaid, Ruaridh
Project Diary (List View, Filter to your name)	100%		set date	set date	Ruaridh
Project Diary Paragraph	100%		set date	set date	Alakbar, Amaan, Humaid, Mark, Numan, Ruaridh

A Cumulative List of Tasks Performed

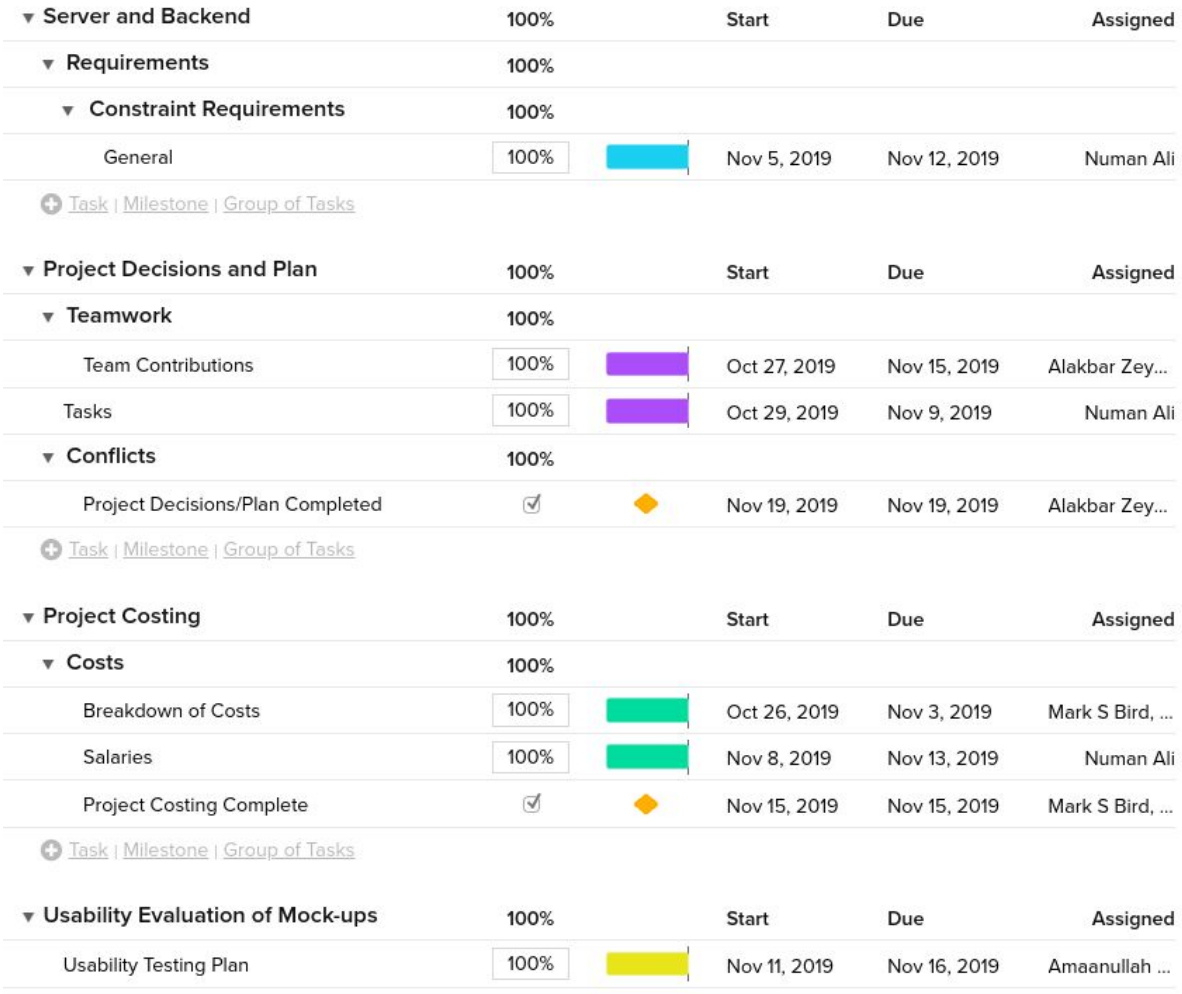
- Added auto update on rooms cards
- Added “options” ellipses on rooms
- Added the ability to remove rooms and devices
- Added functionality to edit device names
- Added functionality to edit room names
- Created ability to move devices between rooms (tidied up by Numan)
- Added the ability to restrict rooms from non admin users
- Added “other” devices tab and cards
- Fleshed out user restrictions across the application i.e. admin only features
- Made it so you cannot move main lights or temp devices
- Added help page in settings with video tutorials
- Added an option to change a users role in account settings
- Fixed register page .go code so it posts to database
- General help across the report (usability, GUI stuff, schedules, features etc.)
-

Full Commit History of Ruaridh Mollica from January 15 2020 - April 10 2020
https://github.com/Nacdlow/iglu-server/commits?author=ruaridhmollica

Numan

In this section of the report I will go over my contributions to the project development. I was given the role of technical manager in stage 1 and later focussed primarily on front-end development. Below are the gantt charts for the three stages of development. The gantt charts have been filtered to only show my tasks in each stage, however, not everything I did is listed as part of the gantt chart especially for stages 2 and 3. A cumulative list of the commits from github will be presented to fill any gaps in my contributions for stages 2 and 3.

