Reducing Environmental Impact in the Kitchen

Group 9: Proposal

1 Background

1.1 Introduction & Domain

The goal of the following paragraphs is to provide sufficient context that justifies why food-waste is a much greater concern than we realise and hence why we have decided to develop a solution to reduce it. Decreasing food-waste at both the individual level and corporate level is a key element in creating an efficient and waste-free world. An exponential growth in population, causing a strain on available resources, combined with the damage inflicted on the environment due to over-production, provides enough justification as to why food-waste should be minimised and expectantly eradicated.

Dr Salmony states that “overproduction, overconsumption and overpopulation activities of the human species are on the verge of causing a global ecological wreckage” [Steven E. 2019]. It is therefore difficult to pinpoint a particular aspect of human-life as the cause of climate change (the most significant form of ecological wreckage of our era), as it is apparent that a mentality of greed and selfishness, as well as biological factors, are at the root of the problem. An example however, that a lot of us are first-hand witnesses to, is food-waste (which encapsulates overconsumption and overproduction), with rotting foods being responsible for “8% of emissions” [Lewis, D. 2020]. Evidently, it is not the literal act of throwing food away that contributes to climate change, it is the fact that manufactures are considering our careless nature and are therefore over-producing and in turn contaminating our atmosphere unnecessarily.

In the last few decades, climate change is becoming an ever more prominent problem, with the average temperature of the Earth's surface “rising by 1.14 degrees Celsius since the end of the 1800s” [Schmidt, G. et al., 2017]. With the rise in temperature comes a range of surprisingly drastic effects, from lowered water and food supply to extreme weather conditions and forest fires. Additionally, with “nearly 4 in 10 people [living] within 100 kilometres of a shoreline” [Met Office, n.d.], and as sea levels are sure to keep rising until 2100, many of these inhabitants will be forced to leave their homes. Another factor that only increases the severity of these problems is the rapidly growing population, predicted to reach 11 billion by 2100 [Carrington, D. 2014], which would naturally make resources like housing, food and water supply even more difficult to supply.

Specifically, by shedding light on the devasting effects that climate change will have on our food supply, it has been demonstrated that “consumable food calories [are reducing] by around 1 percent yearly for the top 10 global crops” [Deepak R. 2019]. That is equivalent to 35 trillion calories every year which would supply more than 50 million people with a daily diet of over 1,800 calories. The hypocrisy at hand is clear, food-waste reduces food supply, food-waste contributes to climate change and climate change also reduces our food supply. Therefore, action needs to be taken immediately to accommodate the excepted growth in food demand. This is emphasized by the fact that the rapid growth in population implies that food demand is expected to increase between “59% to 98% by 2050” [Maarten E. 2016].

There are numerous courses of action to compensate this growing demand in food. For instance, we could adapt our diet, given that drought-resistant crops have benefitted from climate change. The yield of sorghum has increased “by 0.7% in sub-Saharan Africa and 0.9% yearly in western, southern and south-eastern Asia” [Deepak R. 2019]. This however directly affects our quality of life as the restrictions-imposed limit what food is available to us and more importantly the solution should not condone climate change as this is a pressing issue. However, the most likely short-term solution, is farmers worldwide attempting to boost crop production “by

increasing the amount of agricultural land to grow crops or by enhancing productivity on existing agricultural lands through fertilizer" [Maarten E. 2016] and precision farming. Deforestation and the use of fertilizers are not practical solutions given that "fertilizers such as Nitrous oxide are 265 times more effective at trapping heat in the atmosphere than carbon dioxide" [Pep C. 2019] and deforestation means a reduction in the absorption of carbon dioxide in the atmosphere, both of which are catalysts in climate change.

