

IMPROVING FOOD SUPPLY WITHIN COMMUNITIES EXPERIENCING FOOD INSECURITY

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CONTEXT: SECONDARY RESEARCH

Initial Research: HMW improve food supply to those suffering from food shortages or malnutrition

GLOBALLY

- Over 820 million people worldwide were suffering from chronic undernourishment or food insecurity in 2018. (1).
- The number of people facing acute food insecurity could increase to 270 million in 2020 due to the COVID-19 pandemic, an 82% increase from before the pandemic. (2).
- Approximately 1.3 billion tonnes of food produced for human consumption is lost or wasted globally each year, which amounts to roughly one-third of all food produced (5).

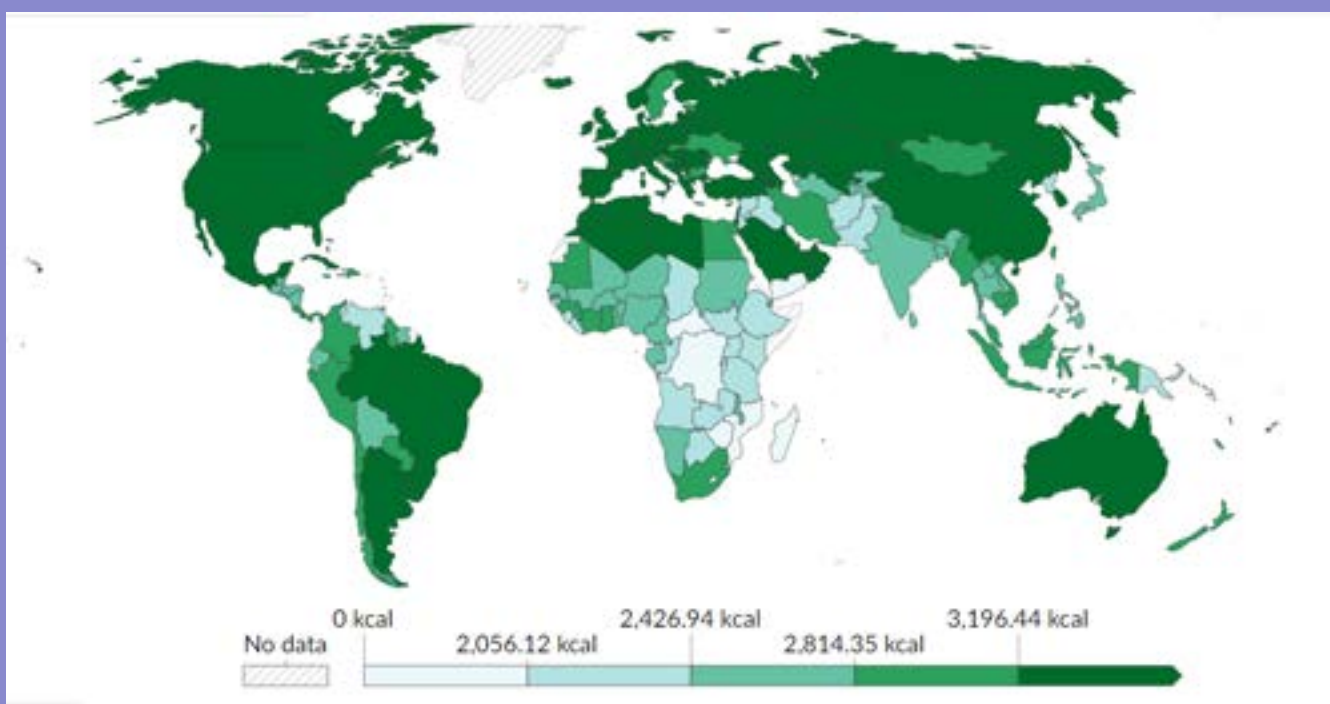
CHILDREN

- Poor nutrition causes nearly half (45%) of deaths in children under five - 3.1 million children each year. (3).
- In 2020, 149 million children under 5 were estimated to be stunted (too short for their age), 45 million were wasted (too thin for their height), and 39 million were overweight (4).

ECONOMIC

- Climate change could reduce global crop yields by up to 25% by the end of the century under high greenhouse gas emission scenarios (6).
- The economic cost of malnutrition, in terms of lost productivity and healthcare expenses, is estimated to be as high as 5% of global GDP, or \$3.5 trillion per year (7).

HEAT MAP OF DAILY CALORIC INTAKE



The graph (8) shows that Africa and the Middle East suffer most heavily from food supply issues.

GRAPH OF DAILY CALORIC SUPPLY VS GDP PER CAPITA



The chart (9) shows that there is a strong positive correlation between GDP per capita and daily caloric supply.

4 W'S AND 1 H

WHAT

Improve the food supply and food quality to those struggling with food scarcity and malnutrition

WHERE

Food insecurity occurs all over the world in lower income communities. Places such as Africa suffer most heavily.

WHY

Without proper nutrition, life expectancy decreases as well as people's ability to function, overall limiting the development of countries

WHO

Children under 5 years old are most vulnerable to malnutrition due to their higher risk of infection from a weakened immune system.