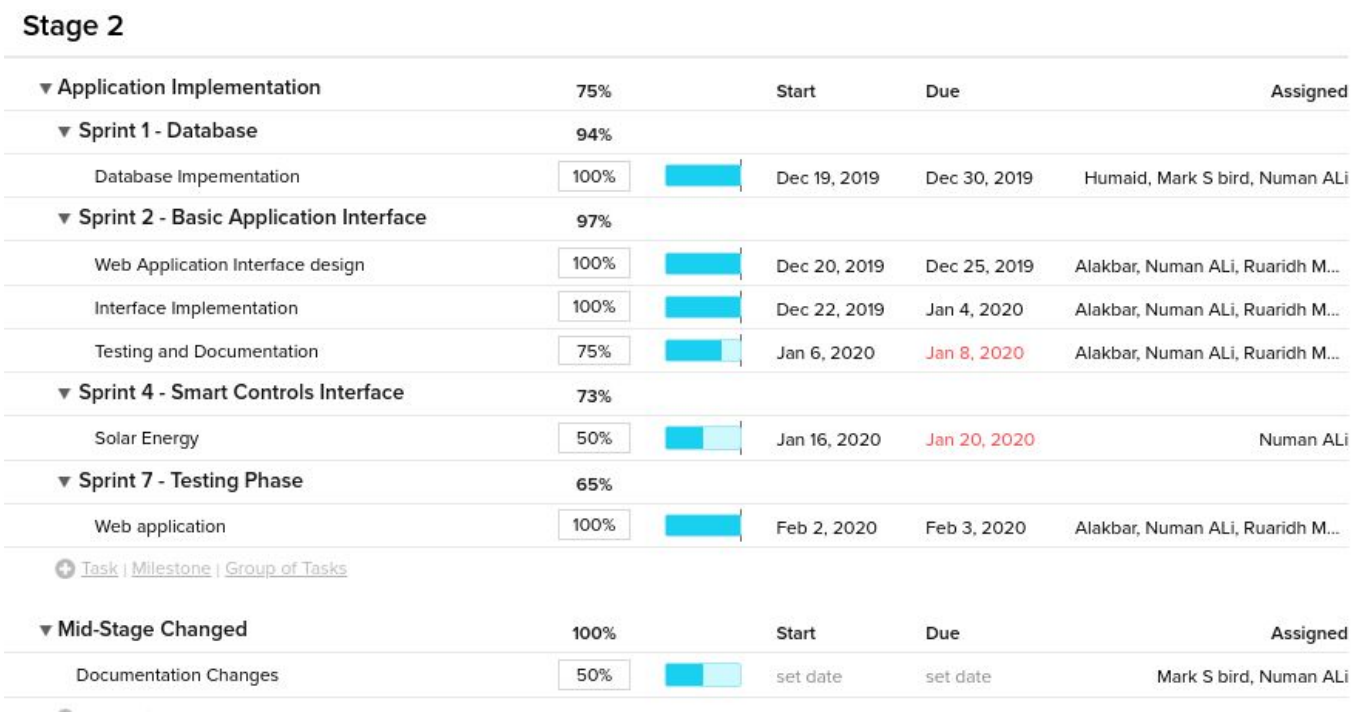
Stage 1



▾ Server and Backend	100%		Start	Due	Assigned
▾ Requirements	100%				
▾ Constraint Requirements	100%				
General	100%		Nov 5, 2019	Nov 12, 2019	Numan Ali
⊕ Task | Milestone | Group of Tasks					
▾ Project Decisions and Plan	100%		Start	Due	Assigned
▾ Teamwork	100%				
Team Contributions	100%		Oct 27, 2019	Nov 15, 2019	Alakbar Zey...
Tasks	100%		Oct 29, 2019	Nov 9, 2019	Numan Ali
▾ Conflicts	100%				
Project Decisions/Plan Completed	☑	◆	Nov 19, 2019	Nov 19, 2019	Alakbar Zey...
⊕ Task | Milestone | Group of Tasks					
▾ Project Costing	100%		Start	Due	Assigned
▾ Costs	100%				
Breakdown of Costs	100%		Oct 26, 2019	Nov 3, 2019	Mark S Bird, ...
Salaries	100%		Nov 8, 2019	Nov 13, 2019	Numan Ali
Project Costing Complete	☑	◆	Nov 15, 2019	Nov 15, 2019	Mark S Bird, ...
⊕ Task | Milestone | Group of Tasks					
▾ Usability Evaluation of Mock-ups	100%		Start	Due	Assigned
Usability Testing Plan	100%		Nov 11, 2019	Nov 16, 2019	Amaanullah ...

- Worked primarily on the project costing with Mark.
- Worked out theoretical salaries and typical software engineering roles for the project costing.
- Added to constraint requirements.
- Worked on the usability testing plan with the team.
- Contributed to brainstorming ideas for the web app.