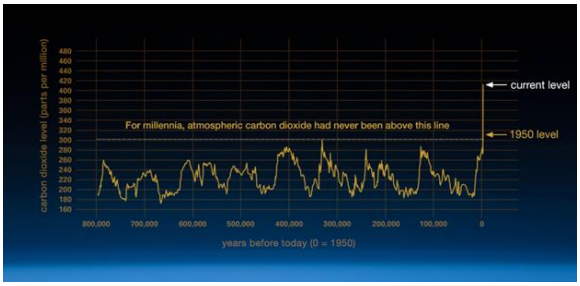
It is quite absurd that the most likely course of action to overcome the growing need for food will in the long run reduce crop yield through climate change. The most apparent solution to needing more food would be to waste less food given that we throw out a "third of all the food that we grow" [Jake N. 2014]. As discussed earlier, food wastage contributes to climate change and climate change reduces crop yield, which merely highlights how critical reducing food wastage is. In addition, world food-waste will increase in correspondence to the rapid growth in population.

In developing countries, 800 million people are classed as undernourished [Lewis, D. 2020], so it seems outrageous that "an estimated 1.3 billion tonnes of food is wasted globally each year" [Depta, L. 2018]. The staggering rise in population, the reduction in consumable food and expensive solutions employed as result, means that crop prices could rise "by approximately fivefold" [Jay F. 2020] by 2050. Therefore, to add insult to injury, higher food prices will accentuate the already devastating economic difficulties present in these poverty-ridden countries ("decreases in consumable food calories are already occurring in roughly half of the world's food insecure countries" [Deepak R. 2019]). Affluent countries such as the UK, will also suffer, though to a lesser extent. Higher food prices combined with "the average family in the UK unnecessarily spending £355.68 on food that goes to waste each year" [Dando, T., 2019], means ultimately food wastage will become a very expensive loss.

Food-waste contributes to climate change and directly reduces the availability of food. Climate change will have detrimental effects on our way of life and challenges the existence of the human-race on this world, as well as reducing the consumable foods available. The most obvious solution would be to reduce our food-waste on a global level. However, currently alternative techniques are employed such as the use of fertilizers and deforestation which likewise contribute to climate change which in the long run reduce our food supply, thus returning to the origin of this vicious cycle. The economic consequences are significant in affluent countries and disastrous in developing countries as world hunger will continue to rise. It is difficult for an individual to fathom the detrimental effects of food-waste as it is the collective waste of people as an entity that has deleterious effects. We have been encouraged to 'think globally', now is the time to 'act globally'. Food-waste is not a joke.

1.2 Motivation

Climate change has been a known issue for years but only in the recent years has it been brought to the spotlight resulting in entire movements, controversy, laws and so much more. We have conducted research upon the issue and found out that, as shown in the graphic above, the current level of carbon dioxide is at an all-time high, unprecedented during an entire millennium. According to studies conducted by NASA, there is a greater than 95% possibility that this warming scene is caused by human activity, starting in 1950 as well as growing at a rate that has never been seen before. More accurately, it is believed that the carbon dioxide caused by human activity is increasing "more than 250 times faster than it did from natural sources after the last Ice Age".



Credit: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record

Global warming is strongly believed to be a consequence of increased carbon dioxide and multiple anthropic emissions into the atmosphere. More so, the warming wasn't growing constantly as most of the change occurred in the past 40 years. The main reason behind the rise in temperature is the tremendous increase in greenhouse gasses such as: carbon dioxide, methane, nitrous oxide, fluorinated gases, all due to human activity and industrialization.

Most threatening out of all of them is CO2 – carbon dioxide – as it is responsible for 64% of man-made global warming with its concentration being 40% higher than it was at the start of industrialization.
Even though not as threatening from an emitted quantity point of view as CO2, other greenhouse gases are not to be ignored as their danger stands in how effective they are in trapping heat; both methane and nitrous oxide are far stronger and more dangerous than CO2 while also being directly responsible for 17% of man-made global warming, respectively 6%.