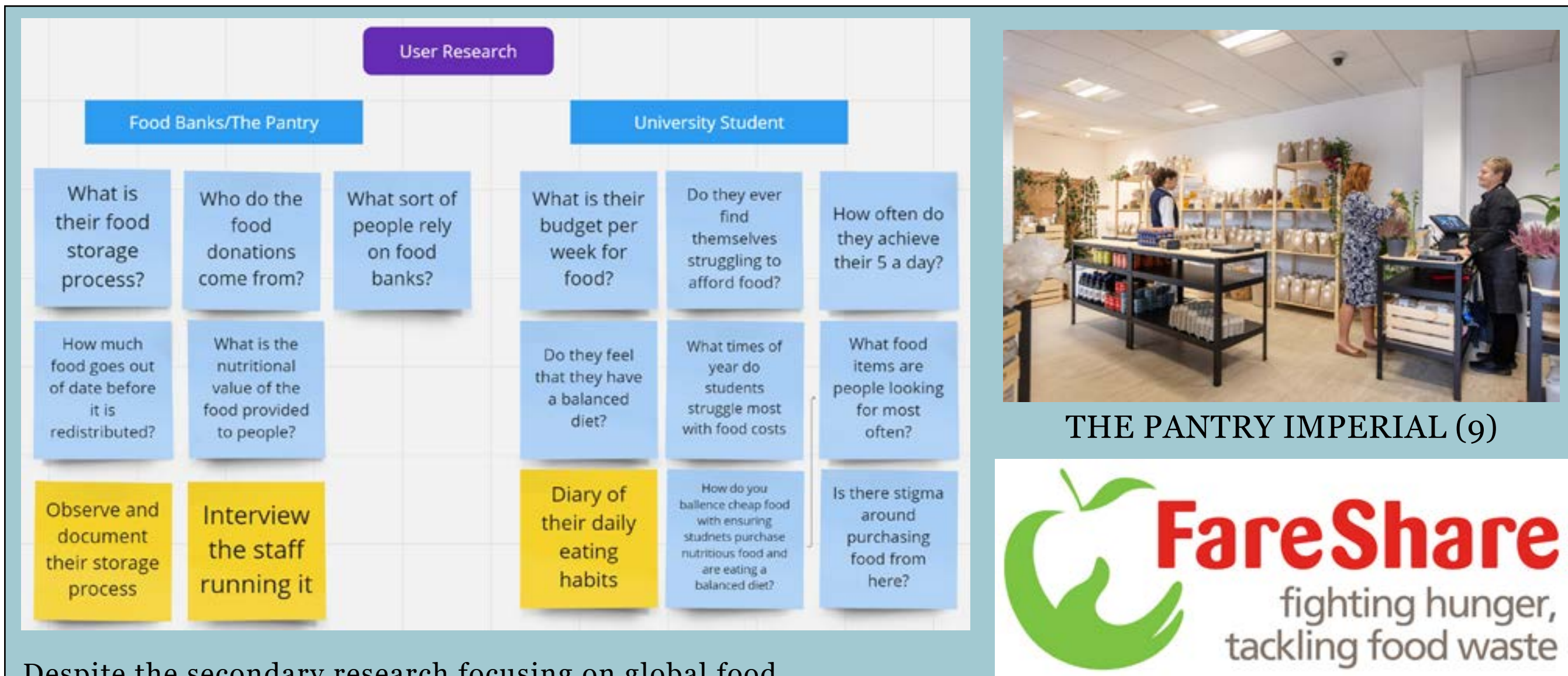
HOW

Initial exploration suggests either improving food sources or improving supply chain networks to better distribute food.

PRIMARY RESEARCH OVERVIEW

INTERVIEWS

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Despite the secondary research focusing on global food insecurity issues, we decided to target London based university students and businesses for the primary research as these were much more accessible.

Shown below is the interview plan for a student, FareShare and The Pantry. The questions for the student will likely be used as part of the survey.

User	Student	Fareshare	The Pantry
Type of User	Representative	Extreme	Extreme
Research Method	Anonymous Survey	Interview + Observation	Interview + Observation
Interview Objective	Understand how students budget and how they achieve a balanced diet on a budget	Understand	Understand how students deal with financially difficult situations and what options students have to get by.
Questions To Ask	Anonymous Survey: <ul style="list-style-type: none">- Do you think you have enough money to afford a balanced diet?- Where do you buy most of your food from?- What is your food budget?- What is your monthly budget?- Do you know what the pantry kitchen is at imperial?- If so, would you find there is any stigma around purchasing food from the pantry kitchen		Interview: <ul style="list-style-type: none">- How do you balance cheap food with ensuring students purchase nutritious food and are eating a balanced diet?- Is there stigma around purchasing food from here?- What food items are people looking for most often?- Does the cost of food items include staffing or is that cost taken on by imperial?<ul style="list-style-type: none">- What is the storage process?- How much food is discarded? Observation: <p>Is there room for a more efficient storage system? How could a similar concept be introduced in less developed countries?</p>

SURVEY/OBSERVATIONS

Student Questionnaire

This is an anonymous survey performed by students in the Dyson School of Design Engineering at Imperial College London to better understand student food security and eating habits. All questions are optional, and your responses will remain confidential. The data collected will be used exclusively for research purposes. Participation in this survey is entirely voluntary, and you can choose to withdraw at any time without any consequences. We appreciate your time and contribution to this important matter.

Do you think you have enough money to afford a balanced diet (do you feel you have food security)?

☐ Yes

☐ No

Where do you buy most of your food from?

☐ Aldi

☐ Tesco

☐ Waitrose

☐ M&S

☐ Lidl

☐ Sainsbury's

☐ Food Banks

Participants Consent Form

University Student Food Security User Research

Please initial box

1. I consent to take part in the above study conducted by a team of students as part of their academic activities at Imperial College.	
2. I confirm that I had the opportunity to ask questions which have been answered fully.	
3. I understand that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	
4. I understand that photographs will be taken and will be anonymized before being included in academic reports.	
5. I understand that anonymized quotations from the interview will be used in academic reports.	

Name of Participant _____ Signature _____ Date _____

Name of Person taking consent _____ Signature _____ Date _____

PAGE 1

Here is the student questionnaire that we produced in order to obtain data on their average food spend, where they typically shop as well as their experience with The Pantry.

We also produced the consent form shown above in order to safely interview and use the data of The Pantry and FareShare.

What is your monthly food budget (excluding eating out)?

Short answer text

What is your total monthly budget?

Short answer text

Do you know what The Pantry is at imperial?

☐ I have heard of it but have never been

☐ I have never heard of it

☐ I shop there regularly

☐ I have shopped there once

If so, would you find there is any stigma around purchasing food from The Pantry?

☐ Yes

☐ No

PAGE 2

We plan to take observations on the contents of randomly sampled students' fridges in order to gain insight into their typical diet and whether they are 1) eating sufficient food and 2) achieving a balanced diet.

PRIMARY RESEARCH: USER DATA

SURVEY - STUDENTS

INTERVIEWS - THE PANTRY

Q1: How do you balance cheap food with ensuring that students get nutritional food and eat a balanced diet?

How it cheap? Of course if you cook at home its getting cheaper. Some vegetables very cheap.

Q2: Do you think there is any stigma around purchasing food from here for students?

No, but I hear some students complaining - they send mails complaining that eggs are too expensive. But yeh no, no pressure.

Q3: What food items do people look for most in here?

Muesli, cornflakes. Eggs also. Rice. Vegetables.

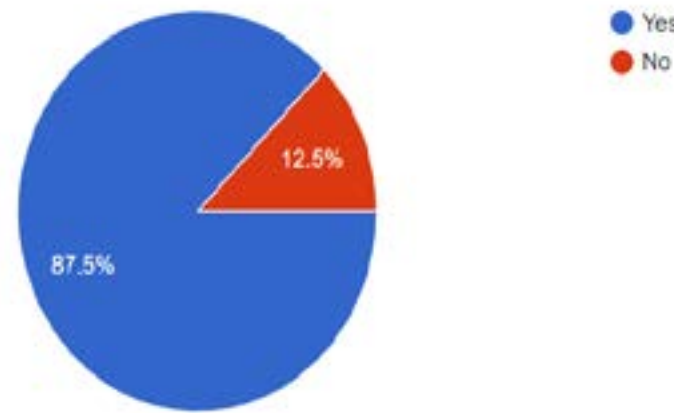
From the interview with the shopkeeper at The Pantry, we discovered that students typically buy the carbohydrate based items from here such as cornflakes, pasta and rice as opposed to the protein rich products such as yogurt, milk or eggs. Some students had complained that these products are not proportionally cheaper compared to the rest of the goods. **This suggests a lack of cheap protein based products being sold which may result in an unbalanced diet.**

OBSERVATIONS - THE PANTRY AND STUDENT FRIDGES



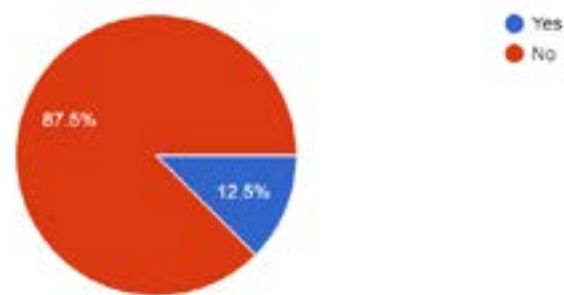
From the research visit, we learnt that The Pantry solely sells the raw unprocessed goods such as rice and pasta. **It does not provide options for sauces, herbs or high fat products which as also key for a balanced diet.**

Do you think you have enough money to afford a balanced diet (do you feel you have food security)?
8 responses