Stage 2



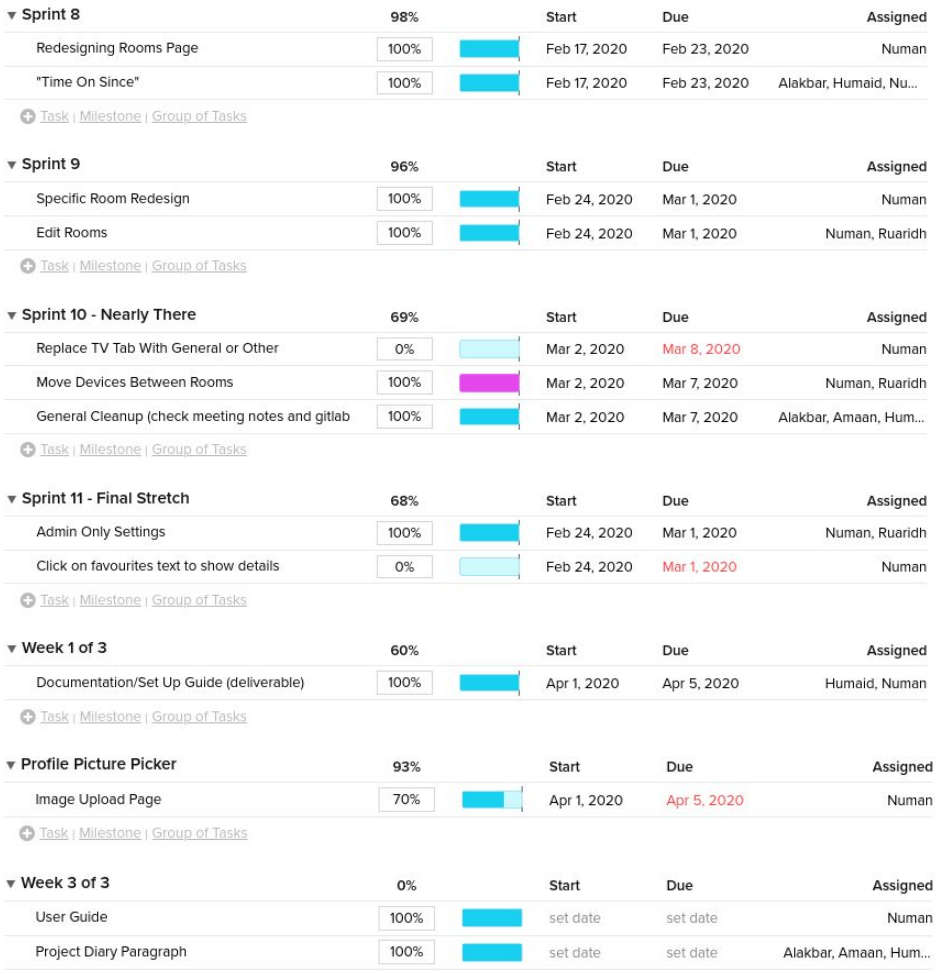
Stage 2

▼ Application Implementation	75%		Start	Due	Assigned
▼ Sprint 1 - Database	94%				
Database Impementation	100%		Dec 19, 2019	Dec 30, 2019	Humaid, Mark S bird, Numan ALi
▼ Sprint 2 - Basic Application Interface	97%				
Web Application Interface design	100%		Dec 20, 2019	Dec 25, 2019	Alakbar, Numan ALi, Ruaridh M...
Interface Implementation	100%		Dec 22, 2019	Jan 4, 2020	Alakbar, Numan ALi, Ruaridh M...
Testing and Documentation	75%		Jan 6, 2020	Jan 8, 2020	Alakbar, Numan ALi, Ruaridh M...
▼ Sprint 4 - Smart Controls Interface	73%				
Solar Energy	50%		Jan 16, 2020	Jan 20, 2020	Numan ALi
▼ Sprint 7 - Testing Phase	65%				
Web application	100%		Feb 2, 2020	Feb 3, 2020	Alakbar, Numan ALi, Ruaridh M...
Task | Milestone | Group of Tasks					
▼ Mid-Stage Changed	100%		Start	Due	Assigned
Documentation Changes	50%		set date	set date	Mark S bird, Numan ALi

A Cumulative List of Tasks Performed

- Suggested using the MDB framework for the front-end development.
- Made schema for statistics table model using Go.
- Added devices page.
- Added significant CSS to make pages more consistent.
- Added bottom navbar for mobile view.
- Completely redesigned login page using own CSS and HTML.
- Made sure all pages look as intended on mobile
- Redesigned overview page and weather page.
- Added form for adding a device.
- Added overview page with prototype floor plan (which was later redacted).
- Other minor UI changes like changing colour scheme... multiple times, and consistency updates as some team members were unfamiliar with MDB.
- Helped with stage 2 report with the rest of the team.

Stage 3



▾ Sprint 8	98%		Start	Due	Assigned
Redesigning Rooms Page	100%		Feb 17, 2020	Feb 23, 2020	Numan
"Time On Since"	100%		Feb 17, 2020	Feb 23, 2020	Alakbar, Humaid, Nu...
Task | Milestone | Group of Tasks					
▾ Sprint 9	96%		Start	Due	Assigned
Specific Room Redesign	100%		Feb 24, 2020	Mar 1, 2020	Numan
Edit Rooms	100%		Feb 24, 2020	Mar 1, 2020	Numan, Ruaridh
Task | Milestone | Group of Tasks					
▾ Sprint 10 - Nearly There	69%		Start	Due	Assigned
Replace TV Tab With General or Other	0%		Mar 2, 2020	Mar 8, 2020	Numan
Move Devices Between Rooms	100%		Mar 2, 2020	Mar 7, 2020	Numan, Ruaridh
General Cleanup (check meeting notes and gitlab	100%		Mar 2, 2020	Mar 7, 2020	Alakbar, Amaan, Hum...
Task | Milestone | Group of Tasks					
▾ Sprint 11 - Final Stretch	68%		Start	Due	Assigned
Admin Only Settings	100%		Feb 24, 2020	Mar 1, 2020	Numan, Ruaridh
Click on favourites text to show details	0%		Feb 24, 2020	Mar 1, 2020	Numan
Task | Milestone | Group of Tasks					
▾ Week 1 of 3	60%		Start	Due	Assigned
Documentation/Set Up Guide (deliverable)	100%		Apr 1, 2020	Apr 5, 2020	Humaid, Numan
Task | Milestone | Group of Tasks					
▾ Profile Picture Picker	93%		Start	Due	Assigned
Image Upload Page	70%		Apr 1, 2020	Apr 5, 2020	Numan
Task | Milestone | Group of Tasks					
▾ Week 3 of 3	0%		Start	Due	Assigned
User Guide	100%		set date	set date	Numan
Project Diary Paragraph	100%		set date	set date	Alakbar, Amaan, Hum...

A Cumulative List of Tasks Performed - lots of commits were made so only the most important ones will be listed here

- Refined mobile user experience - I did this by using my smartphone as the main device and looking for inconsistencies.
- Completely redesigned rooms page as per Humaids request.
- Implemented and designed the plugin settings page and alerts page.
- Redesigned the settings, made it more user friendly.
- Almost completely redesigned the look of the devices page
- Helped implement various front-end modals and functionality, and worked with humaid to suit the backend needs.
- In general helped team members with any front-end issues they had.
- The last major change I made to the UI was to implement the MDB card look to any every card type element in Iglü, including modals and modal type pages like for example the add device page.
- In terms of this report, I worked on and completed the user guide.