Firstly, from a strictly efficiency point of view, with wasted food, not only we lose the food as an edible material but also all the resources that went in creating it – water, transport, packaging, etc.
Furthermore, food that goes to the landfill and eventually rots also produces methane, which, as said previously, is more potent than carbon dioxide even. Overall, 11% of all greenhouse gas emissions that are related to the food system could be reduced if we stop wasting food. If it were a country, food waste would be the third highest emitter of greenhouse gases in the world, only in the UK there are over 10 million tonnes of food binned away each year, roughly 240,000 only by UK supermarkets.
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There are many ongoing actions to fight climate change, from massive riots against corporations, laws regarding ecological issues to simple rules of binning. It obviously it is not in our control nor is it possible for us to fix food waste fully but we are aware of all the small bits each person can do which begin a domino effect – small change big impact. Whether its composting or respecting recycling rules to simply finding out what recipes to cook and how to deal with expiry dates or fermented foods, each of these represent a small domino which will eventually end up having a big impact if kept up consistently.

We decided to address the domain of climate change as we agree that it is a pressing issue that affects everyone, and is affected by everyone, including us. As a group we felt like we could reduce our own negative impact on the world, concluding that food waste is a very common, especially amongst students, issue that a web app could help with. Our motivation is therefore providing another small mechanism to prevent climate-based issues from damaging our lives and future generations.

1.3 Existing Work

There have been many attempted solutions to the problems in this domain. For example, the technology company Winnow has recently released their Vision product, which uses machine learning and computer vision to monitor all foods which are thrown into the food waste bin. After a brief, user-friendly training period, the camera can identify which foods are wasted, and alert staff of the financial loss due to this waste. A scale is placed under the bin in order to measure the quantity of food wasted. Reports are then generated for the kitchen staff to analyse and help use their ingredients more efficiently. Ikea is an example of a company which partnered with Winnow, and they claim to have "achieved a 50% food waste reduction in the UK [restaurants] since they started the partnership" [Winnow Website, n.d.]. Winnow also provide a simpler service which requires a touch screen input to identify what food is being thrown away, but in particular, Visionwas praised by Ikea for its ease of use and how it fits into their workflow; "this frees up capacity for recording waste, minimizes time that we spend with the Winnow system".

While Winnow focuses on making bigger companies aware of the amount of food wasted, solutions like OLIO are focused on the consumers. Using OLIO, neighbours can easily contact each other to share food if they think that it will not get used. According to

OLIO's website from [Hubbub, n.d.], "81% of us would be happy to receive food from a neighbour", and OLIO aims to make this process as easy as possible. According to their website, over 6.5 million portions of food have been shared through their app [OLIO, n.d.].

All our interviewees mentioned being less motivated than they'd like to be when it comes to making a change to environmental issues. In order to keep our users engaged, we should consider using gamification - described as 'a process of enhancing services with motivational affordances in order to invoke game-like experiences and further behavioural outcomes' in a study by Hamari, J. et. al in 2014. The psychological effects of doing so are almost always positive, with all 24 cases of gamification in the study being reported to bring 'positive experiences' to their users. The study categorises a group of game-like features as 'motivational affordances'; features intended to make the user feel invested in the system and motivated to reach a goal. The most common of these used in the study were 'points', 'leaderboards' and 'achievements/badges' - all ways of rewarding the user for their engagement.

1.4 Proposed System

Our proposed novel system will be a 'Food Shopping Helper' mobile application which will ensure that users only purchase food that they will be able to use in time. This will help reduce food thrown out, and in turn will leave the suppliers that are 'higher up in the chain' to deal with any excess of food - which they are much more equipped to do without wasting it (for example by taking bulk amounts to a food bank). Our app could also contain other features to help users decrease their impact on the environment that are also kitchen related, such as helping them to properly deal with food packaging. Keeping our scope limited to the kitchen will help give the app an identity and a clear reason to install, while also increasing our chance of successfully producing a complete product.