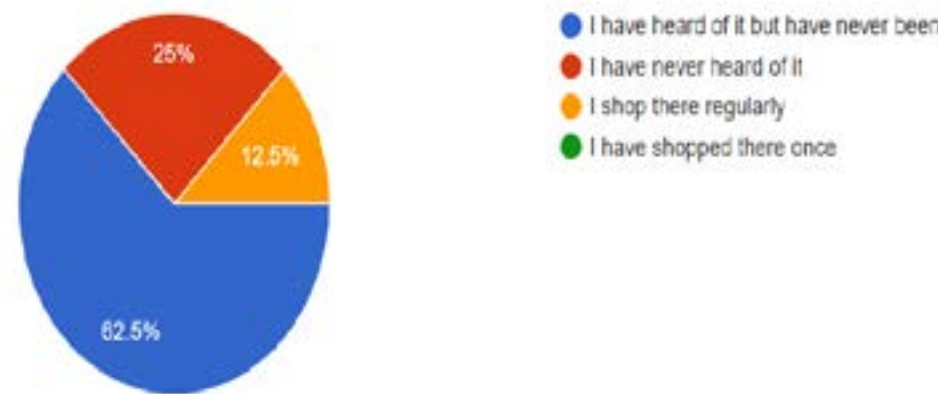
From the study conducted on Imperial first year students, 87.5% of them reported that they can afford a balanced diet. **This suggests that this may not be the user group to focus the product on.**

If so, would you find there is any stigma around purchasing food from The Pantry?
8 responses



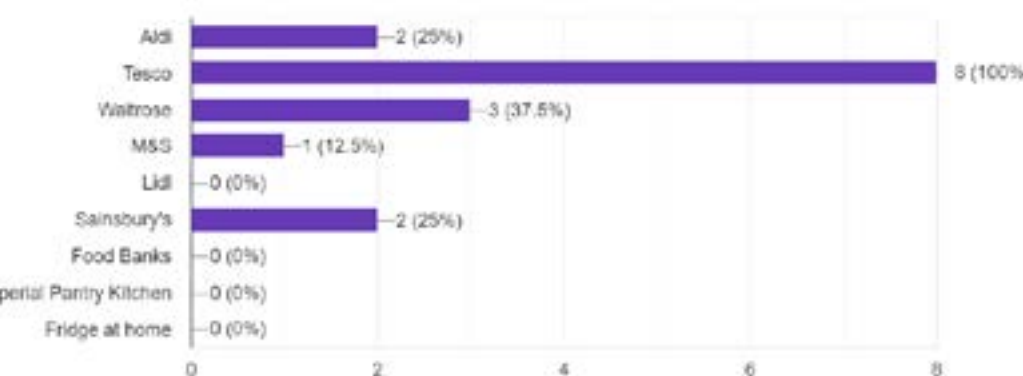
87.5% of the responses said that their wasn't any stigma around buying food from The Pantry. This suggests that **the lack of students attending it is not necessarily due to any negative perception.**

Do you know what The Pantry is at imperial?
8 responses



Most students reported that they had heard of The Pantry but never been. This could likely have a correlation to the first survey question as many students do not have to resort to this option.

Where do you buy most of your food from?
8 responses



The majority of students surveyed shop at mid/high range supermarkets such as Tesco, Waitrose, Aldi and Sainsburys. None used food banks.



We observed the contents of a randomly sampled set of fridges at an Imperial accommodation. These images show before (top) and after 4 days (bottom). There is a clear difference in food supplies between students such as in the left fridge top shelf compared to right fridge middle shelf.

This suggests that some students are not achieving a consistent, balanced diet.

PERSONAS AND JOURNEY MAPPING

JOURNEY MAPPING

PERSONAS

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COMFORTABLE



Name: Jasmine

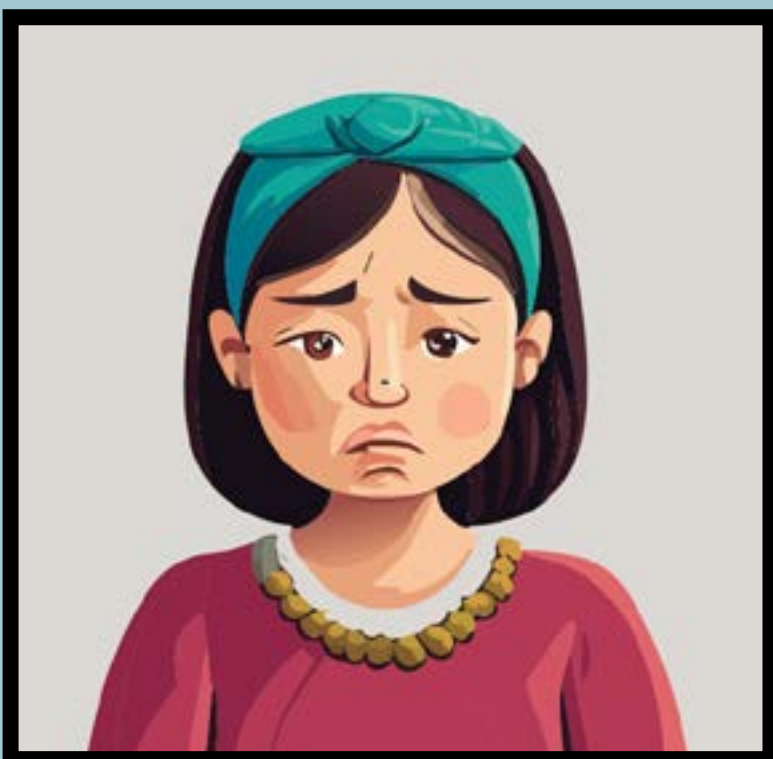
Age: 21

Current Role: University Student

Situation:

- Has a limited budget for food due to her full time studies and minimal student loan.
- Has access to discounted student food shops such as The Pantry
- Is comfortable using discounted food shops

UNHAPPY



Name: Carol

Age: 31

Current Role: Single mother

Situation:

- Has an extremely limited budget for food due to a low paying job and having to care for children by herself
- Does not have the time or money to travel to the nearest food bank