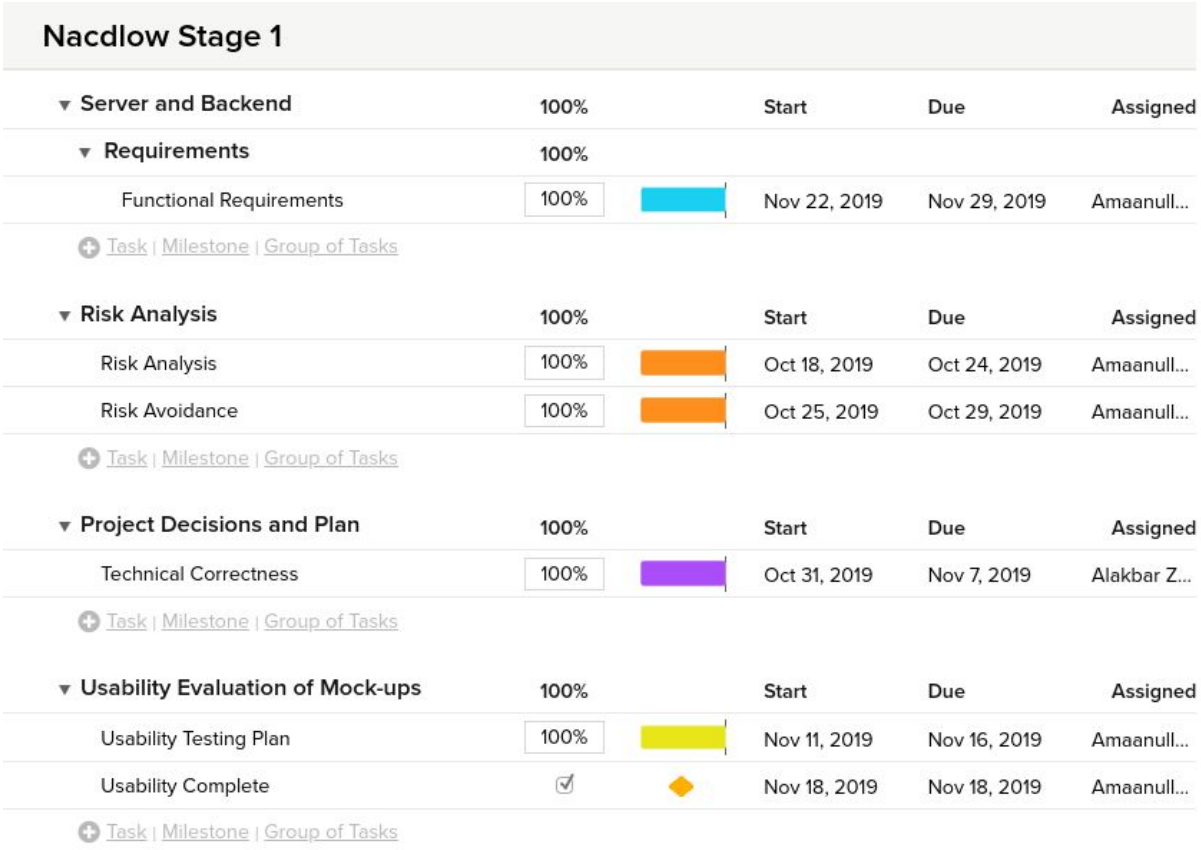
Full Commit History of Numan Ali from January 15 2020 - April 10 2020

https://github.com/Nacdlow/iglu-server/commits?author=n-ali1

Amaan

This section of the report is for me to go over what I have contributed to Nacdlow and the development of our smart home application. As I had the role of organisation manager and technical manager I helped to set up meetings as well as develop many components of the application including front and back end. Below is a breakdown of my gantt chart over the past three stages as well as an accompanying acumaltive list briefly going over what I had accomplished.

Stage 1



A Cumulative List of Tasks Performed

-Worked on functional and non requirements
-Created full use case diagram
-Created individual user use case diagrams
-Descriptions for each diagram
-Full system overview diagram
-Risk analysis and avoidance with ruaridh
-Worked on Technical Correctness
-Helped with usability test plan
-Conducted usability tests

Stage 2

A Cumulative List of Tasks Performed
-Helped setup the database with the team
-Started front end development
-Login, signup and register page design and functionality
-Worked on the authentication system
-Worked on user profiles
-Started working on implementing the PWA
-implemented user tips in dashboard
-front end changes through the application
-More diagrams for the stage 2 report

Stage 3

▾ **Sprint 8**	**98%**		**Start**	**Due**	**Assigned**
PWA Service Worker	100%		Feb 17, 2020	Feb 23, 2020	Amaan
Manifest.js file	100%		Feb 17, 2020	Feb 23, 2020	Amaan
⊕ Task | Milestone | Group of Tasks					
▾ **Sprint 9**	**96%**		**Start**	**Due**	**Assigned**
Alert/Nofications (in app)	100%		Feb 24, 2020	Mar 1, 2020	Amaan
Netflix Login Redesign	100%		Feb 24, 2020	Mar 1, 2020	Amaan
⊕ Task | Milestone | Group of Tasks					
▾ **Sprint 10 - Nearly There**	**69%**		**Start**	**Due**	**Assigned**
Add Users	90%		Mar 2, 2020	Mar 8, 2020	Amaan
General Cleanup (check meeting notes and gitlab	100%		Mar 2, 2020	Mar 7, 2020	Alakbar, Amaan, Hum...
Device Settings	100%		Mar 2, 2020	Mar 7, 2020	Amaan
⊕ Task | Milestone | Group of Tasks					
▾ **Sprint 11 - Final Stretch**	**73%**		**Start**	**Due**	**Assigned**
Implement Netflix Login Fully	50%		Feb 24, 2020	Mar 1, 2020	Amaan
Populate Settings Menu	100%		Mar 3, 2020	Mar 10, 2020	Amaan
▾ **Week 1 of 3**	**60%**		**Start**	**Due**	**Assigned**
Report	50%		Apr 1, 2020	Apr 5, 2020	Alakbar, Amaan, Mark
⊕ Task | Milestone | Group of Tasks					
▾ **Week 2 of 3**	**77%**		**Start**	**Due**	**Assigned**
Usability	50%		Apr 1, 2020	Apr 5, 2020	Alakbar, Amaan
⊕ Task | Milestone | Group of Tasks					
▾ **Week 3 of 3**	**0%**		**Start**	**Due**	**Assigned**
Usability	100%		set date	set date	Alakbar, Amaan, Ruar...
Project Diary Paragraph	100%		set date	set date	Alakbar, Amaan, Hum...