In particular, the features we plan to implement are as follows – a shopping list helper, a recipe finder and a food packaging recycling helper. The first idea arose from a series of interviews where 75% of participants said that the primary reason that food is wasted around them is that too much is bought in the first place. The shopping list helper will show the user recommendations on items to add or remove from their shopping list based on two factors – their environmental 'grade' and their compatibility with other items on the list. An item that will expire quickly, has non-recyclable packaging and is difficult to use in recipes with the remainder of the list will get a low rating and will be recommended to be removed or substituted by the app. We should be careful with how often and how obtrusive this feature is as one of our interviewees clarified that they would like this feature to give 'helpful information' without being 'pushy'. The recipe finder works similarly – the user can input items and the app will list recipes that can (or can almost) be made using them. An interviewee said that they tend to waste food when they 'plan the wrong meals', and we believe this feature tackles this problem. When the user is done with a food product, our app will also help them find out if it is recyclable – this will be done through a short questionnaire to help the user navigate a flowchart to find out which bin to put the packaging in.

All of these features could then be integrated with each other. After creating a shopping list with the app, the user could then add the items to their 'Virtual Kitchen', where those same ingredients are used to recommend compatible recipes. This would let us add another side-feature: tracking of food expiry dates. This was a feature that many interviewees felt strongly about including in the app. We could notify the user whenever an item is close to expiring, and give it a stronger weighting when recommending recipes.

An advantage of this idea is that its target audience is not just limited to those who are passionate about making a difference, as its features can be used for more general reasons. Anyone could use the app in order to reduce the amount they spend on food, or to slow down the rate at which they fill their general waste bin bags. In order to have societal impact, we could then perhaps include features to educate this portion on the audience, and even use gamification to encourage them to care more about the issue. In fact, all of our interviewees said that they are conscious of environmental issues and would to change some habits, so adding a way for our users to feel motivated to consistently take small actions would be a good idea. In general, reaching many people is crucial with a solution like this, as its focus is to make a large amount of people's small changes in behaviour add up to make a difference.

2 Programme and Methodology

2.1 Aims & Objectives

The first aim of our project is for users of our application to reduce the amount of food that they waste. In order to meet this aim, we plan to add two key features to our app: the recipe finder and the shopping list helper. Our second aim is to encourage users to recycle food packaging, which we'll encourage through the recycling helper feature, and a sub-feature of the shopping list helper that recommends recyclable packaging. Finally, our third aim is to incentivise users to consistently use the app, and therefore to be conscious of the ways they may be negatively impacting the environment. To meet this aim, we'll include gamification to encourage users to meet goals, or perhaps to raise 'stats' on their profile to share with friends. We will of course also need an intuitive and attractive user interface such that users are never put off using the app due to confusion.

Meeting these established aims and building their corresponding features will require the completion of many smaller objectives. In order to try to better our understanding of the specifics of the problem, we will gather information from our stakeholders, namely students. We will inquire about their experiences to understand why exactly food ends up being wasted and ensure our system's use cases will line up with the causes of the problem. We would also ask them to name some of the most common meals that they like to eat, which we will use later in the process to fill our database with recipes. We would then go through the most used ingredients grade each one based on two factors – how fast they expire, and how much of their packaging is recyclable. An important objective here would be the successful implementation of a system to allow easy grading of new ingredients. Refining this algorithm over time will also be a crucial objective, as its success could allow us to add new ingredients to the app, graded solely on user input. In fact, with regards to packaging, we could even give a higher score to certain materials – with aluminium for example being considered an extremely 'recyclable' material as it can be reused indefinitely, with most countries having a good infrastructure for recycling it. The UK has been recently reported to have an aluminium recycling rate of 70-80% [Latchem, 2020].

After researching into commonly used ingredients and grading them, our next objective will be to collate them into a database. We would like to ensure that at least 70% of ingredients suggested by our stakeholders are included in the database. We would need a table for these ingredients, as well as a table for recipes, including information on the ingredients they use. This way, we could develop and refine another algorithm for grading recipes based on the grades of their ingredients. This structure would allow users to submit their own recipes to the app using the ingredients in the database.