EMBARRASSED



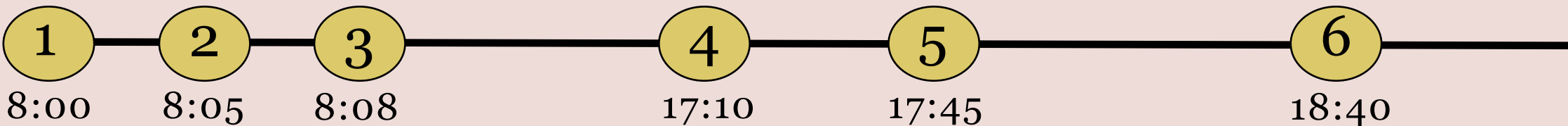
Name: Robert

Age: 19

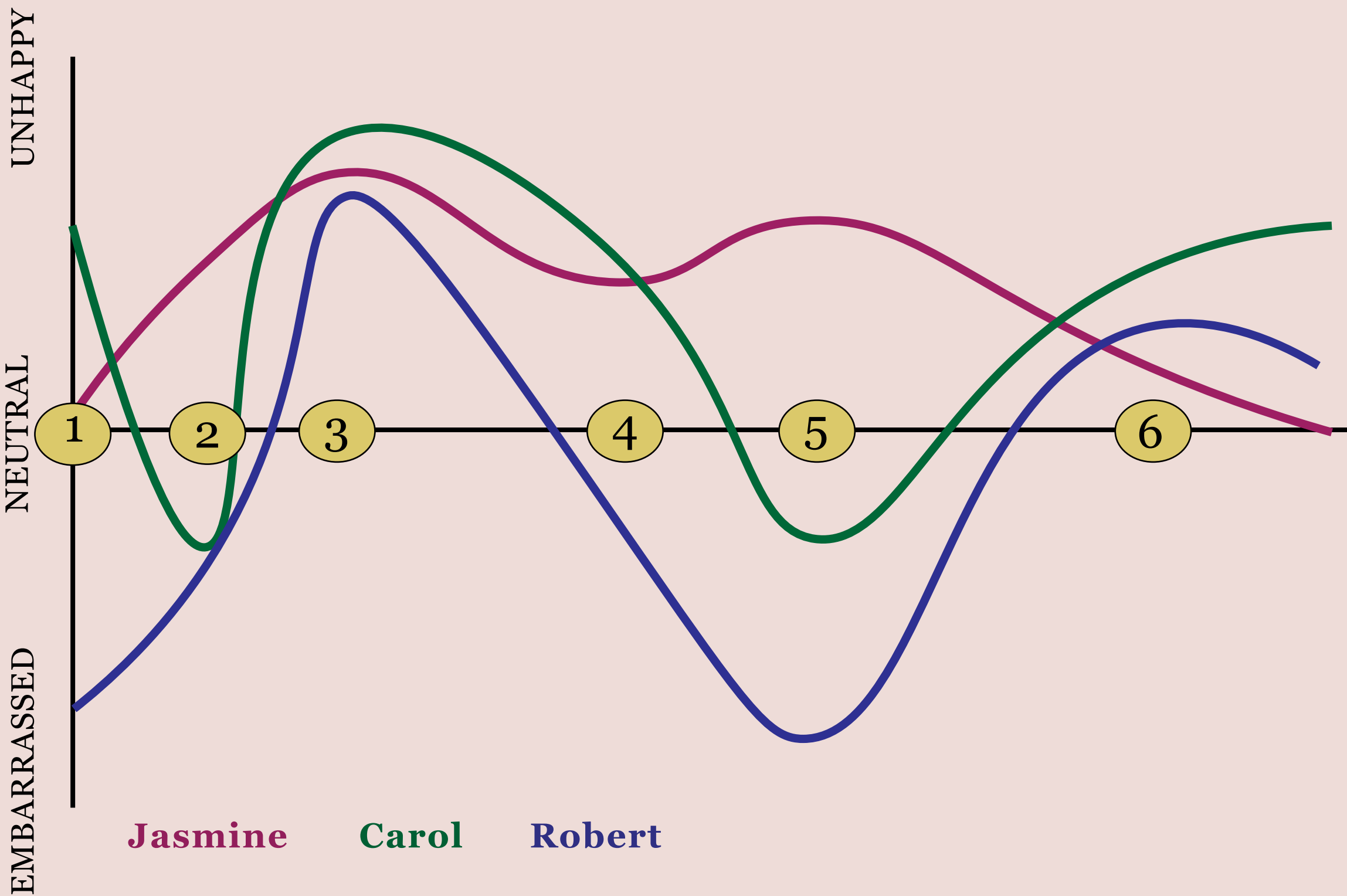
Current Role: University Student

Situation:

- Has a limited budget for food due to his full time studies
- Has access to discounted food shops such as The Pantry
- Believes that his friends will mock him for shopping at a discounted food shop.



- 1 Takes inventory of food in the kitchen and realizes they need to go shopping.
- 2 Checks bank account to assess their budget for food and realizes they do not have enough to shop at a regular supermarket
- 3 Searches online for the nearest food bank or discount shop. Discovers that it is 30 minutes away by public transport, costing £1.75 - another cost that has to be factored into the food budget
- 4 Finishes work/study early in order to arrive at the food bank/shop before it closes at 6:00 pm. Begins the 30 minute bus journey.
- 5 Arrives at the food bank. Secures as much food as possible whilst trying to maintain a nutritious diet.
- 6 Finally returns back home with the food. Begins preparing dinner with limited ingredients.



INSIGHTS

SELECTED HMW

Most food banks and discounted food shops have severely limited options for protein and fat sources which are required for a balanced diet

Many food banks are over 30 minutes away from people. They also close at around 6:00 pm which can result in many people have to either leave work early or not attend at all.

Some people - especially students - believe there is a negative stigma around using food banks or discount shops resulting in them being embarrassed to take advantage of their benefits.

Food insecurity affects children's physical and cognitive development, leading to long-term adverse effects on their health and well-being.

One third of all food produced globally is wasted. This suggests that by redistributing supplies, global food shortages could be greatly reduced.

HMW Develop cheap, protein rich food options in order to ensure that people suffering with food insecurity still achieve a balanced diet

HMW Enhance the selection of food products supplied by food banks to ensure balanced diets for people suffering with food insecurity

HMW Design distribution or delivery systems to connect food banks with people requiring food support

HMW Redesign the experience of using food banks or discount shops to feel more like a retail experience

HMW Leverage technology to provide discreet access to food bank services including scheduling pickups, choosing food items, and receiving notifications about available resources without having to physically visit the location

HMW Leverage technology to identify and reach children at risk of food insecurity more effectively

HMW Develop engaging nutritional education content for children to promote healthy eating from an early age