A Cumulative List of Tasks Performed

-Finished implementing PWA portion of application
-Started implementation of in app notifications
-Created new alerts table
-Started implementing new account system
-Started implementing new account switcher
-populated settings pages
-Started working on device settings allowing you to view all device stats
-Added more tips for the app to cycle through

Full Commit History of Amaan Akram from January 15 2020 - April 10 2020

https://github.com/Nacdlow/iglu-server/commits?author=amaan-akram

Alakbar

This little section of the report will detail my contributions to this group project, split up into stages 1, 2, and 3.

Stage 1

In this.Stage() I worked with Ruaridh to create a mockup of the application. This mockup would allow the group to see a general design trajectory for the application. This mockup would also be used for the usability tests; another thing that I worked with Ruaridh on. Ruaridh handled the meeting notes for the first half of this.Stage() whilst I handled the meeting notes for the second half of the stage, right through to the end of the project. It must be said though, that especially as COVID-19 became an issue, less and less meeting notes were taken. Oh, and of course, I worked on the this.Stage() report.

▾ **Server and Backend**	100%		Start	Due	Assigned
▾ **Overall Description**	100%				
Assumptions and Dependencies	100%		Nov 2, 2019	Nov 6, 2019	Alakbar Zey...
▾ **Requirements**	100%				
▾ **Constraint Requirements**	100%				
Security and Performance	100%		Nov 17, 2019	Nov 22, 2019	Alakbar Zey...
⊕ Task | Milestone | Group of Tasks					
▾ **Project Decisions and Plan**	100%		Start	Due	Assigned
Software Development Process	100%		Oct 19, 2019	Oct 23, 2019	Alakbar Zey...
▾ **Systems**	100%				
Sub-systems	100%		Nov 4, 2019	Nov 7, 2019	Alakbar Zey...
Usability Assessment Procedures	100%		Oct 25, 2019	Nov 1, 2019	Alakbar Zey...
Technical Correctness	100%		Oct 31, 2019	Nov 7, 2019	Alakbar Zey...
Customer Expectations	100%		Nov 8, 2019	Nov 15, 2019	Alakbar Zey...
▾ **Teamwork**	100%				
Team Contributions	100%		Oct 27, 2019	Nov 15, 2019	Alakbar Zey...
▾ **Conflicts**	100%				
Interpersonal Conflicts	100%		Nov 13, 2019	Nov 17, 2019	Alakbar Zey...
Project Decisions/Plan Completed	☑	◆	Nov 19, 2019	Nov 19, 2019	Alakbar Zey...
⊕ Task | Milestone | Group of Tasks					
▾ **Usability Evaluation of Mock-ups**	100%		Start	Due	Assigned
Testing Protocol	100%		Nov 26, 2019	Dec 1, 2019	Alakbar Zey...

Stage 2

For this.Stage() I was mainly doing front end work on the application, however I did dabble in some of the back end when necessary. I was part of the (questionably legitimate) subteam of “Make Things Look Pretty Team” in which I was tasked with making sure that the design language of the website was consistent and visually attractive.

I worked on the report for this stage, but more prominently I had an overwhelmingly large role in creating the presentation for our manager. It was unfortunate that Ron could not attend as I spent hours making it look nice for him..

Stage 2

▼ Nacdlow Company Website	100%		Start	Due	Assigned
UI refinement	100%		Dec 20, 2019	Dec 29, 2019	Alakbar, Mark S bird, Ruaridh M...
Task | Milestone | Group of Tasks					
▼ Application Implementation	75%		Start	Due	Assigned
▼ Sprint 2 - Basic Application Interface	97%				
Web Application Interface design	100%		Dec 20, 2019	Dec 25, 2019	Alakbar, Numan ALi, Ruaridh M...
Interface Implementation	100%		Dec 22, 2019	Jan 4, 2020	Alakbar, Numan ALi, Ruaridh M...
Testing and Documentation	75%		Jan 6, 2020	Jan 8, 2020	Alakbar, Numan ALi, Ruaridh M...
▼ Sprint 3 - Back-end Authentication System	50%				
Authentication system	100%		Jan 6, 2020	Jan 12, 2020	Alakbar, Amaan, Humaid
▼ Sprint 4 - Smart Controls Interface	73%				
Battery	100%		Jan 18, 2020	Jan 21, 2020	Alakbar
Statistics	50%		Jan 18, 2020	Jan 22, 2020	Alakbar, Ruaridh Mollica
Testing and Documentation	50%		Jan 23, 2020	Jan 24, 2020	Alakbar, Mark S bird, Ruaridh M...
▼ Sprint 7 - Testing Phase	65%				
Web application	100%		Feb 2, 2020	Feb 3, 2020	Alakbar, Numan ALi, Ruaridh M...
Task | Milestone | Group of Tasks					
▼ Mid-Stage Changed	100%		Start	Due	Assigned
UI changes	100%		Feb 3, 2020	Feb 5, 2020	Alakbar, Ruaridh Mollica

Stage 3

In this.Stage() I gave our market.nacdlow.com a huge visual overhaul, creating the icons, descriptions, and custom CSS in order to make it feel like a proper marketplace for plugins. Alongside this I did more 75/25 front end/back end, respectively.