With these objectives complete, implementing the required features boils down to building an effective front-end that can process and display the data in helpful ways to the user. We should focus on maintaining data independence here, as the database will grow and change as the app is used. We should also use gamification to challenge and motivate users. A study in gamification [Hamari, J. et. al, 2014] reported some specific behavioural outcomes such as 'site participation', 'amount and quality of user activities' and 'change in relative energy consumption'; all qualities that could also be beneficial in our app.

We would consider these objectives in an iterative sense, and by testing after each iteration, we can get direct feedback from the users on how much they use each feature, whether there are any features they think should be added, the accuracy of the recommendations from the database and their level of motivation to use the app. From this feedback, we could go on to improve the app, analysing the data in each iteration and striving for a positive trend in both user retention rate and quality of experience.

Ethical considerations

The ACM Code of Conduct will be used throughout the project as a guide for how we should ethically operate as a team throughout the project as well as to verify the features of the project are in the public interest.

1.1 Contribute to society and to human well-being, acknowledging that all people are stakeholders in computing.	The project will reduce food waste and recycle packaging, which will contribute to society because: it will promote cooking to the user, and therefore healthier eating. This will lower the negative impact of the stakeholder on global warming too.
1.2 Avoid harm. 1.3 Be honest and trustworthy. 1.6 Respect privacy. 1.7 Honour confidentiality. 2.9 Design and implement systems that are robustly and useably secure.	Any dietary requirements will be protected and not shared with anyone and will not be kept for any longer than necessary. Any recipes included will be from trusted and reviewed sources. Privacy will need review based on which direction we decide to go. A local database will pose substantially less privacy issues than a remote one because there is no chance a different user can access another's data.
1.4 Be fair and take action not to discriminate.	We will make sure that our system doesn't only have recipes from one culture and that the database has content representative of the wide range of users and includes users with dietary requirements.
2.1 Strive to achieve high quality in both the processes and products of professional work. 2.2 Maintain high standards of professional competence, conduct, and ethical practice.	We are using the SCRUM agile method to ensure we work closely with stakeholders and have an opportunity to review each prototype and improve from feedback to create a product that our stakeholders are happy with. We will also be using trusted sources to determine recyclability.
2.3 Know and respect existing rules pertaining to professional work. 2.4 Accept and provide appropriate professional review. 2.5 Give comprehensive and thorough evaluations of computer systems and their impacts, including analysis of possible risks.	We will be following relevant data protection laws and through the SCRUM methodology create evaluations and risk analysis on each iteration.
2.7 Foster public awareness and understanding of computing, related technologies, and their consequences. 2.8 Access computing and communication resources only when authorized or when compelled by the public good.	There is low risk involved in our system, and through iterative feedback the GUI will be intuitive and user friendly.
2.6 Perform work only in areas of competence.	We will only implement functions that we have reviewed sources to back up with, within our 3 set out aims.

(ACM council, 2018)

2.2 Methodology

We have decided to adopt an incremental software development methodology for this project, namely, the SCRUM methodology. We are placing an emphasis on getting a working prototype as soon as possible, then we can incrementally improve it with user feedback. A major factor in choosing an agile methodology is our, first year, team experience with it. Additionally, the project is year-long so there is most definitely going to be evolution and modification to requirements; agile is designed specifically to address this. To achieve our aims, our development will involve extensive interaction and feedback from stakeholders, which is an important aspect of sprints. We will have frequent meetings with both the team and stakeholders to review work and make necessary changes. Iterative development is very flexible meaning we can play to our strengths and easily assign jobs to spread the workload. On top of this, it provides a natural way to split work and development into sprints, which will help our team balance project and university work.