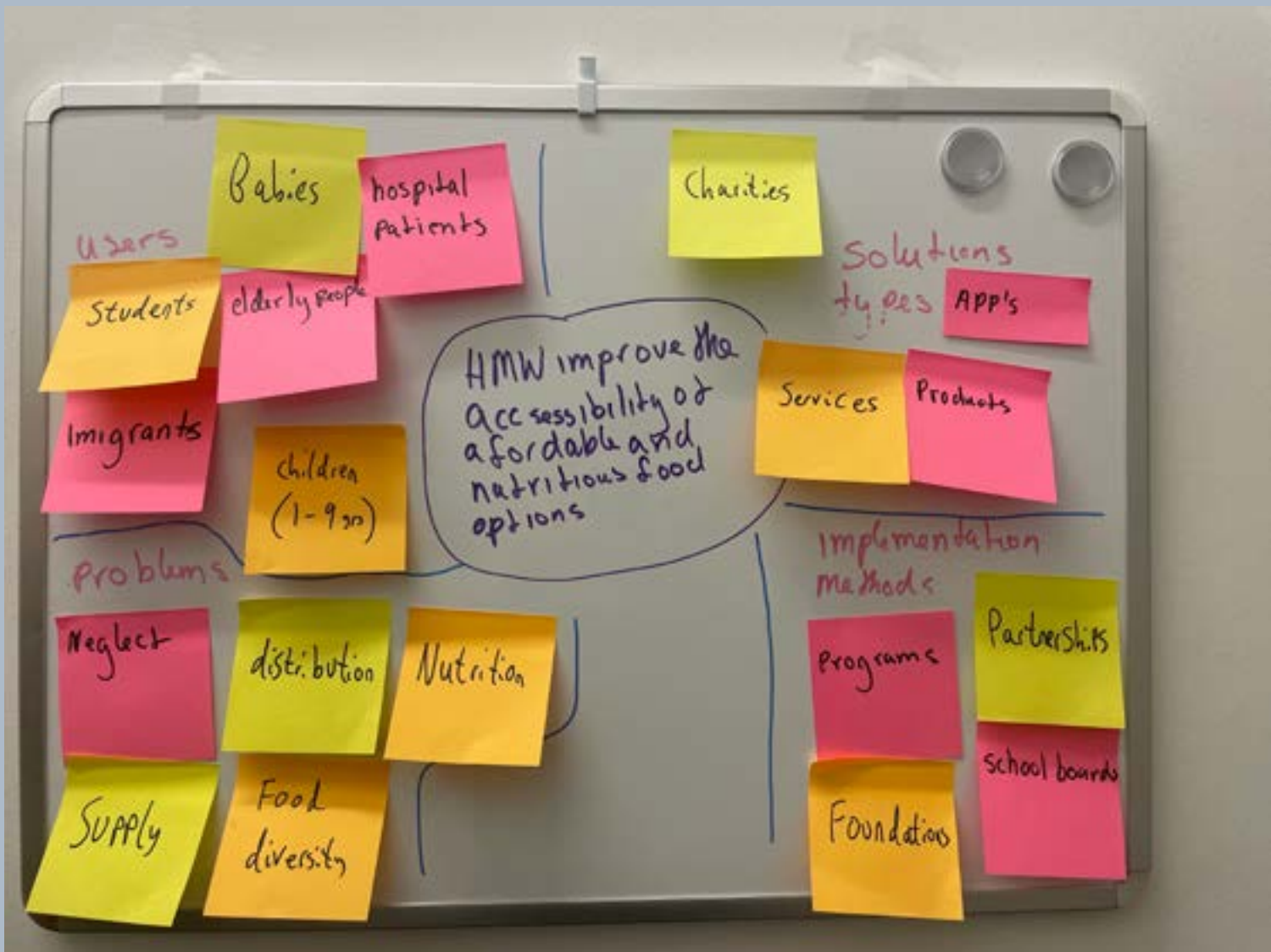
HMW Create more efficient food distribution networks that connect surplus food with areas of need

HMW Design packaging and preservation methods that extend the shelf life of food, making redistribution more feasible

INITIAL IDEATION

In order to help generate 15 design concepts, we completed three ideation phases as a pair.

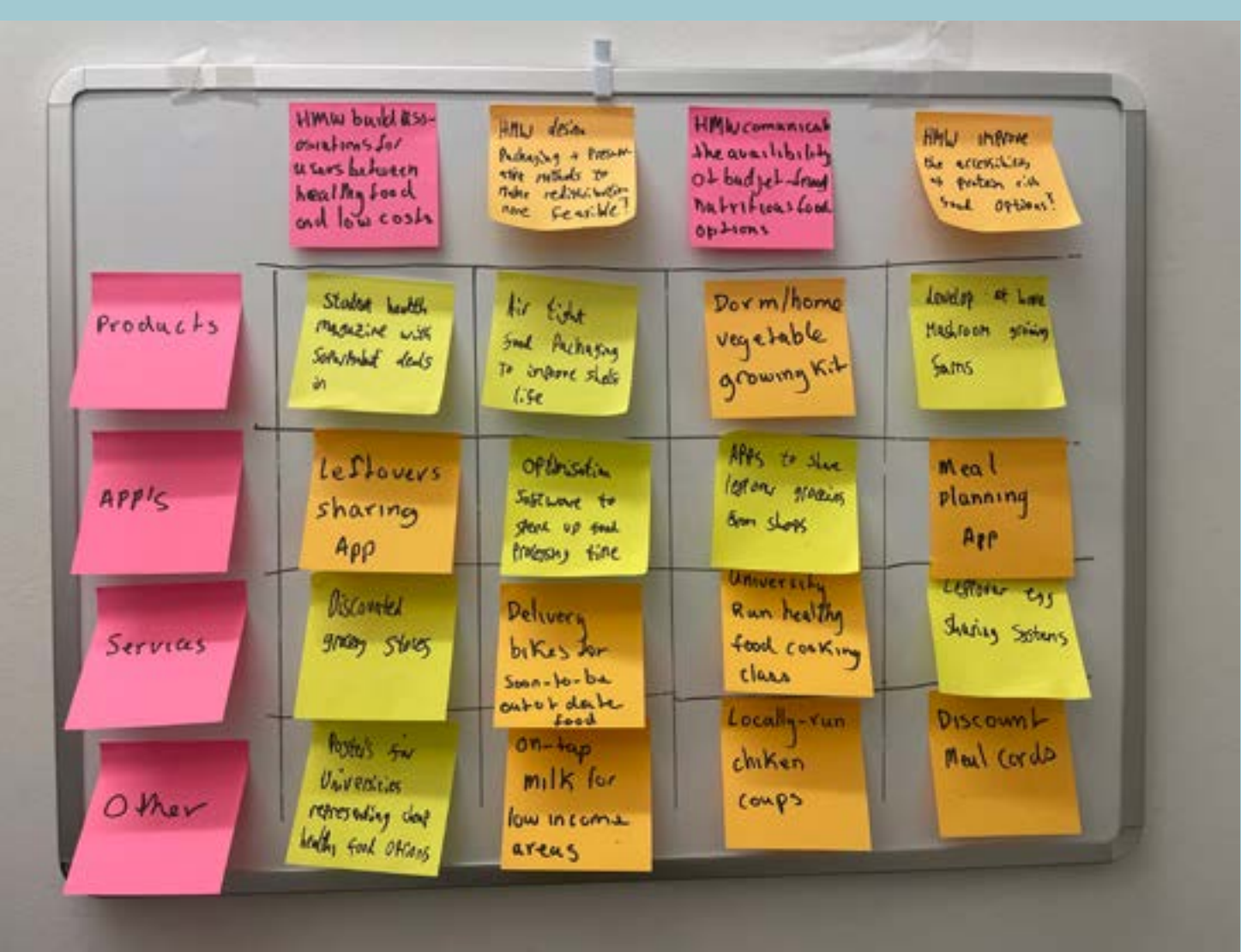
GROUP MINDMAP



We began by producing a mind map around the question: ‘How might we improve the accessibility of affordable and nutritious food options?’. This sparked ideas over potential problems, affected people, potential solutions and implementation methods.