I also worked on the stage 3 report, which I'm doing right now. In the past.

My magnum opus, however, is the final demonstration video that I made. Like the presentation from stage 2, I did the majority of the work. Just to be clear, this was no accident. These things are my strengths and the group accepted that my efforts would be best spent here. Thus I contributed very little to this report.

I also designed the poster, iglü logo, roller banner, and other minor things.

Here's my commit history:
https://github.com/Nacdlow/iglu-server/commits?author=alakbar234@gmail.com

▾ Sprint 8	98%		Start	Due	Assigned
▾ Marketplace	100%				
Store	100%		Feb 17, 2020	Feb 23, 2020	Alakbar
Icons	100%		Feb 17, 2020	Feb 23, 2020	Alakbar
Descriptions	100%		Feb 17, 2020	Feb 23, 2020	Alakbar
"Time On Since"	100%		Feb 17, 2020	Feb 23, 2020	Alakbar, Humaid, Nu...
Task | Milestone | Group of Tasks					

▾ Sprint 9	96%		Start	Due	Assigned
Accessibility (Colour Blindness/Text Size)	100%		Feb 24, 2020	Mar 1, 2020	Alakbar
Edit Devices	100%		Feb 24, 2020	Mar 1, 2020	Alakbar
Move Devices Between Rooms	100%		Feb 24, 2020	Mar 1, 2020	Alakbar, Ruaridh
T-SHIRTS/MERCH	100%		Feb 24, 2020	Mar 1, 2020	Alakbar, Ruaridh
Task | Milestone | Group of Tasks					

▾ Sprint 10 - Nearly There	70%		Start	Due	Assigned
Design Usability Study (POSTPONED)	15%		Mar 2, 2020	Mar 7, 2020	Alakbar, Mark
Make Icons for Users	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
General Visual Changes	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
Add "Back to iglu" Button Marketplace	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
Button Redesign	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
Raspberry Pi 3D Model	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
General Cleanup (check meeting notes and gitlab	100%		Mar 2, 2020	Mar 7, 2020	Alakbar, Amaan, Hum...
Task | Milestone | Group of Tasks					

▾ Sprint 11 - Final Stretch	73%		Start	Due	Assigned
Open Dyslexic Font	100%		Feb 24, 2020	Mar 1, 2020	Alakbar
(not a priority) add info on e-ink display	100%		Feb 24, 2020	Mar 1, 2020	Alakbar
https://www.edinburghbanners.co.uk/cart	100%		Feb 24, 2020	Mar 1, 2020	Alakbar
⊕ Task | Milestone | Group of Tasks					
▾ Week 1 of 3	60%		Start	Due	Assigned
Report	50%		Apr 1, 2020	Apr 5, 2020	Alakbar, Amaan, Mark
OpenDyslexic Font	50%		Apr 1, 2020	Apr 5, 2020	Alakbar
Rough Cut of Intro	45%		Apr 1, 2020	Apr 5, 2020	Alakbar
⊕ Task | Milestone | Group of Tasks					
▾ Profile Picture Picker	93%		Start	Due	Assigned
Images	100%		Apr 1, 2020	Apr 5, 2020	Alakbar
⊕ Task | Milestone | Group of Tasks					
▾ Week 2 of 3	77%		Start	Due	Assigned
Usability	50%		Apr 1, 2020	Apr 5, 2020	Alakbar, Amaan
Scripts (what to record)	0%		Apr 1, 2020	Apr 5, 2020	Alakbar
⊕ Task | Milestone | Group of Tasks					
▾ Week 3 of 3	0%		Start	Due	Assigned
Usability	100%		set date	set date	Alakbar, Amaan, Ruar...
Project Diary Paragraph	100%		set date	set date	Alakbar, Amaan, Hum...

Stage 2 Schedule

Stage 2

Nacdlow Company Website	100%	Start	Due	Assigned
Website structure and plan	100%	Dec 20, 2019	Dec 25, 2019	Mark S bird
Website design and implementation of plan	100%	Dec 20, 2019	Dec 28, 2019	Mark S bird
UI refinement	100%	Dec 20, 2019	Dec 29, 2019	Alakbar, Mark S bird, R…
Deployment	100%	Dec 27, 2019	Dec 29, 2019	Humaid, Mark S bird
Application Implementation	**75%**	**Start**	**Due**	**Assigned**
Sprint 1 - Database	**94%**			
Database Design Plan	100%	Dec 19, 2019	Dec 21, 2019	Nacdlow Stage II
Database Impementation	100%	Dec 19, 2019	Dec 30, 2019	Humaid, Mark S bird, N…
Server Set-up	100%	Dec 24, 2019	Dec 31, 2019	Amaan, Humaid
Testing and Documentation	50%	Dec 31, 2019	Jan 2, 2020	Nacdlow Stage II
Sprint 2 - Basic Application Interface	**97%**			
Web Application Interface design	100%	Dec 20, 2019	Dec 25, 2019	Alakbar, Numan ALi, Ru…
Interface Implementation	100%	Dec 22, 2019	Jan 4, 2020	Alakbar, Numan ALi, Ru…
Server Connection	100%	Jan 5, 2020	Jan 7, 2020	Amaan
Testing and Documentation	75%	Jan 6, 2020	Jan 8, 2020	Alakbar, Numan ALi, Ru…
Sprint 3 - Back-end Authentication	**50%**			
Code Design choices and allocation	100%	Jan 3, 2020	Jan 5, 2020	Amaan, Humaid, Ruarid…
Authentication system	100%	Jan 6, 2020	Jan 12, 2020	Alakbar, Amaan, Humaid
Two-Factor Authenticaion	0%	Jan 13, 2020	Jan 17, 2020	Humaid
User access and profiles	0%	Jan 14, 2020	Jan 17, 2020	Amaan
Password Reset Capabilities	30%	Jan 18, 2020	Jan 20, 2020	Ruaridh Mollica
Testing and Documentation	50%	Jan 20, 2020	Jan 21, 2020	Nacdlow Stage II
Sprint 4 - Smart Controls Interface	**73%**			
Devices	100%	Jan 16, 2020	Jan 21, 2020	Ruaridh Mollica
Solar Energy	50%	Jan 16, 2020	Jan 20, 2020	Numan ALi
Battery	100%	Jan 18, 2020	Jan 21, 2020	Alakbar
Statistics	50%	Jan 18, 2020	Jan 22, 2020	Alakbar, Ruaridh Mollica
Testing and Documentation	50%	Jan 23, 2020	Jan 24, 2020	Alakbar, Mark S bird, R…
Sprint 5 - Administrator capabilities	**0%**			
User removal/addition	0%	Jan 23, 2020	Jan 28, 2020	Humaid
Custom permissions	0%	Jan 24, 2020	Jan 28, 2020	Amaan
Testing and Documentation	0%	Jan 29, 2020	Jan 30, 2020	Nacdlow Stage II
Sprint 6 - Backend Routing	**99%**			
Continuous Routing Integration	100%	Jan 1, 2020	Feb 1, 2020	Humaid
Testing and Documentation	75%	Feb 2, 2020	Feb 3, 2020	Nacdlow Stage II
Sprint 7 - Testing Phase	**65%**			
Write and discuss tests	0%	Jan 30, 2020	Feb 1, 2020	Nacdlow Stage II
Company website	100%	Feb 2, 2020	Feb 3, 2020	Mark S bird