Throughout the project, we aim to have frequent stakeholder engagement through a variety of different methods. We plan to use interviews and surveys to develop an initial understanding of requirements and desires within our domain and project scope. Some stakeholders will engage for the entire duration of the project, namely housemates and internal team members, while some may only engage in a survey or interview. Due to COVID-19 restrictions, much of this process will be done online through services like Google Meet and Forms. However luckily. we focus on students in the kitchen, and so some engagement can be done in person with housemates of our team. In person interaction will allow for better engagement and understanding between us and our stakeholders. Once development has started, we will run tests by providing stakeholders with prototypes of the system. This will help us to refine

features, investigate new ideas, find potential bugs, and test effectiveness. As a team, we understand that our project will succeed only if we listen to our stakeholders and their feedback. For this reason, we must ensure stakeholder (and team) ambiguity is addressed and their ideas considered.

Our application is targeting the mobile platform, namely Android; these applications are mostly written in the programming language Java. Therefore, we have chosen Java to be the primary language of choice for our project. Furthermore, each member of our team is comfortable using the core functionality of Java so we will not have to spend time learning features. The Android SDK build system uses Gradle to manage libraries and build settings, and therefore developers will be able to use their preferred IDE provided they have Gradle installed. Importantly, the Android SDK provides an IDE called Android Studio which has support for an emulator. This will be a very useful feature that will speed up development tremendously and allow team members, who do not own an Android device, to test the application. Our system will need to process and store lots of data and we will require a DBMS for this. At this stage in the project, we are considering the client-side DBMS SQLite, but we should use stakeholder feedback and testing to identify possible flaws (i.e. application size and stored content). If we later decide to move the database to a client-server DBMS, then MySQL would be an appropriate choice.

2.3 Programme of Work

Our programme of work will split the work into several larger sections indicating the general theme of work being carried out: proposal, design, development, and evaluation. These will be further separated into manageable work sprints to be done over 1-3 weeks depending on their size and difficulty.

The first of these main themes is the project proposal. The first sprint will consist of brainstorming and researching several domains which will be completed by all members of the group in pairs. This will be followed by a SCRUM-style stand up meeting where the research is presented, the chosen domain selected and the next steps defined. The next sprint will further involve inspection of existing domain solutions and the creation of a stakeholder interview script to be performed in the following sprint. Simultaneously while several members of the team are conducting interviews, other members will finish the project proposal.

The next general theme will consist of the main requirements gathering and system design. As the design cannot be completed until the initial needs of the stakeholders are fully understood, the first sprint will consist of several group members designing the interview scripts while others will look further into existing systems and academic research around the domain. Once complete, the interview script designers will brief the team on their intentions for the interviews which will be carried out in the next script. Once this sprint is completed and all members have analysed their results to identify requirements and needs for the system, the data will be collated and presented in a sprint review before the final sprint which will consist of the main design steps of the system. Members of the team will be split up to create use cases, scenarios, a UI design, a high level architecture diagram design elements respectively which will all be crucial in ensuring the system is implemented efficiently and meets the requirements of stakeholders as identified.

The final main theme will largely consist of the implementation of the system. This will require all members of the team to work in pairs to undergo pair programming on various parts of the system. As far as possible we will assign tasks suited to any pairs specific talents or interests such as a pair that prefer database creation will work on the back end infrastructure of the system while those more comfortable with Java will work on the front end, user facing interface. Once a team has completed their section of the code, they will then format the code to be tested, demonstrated, and presented to first the other team members in the sprint review and then generally to be assessed.