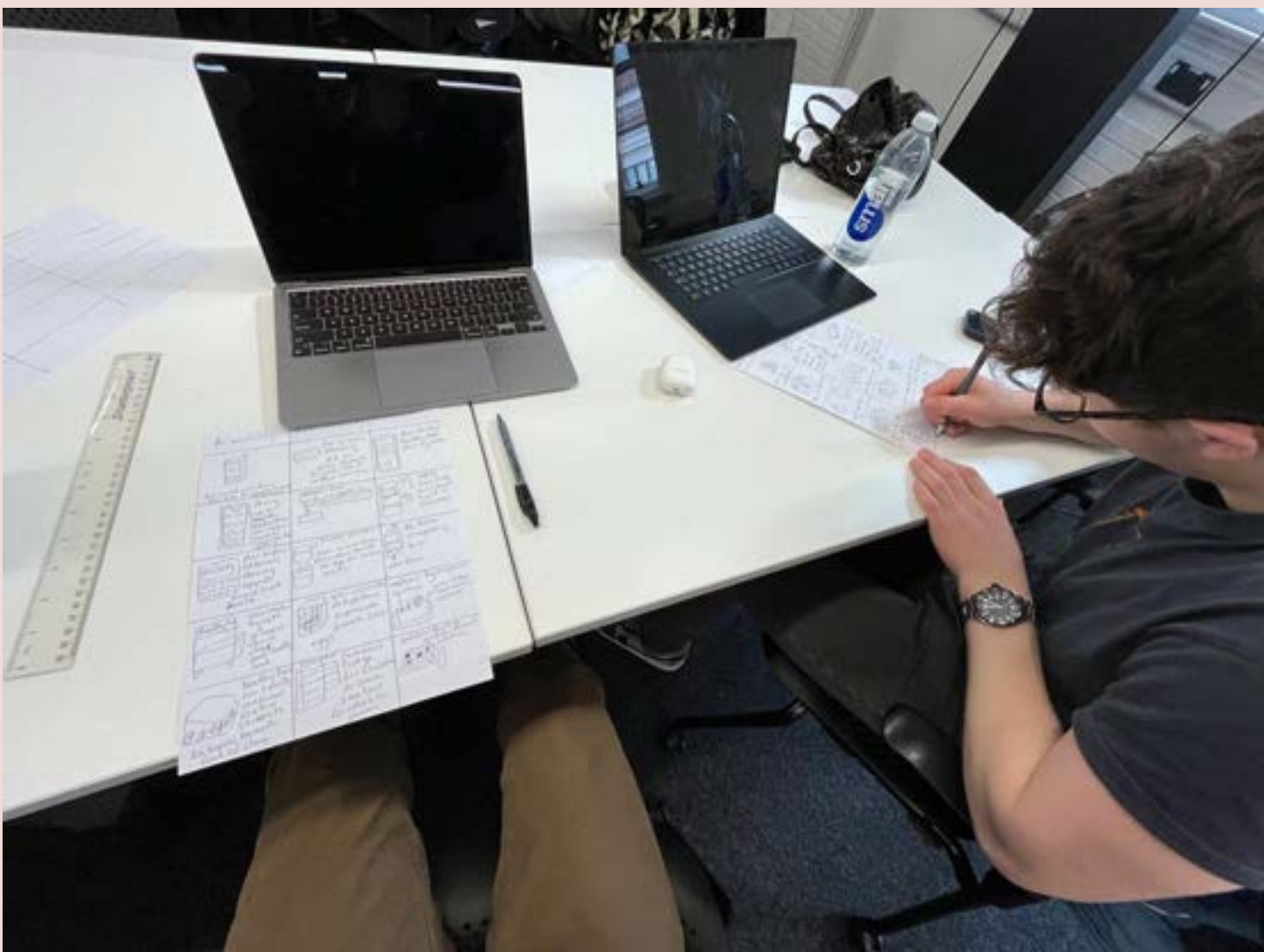
IDEATION MATRIX



As a pair we developed an ideation matrix with 4 HMW question along the top - 2 from each person. Along the y-axis were the different solution types that were developed in the mind map stage.



CODESIGN QUICK SKETCHES



Thirdly, we completed a timed concept brainstorm for each of our selected HMW questions. We had 30 seconds to think of an idea and then 1 minute to sketch it.

Accessibility	Nutrition	Experience

15 DESIGN CONCEPTS

HMW Enhance the selection of food products supplied by food banks to ensure balanced diets for people suffering with food insecurity

These 15 ideas were generated from the 3 processes during the ideation phase, and images constructed using Adobe Illustrator in combination with it's AI image generator

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ULTRA LONG LIFE FOOD PACKAGING



Biodegradable air-tight packaging that uses UV light to kill bacteria, increasing the shelf life of products

EDIBLE HOME MUSHROOM FARM



DIY kits to mass produce nutrient rich mushrooms at home

PORTABLE COLD STORAGE UNITS



Cheap, portable cooling systems to improve the shelf life of products in communities without access to fridges

FOOD BANK FEEDBACK PLATFORMS



Websites and apps to further connect users with food banks to allow for feedback and food requests

DISCREET FOOD BANK DELIVERY SYSTEMS



Food delivery systems to improve the accessibility of food bank goods to consumers

EXCESS FOOD SOURCING APP

6) An app that allows grocery shops, supermarkets, farmers and people to advertise their excess produce to those struggling with food insecurity



FOOD BANK OWNED VEGETABLE GARDENS



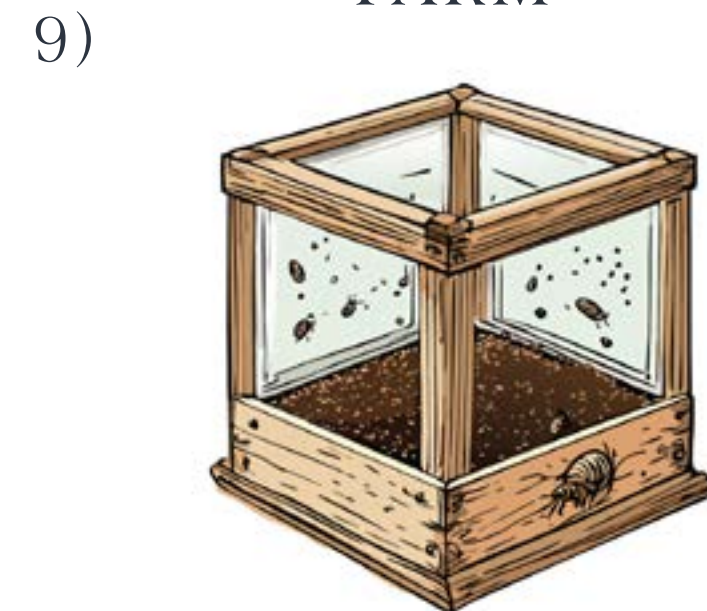
Develop vegetable gardens for food banks to minimize the cost of fresh produce and improve their selection for customers

FOOD BANK RECIPE BOOKS



Recipe books that only include food bank sources items and required limited cooking utensils

HOME EDIBLE INSECT FARM



DIY kits to grow protein rich edible insects at home at a low budget

FOOD BANK USER POINT SYSTEM



A point system for food banks to ensure that the food is spread fairly amongst all users

INDUSTRIAL SCALE EDIBLE MUSHROOM FARM



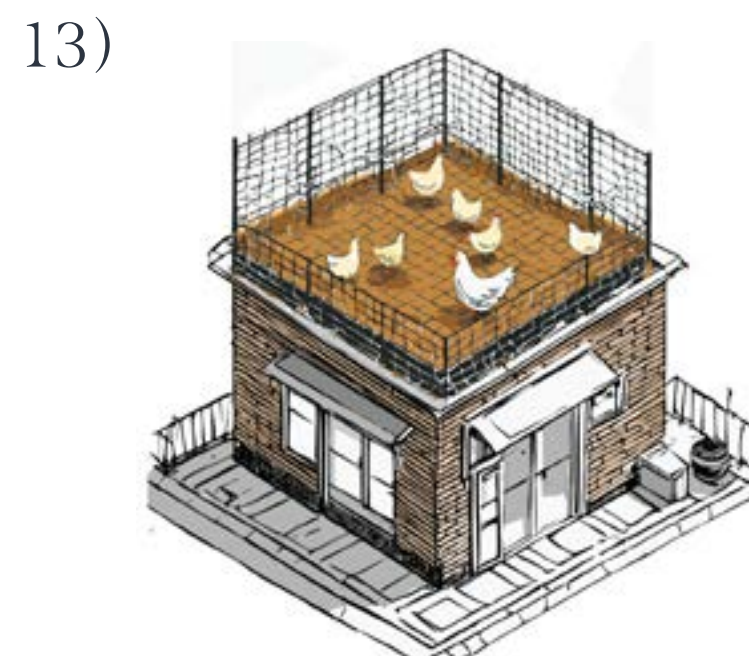
11) Create an industrial scale mushroom farm to mass produce food at minimal costs and increase the supply of nutritious food for food banks