Web application	100%		Feb 2, 2020	Feb 3, 2020	Alakbar, Numan ALi, Ru…
Stress test databse	90%		Feb 2, 2020	Feb 3, 2020	Humaid, Mark S bird
Backend	60%		Feb 2, 2020	Feb 3, 2020	Amaan, Humaid
Initial Harware stress test	0%		Feb 2, 2020	Feb 3, 2020	Nacdlow Stage II
Real-World simulation tests	100%		Feb 2, 2020	Feb 3, 2020	Nacdlow Stage II
Documentation	100%		Feb 2, 2020	Feb 3, 2020	Nacdlow Stage II
▾ Mid-Stage Changed	**100%**		**Start**	**Due**	**Assigned**
Coding changes	100%		Feb 3, 2020	Feb 5, 2020	Humaid
UI changes	100%		Feb 3, 2020	Feb 5, 2020	Alakbar, Ruaridh Mollica
Security Changes	100%		Feb 3, 2020	Feb 5, 2020	Amaan, Humaid
Documentation Changes	50%				Mark S bird, Numan ALi
▾ Final Segments	**100%**		**Start**	**Due**	**Assigned**
Demonstration	100%		Feb 5, 2020	Feb 6, 2020	Nacdlow Stage II
Submission	100%		Feb 5, 2020	Feb 6, 2020	Nacdlow Stage II

View in Gantt

Stage 3 Schedule

Nacdlow Stage 3

Sprint 8	**98%**	**Start**	**Due**	**Assigned**
Marketplace	**100%**			
Store	100%	Feb 17, 2020	Feb 23, 2020	Alakbar
Icons	100%	Feb 17, 2020	Feb 23, 2020	Alakbar
Descriptions	100%	Feb 17, 2020	Feb 23, 2020	Alakbar
Stripe Demo Purchase	100%	Feb 17, 2020	Feb 23, 2020	Humaid
Fix Refresh Issue	90%	Feb 17, 2020	Feb 23, 2020	Ruaridh
PWA Service Worker	100%	Feb 17, 2020	Feb 23, 2020	Amaan
Getting Started On Report	90%	Feb 17, 2020	Feb 23, 2020	Mark
Redesigning Rooms Page	100%	Feb 17, 2020	Feb 23, 2020	Numan
Accounts/Privileges	100%	Feb 17, 2020	Feb 23, 2020	Humaid
"Time On Since"	100%	Feb 17, 2020	Feb 23, 2020	Alakba…
Sprint 9	**96%**	**Start**	**Due**	**Assigned**
Accessibility (Colour Blindness/Text	100%	Feb 24, 2020	Mar 1, 2020	Alakbar
Re-Do Plugin System	100%	Feb 24, 2020	Mar 1, 2020	Humaid
Minecraft Stuff (Windows/Doors)	100%	Feb 24, 2020	Mar 1, 2020	Humaid
Improve Simulation Accuracy	100%	Feb 24, 2020	Mar 1, 2020	Humaid
Alert/Nofications (in app)	100%	Feb 24, 2020	Mar 1, 2020	Amaan
Fix Refresh Issue Further	100%	Feb 24, 2020	Mar 1, 2020	Ruaridh
Specific Room Redesign	100%	Feb 24, 2020	Mar 1, 2020	Numan
Netflix Login Redesign	100%	Feb 24, 2020	Mar 1, 2020	Amaan
Edit Rooms	100%	Feb 24, 2020	Mar 1, 2020	Numa…
Edit Devices	100%	Feb 24, 2020	Mar 1, 2020	Alakbar
Move Devices Between Rooms	100%	Feb 24, 2020	Mar 1, 2020	Alakba…
T-SHIRTS/MERCH	100%	Feb 24, 2020	Mar 1, 2020	Alakba…
More Report Stuff	50%	Feb 24, 2020	Mar 1, 2020	Mark
Sprint 10 - Nearly There	**69%**	**Start**	**Due**	**Assigned**
Replace TV Tab With General or	0%	Mar 2, 2020	Mar 8, 2020	Numan
Add Users	90%	Mar 2, 2020	Mar 8, 2020	Amaan
Design Usability Study	15%	Mar 2, 2020	Mar 7, 2020	Alakba…
Move Devices Between Rooms	100%	Mar 2, 2020	Mar 7, 2020	Numa…