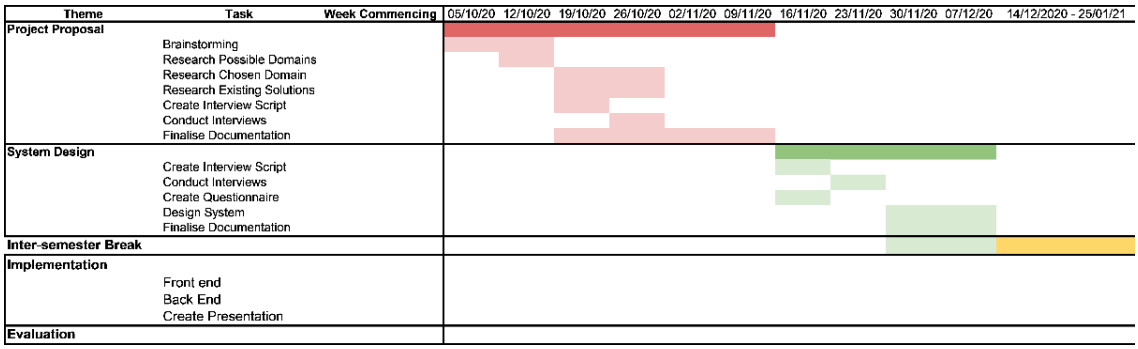
2.4 Project Management

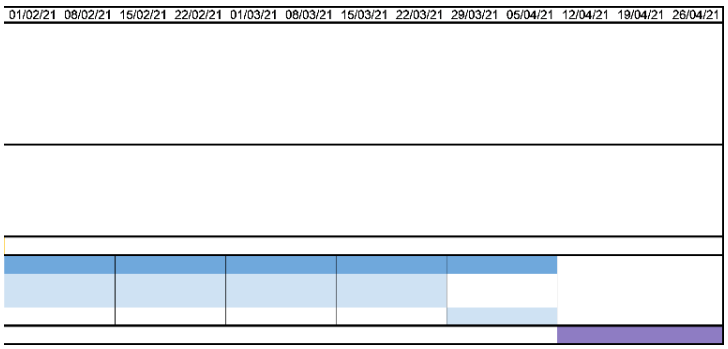
We will be using a range of different tools to manage the project including Trello, Microsoft Teams and Git. We have created a collaborative Trello board to assign tasks and track progress. We are using Microsoft Teams to facilitate meetings, file sharing and general conversation. As we are starting our project during the 2020 Covid-19 pandemic, online interaction is a very important consideration that we must keep on top off. Therefore, to ensure successful collaboration we are scheduling meetings on Teams every week as well as creating an informal group chat on Facebook. Additionally, we are taking notes and minutes about what we have discussed and attendance, respectively. This information will be useful for identifying member contribution and the evolution of our ideas. Once we reach the implementation stage, we will use Git / GitHub as a repository and version control system. By doing this, all team members can simultaneously work on different parts of the system and we merge them together using Git.

There are a range of potential roles for team members throughout this project including: documentation, programming, stakeholder interaction and management. To avoid wasting skills, or interests as well as ensuring all members get a chance at each role, we will not assign long term roles. Instead, at each meeting, we will evaluate the role each member will undertake until the next meeting. To assign roles, we will identify a set of tasks to be completed which will go onto the Trello board, and the team member who wants to complete a task will assign themselves to it. If no one assigns themselves, we will have to assign roles based on skill, availability, and workload.

It is important we identify some potential high-level risks and how we can prevent them. One of the most prevalent risks is if a team member fails to complete an assigned task. To mitigate this risk, we should attempt to identify reasonable deadlines and workloads based on variables like priority, existing workload (other coursework etc) and health. Another potential risk involves communication between the team and stakeholders (also internally). To minimise this occurring we will take detailed notes during interviews and meetings (the minutes); it is important for any ambiguity to be addressed so both team members and stakeholders will be encouraged to ask questions and challenge issues.

3 Work Plan





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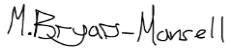
Group Contribution Form for Group

Name	Contribution	Signature
Richard Andrews	8	
Max Bryars-Mansell	10	
Jakob Aylott	8	
Teodora Dinca	8	
Lucy Emmett	8	
Jac Griffiths	10	
Nicolas Sanchez	10