INFANT AND CHILD NUTRITION PACKS



12) Food bank supply packages that are specially tailored to the nutritional needs of young children to help promote healthy development

FOOD BANK OWNED CHICKEN FARMS



13) Develop chicken farms run by food banks in order to create a low cost source of protein rich food options

SPECIALLY DEVELOPED NUTRIENT DENSE SNACKS



14) Low cost snacks with calculated macro nutrient values for food banks to supply to people

DIY AQUAPONICS KITS



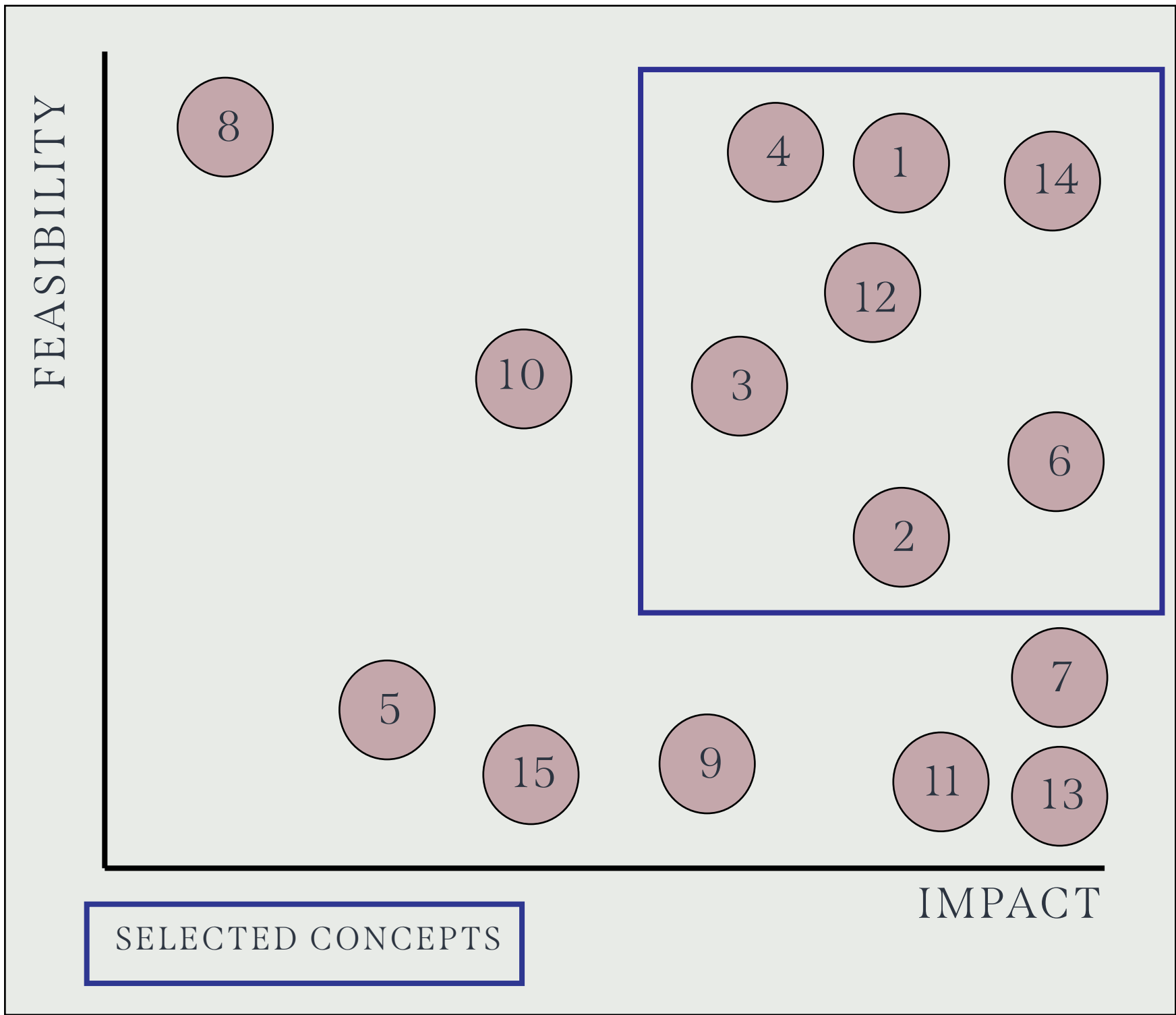
15) DIY aquaponics systems to provide food banks and people with low-cost, year round sources of protein, vitamins and carbohydrates

CONCEPT EVALUATION AND SELECTION

// 09

1) FEASIBILITY MATRIX

Firstly, I developed a feasibility Vs Impact matrix in order to initially filter the design concepts. The top 7 results were selected and highlighted as shown.



3) DESIGN CONCEPT FEEDBACK AND IMPROVEMENT

1 ULTRA LONG LIFE FOOD PACKAGING

Feedback was positive about the idea to use UV light to kill bacteria

Must ensure that the packaging is biodegradable



2 EXCESS FOOD SOURCING APP

- Feedback likes the concept of reducing wasted food
- What is the incentive for businesses to agree to the service?
- Is it feasible for users to collect the food the same day as it is likely to expire after that?
- Could it have competition with existing apps such as Too Good To Go?