T-Shirts	100%		Mar 2, 2020	Mar 7, 2020	Ruaridh
Make Icons for Users	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
General Visual Changes	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
Add "Back to iglu" Button	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
Button Redesign	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
Raspberry Pi 3D Model	100%		Mar 2, 2020	Mar 7, 2020	Alakbar
Minecraft As A Plugin	100%		Mar 2, 2020	Mar 7, 2020	Humaid
General Cleanup (check meeting	100%		Mar 2, 2020	Mar 7, 2020	Alakba…
Overview page with floorplan	0%		Mar 2, 2020	Mar 7, 2020	
Flesh out account permissions	0%		Mar 2, 2020	Mar 7, 2020	
Have a table of permissions for every	0%		Mar 2, 2020	Mar 7, 2020	
Add option to restrict a room	100%		Mar 2, 2020	Mar 7, 2020	Ruaridh
▾ Sprint 11 - Final Stretch	**68%**		**Start**	**Due**	**Assigned**
Marketing Stuff	25%		Feb 24, 2020	Mar 1, 2020	Mark
Test Application	0%		Feb 24, 2020	Mar 1, 2020	Mark
Replace TV with Other for adding	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Only Show Past 24hrs for Graph	100%		Feb 24, 2020	Mar 1, 2020	Humaid
System Update Functionality	100%		Feb 24, 2020	Mar 1, 2020	Humaid
Admin Only Settings	100%		Feb 24, 2020	Mar 1, 2020	Numa…
Remove Description on Room	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Implement Netflix Login Fully	0%		Feb 24, 2020	Mar 1, 2020	Amaan
Open Dyslexic Font	100%		Feb 24, 2020	Mar 1, 2020	Alakbar
Populate Settings Options	0%		Feb 24, 2020	Mar 1, 2020	
Click on favourites text to show	0%		Feb 24, 2020	Mar 1, 2020	Numan
Add Heading in About talking about	0%		Feb 24, 2020	Mar 1, 2020	
(not a priority) add info on e-ink	100%		Feb 24, 2020	Mar 1, 2020	Alakbar
https://www.edinburghbanners.co.uk/	100%		Feb 24, 2020	Mar 1, 2020	Alakbar
Add close button on renaming	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Make "main light" option just for	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Error when trying to move a main	100%		Feb 24, 2020	Mar 1, 2020	Ruaridh
Only one main light	100%		Feb 24, 2020	Mar 1, 2020	Humaid
▾ Week 1 of 3	**60%**		**Start**	**Due**	**Assigned**
Report	50%		Apr 1, 2020	Apr 5, 2020	Alakba…
Documentation/Set Up Guide	100%		Apr 1, 2020	Apr 5, 2020	Humai…

Documentation/Set Up Guide (deliverable)	100%		Apr 1, 2020	Apr 5, 2020	Humaid, Numan
OpenDyslexic Font	50%		Apr 1, 2020	Apr 5, 2020	Alakbar
Help/How-To In App	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Marketing & Analysis	15%		Apr 1, 2020	Apr 5, 2020	Mark
Rough Cut of Intro	45%		Apr 1, 2020	Apr 5, 2020	Alakbar
Task | Milestone | Group of Tasks					
▾ Profile Picture Picker	93%		Start	Due	Assigned
Images	100%		Apr 1, 2020	Apr 5, 2020	Alakbar
Image Encoding	100%		Apr 1, 2020	Apr 5, 2020	Humaid
Image Upload Page	70%		Apr 1, 2020	Apr 5, 2020	Numan
Image Viewing (Database)	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
▾ Week 2 of 3	70%		Start	Due	Assigned
Usability	0%		Apr 1, 2020	Apr 5, 2020	Alakbar, Amaan
Scripts (what to record)	0%		Apr 1, 2020	Apr 5, 2020	Alakbar
Voice Over Recordings	90%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Add "User Role" option in edit account	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Make it so restricted users have little abilities	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Restricted rooms dont show on "add device" page	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Remove "Guest" as a role from dropdown in edit	100%		Apr 1, 2020	Apr 5, 2020	Ruaridh
Task | Milestone | Group of Tasks					
▾ Marketing Section In Report	100%		Start	Due	Assigned
Introduction	100%		Apr 1, 2020	Apr 1, 2020	Mark
Product and Market Background	100%		Apr 1, 2020	Apr 3, 2020	Mark
SWOT Analysis	100%		Apr 4, 2020	Apr 6, 2020	Mark
PESTLE Analysis	100%		Apr 7, 2020	Apr 8, 2020	Mark
Porter's 5 Forces	100%		Apr 9, 2020	Apr 11, 2020	Mark
Marketing Strategies	100%		Apr 9, 2020	Apr 12, 2020	Mark
Marketing Goals	100%		Apr 12, 2020	Apr 12, 2020	Mark
Marketing Mix	100%		Apr 13, 2020	Apr 13, 2020	Mark
Unique Selling Point	100%		Apr 13, 2020	Apr 13, 2020	Mark
Task | Milestone | Group of Tasks					
▾ Week 3 of 3	0%		Start	Due	Assigned
Usability	100%		set date	set date	Alakbar, Amaan, Ruaridh
User Guide	100%		set date	set date	Numan
Future Work	100%		set date	set date	Humaid, Ruaridh
Project Diary (List View, Filter to your name)	100%		set date	set date	Ruaridh
Project Diary Paragraph	100%		set date	set date	Alakbar, Amaan, Humaid, ...
GUI Design	100%		set date	set date	click to assign

Project Evaluation	0%		Start	Due	Assigned
Introduction	100%		set date	set date	Mark
Organisation	100%		set date	set date	click to assign
Implemenatation	100%		set date	set date	click to assign
Product Evaluation	100%		set date	set date	click to assign