3 SPECIALLY DEVELOPED NUTRIENT DENSE SNACKS

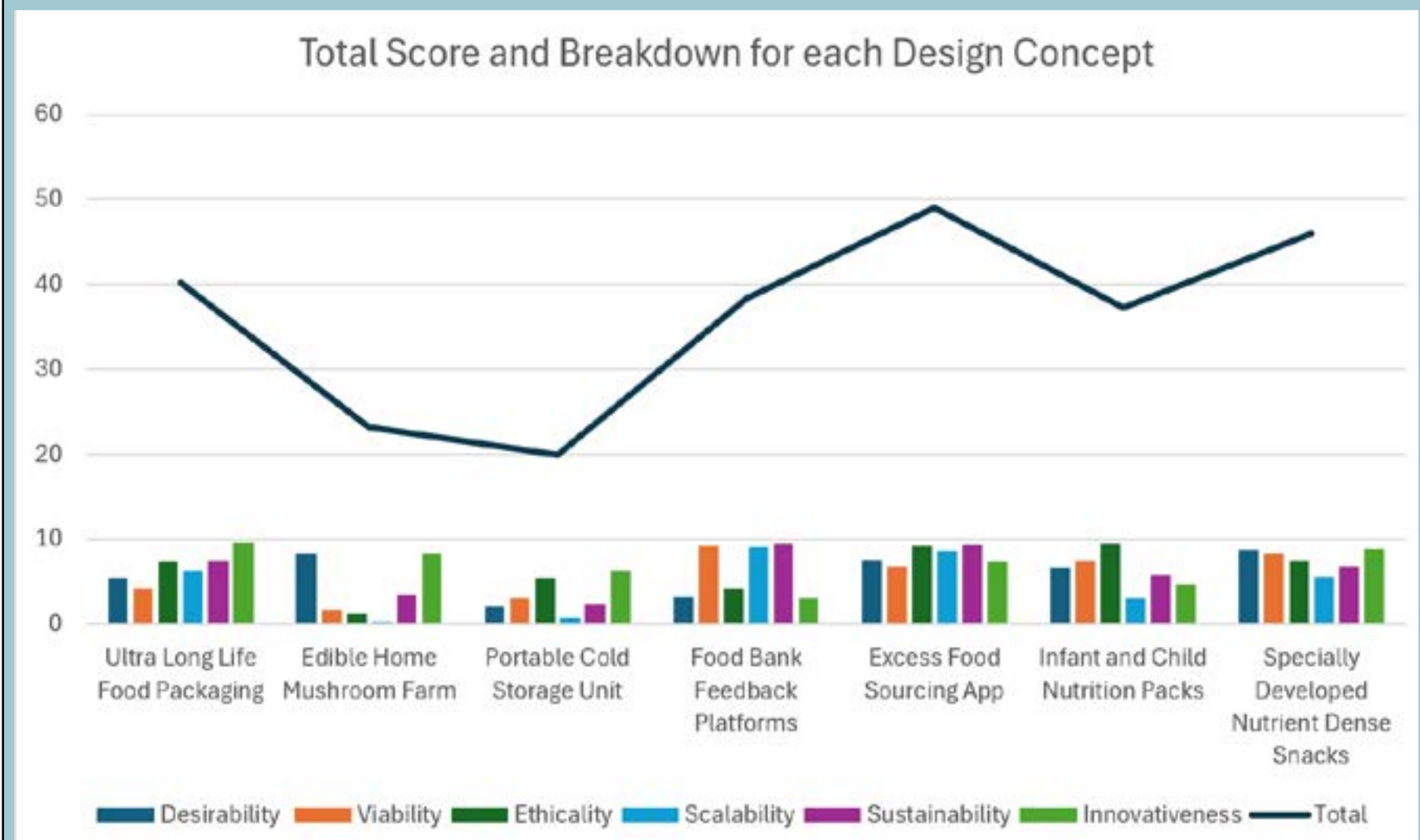
Feedback agrees that it would be beneficial for people on tight schedules and who do not often get the required macro nutrients each day



Questions brought up around the benefits vs negatives of ultra processed food. Is it better to eat enough macro nutrients through processed food or to have none at all?

2) SURVEY AND RATINGS

Design Concept:	1	2	3	4	6	12	14
	Ultra Long Life Food Packaging	Edible Home Mushroom Farm	Portable Cold Storage Unit	Food Bank Feedback Platforms	Excess Food Sourcing App	Infant and Child Nutrition Packs	Specially Developed Nutrient Dense Snacks
Desirability	5.4	8.3	2.1	3.2	7.6	6.7	8.8
Viability	4.2	1.7	3.1	9.2	6.8	7.4	8.3
Ethicality	7.3	1.2	5.4	4.2	9.2	9.5	7.5
Scalability	6.2	0.3	0.8	9.1	8.7	3.1	5.6
Sustainability	7.5	3.4	2.3	9.5	9.4	5.8	6.8
Innovativeness	9.6	8.3	6.2	3.1	7.3	4.7	8.9
Total	40.2	23.2	19.9	38.3	49	37.2	45.9



After selecting the top 7 design concepts from the feasibility matrix, I conducted a survey asking people to rate each concept from 1-10 on the 6 characteristics shown in the table above.

From this table, the top 3 design concepts were selecting for further development.

On the left is a chart visually representing the results from the survey. The Edible Home Mushroom Farm and Portable Cold Storage Units scored the lowest primarily due to their issues with viability and scalability.

CONCEPT 1: ULTRA LONG LIFE FOOD PACKAGING

// 010

1

Current Concept:

Tupperware containers that include a UV-C LED in order to sterilize food products, increasing the life span and allowing for the redistribution of excess food

2

Prototyping:



- Can it be designed to be compact enough to not impact usage?

- Will the added electronic components be too heavy?


In the prototype, the light was emitted from a point source, resulting in little coverage inside. Further versions should have full LED coverage

The electronics were approximated by an Iphone 12 Mini encased in a cardboard holder. This did not affect the use nor add too much weight

3

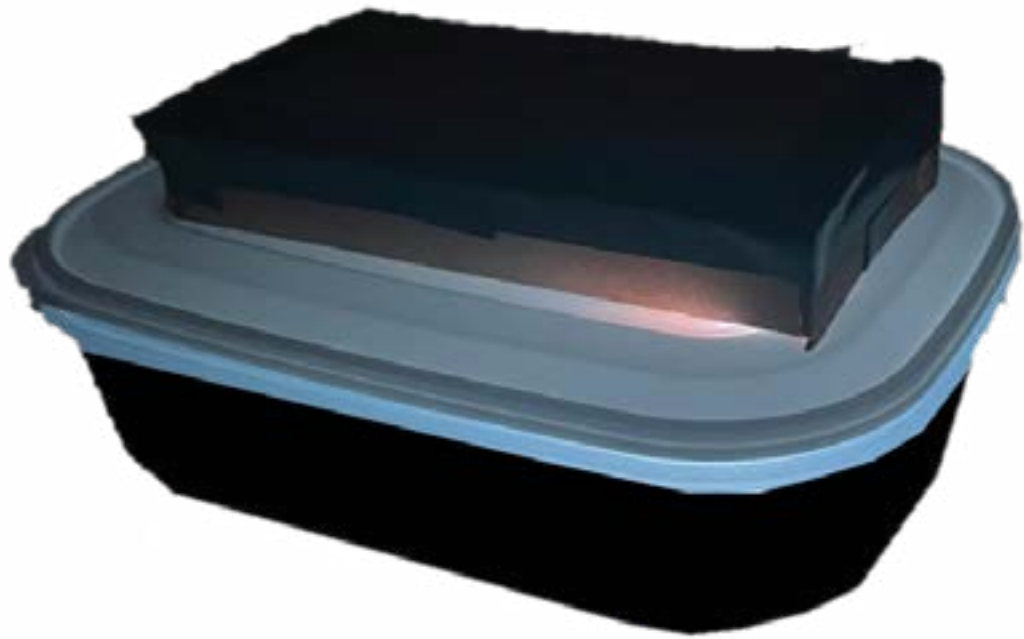
Improvements:

Full Lid LED Coverage



The main concern over the original concept was the coverage of UV-C light. In future versions, a large proportion of the lid should be covered with the UV-C LEDs.

Blacked Out Container Sides




Another concern was UV-C light escaping the transparent container. UV-C light is highly effective at destroying genetic material (hence its excellent properties for sterilization) and so no light should be able to escape.

Therefore, by added a reflective internal coating on the walls and an opaque coating on the outside, all of the UV-C light should remain inside.

4

Final Concept (11)



The container does not need to be refrigerated, allowing for cost-effective redistribution of excess food to those in need.

The low power UV-C LED light strip on the roof continually sterilize the food inside, restricting mold growth.

The transparent acrylic container walls allow for ease of viewing inside, cheap manufacture, durable and tough container properties as well as blocking any UV-C light from exiting the container.

CONCEPT 2: EXCESS FOOD SOURCING APP

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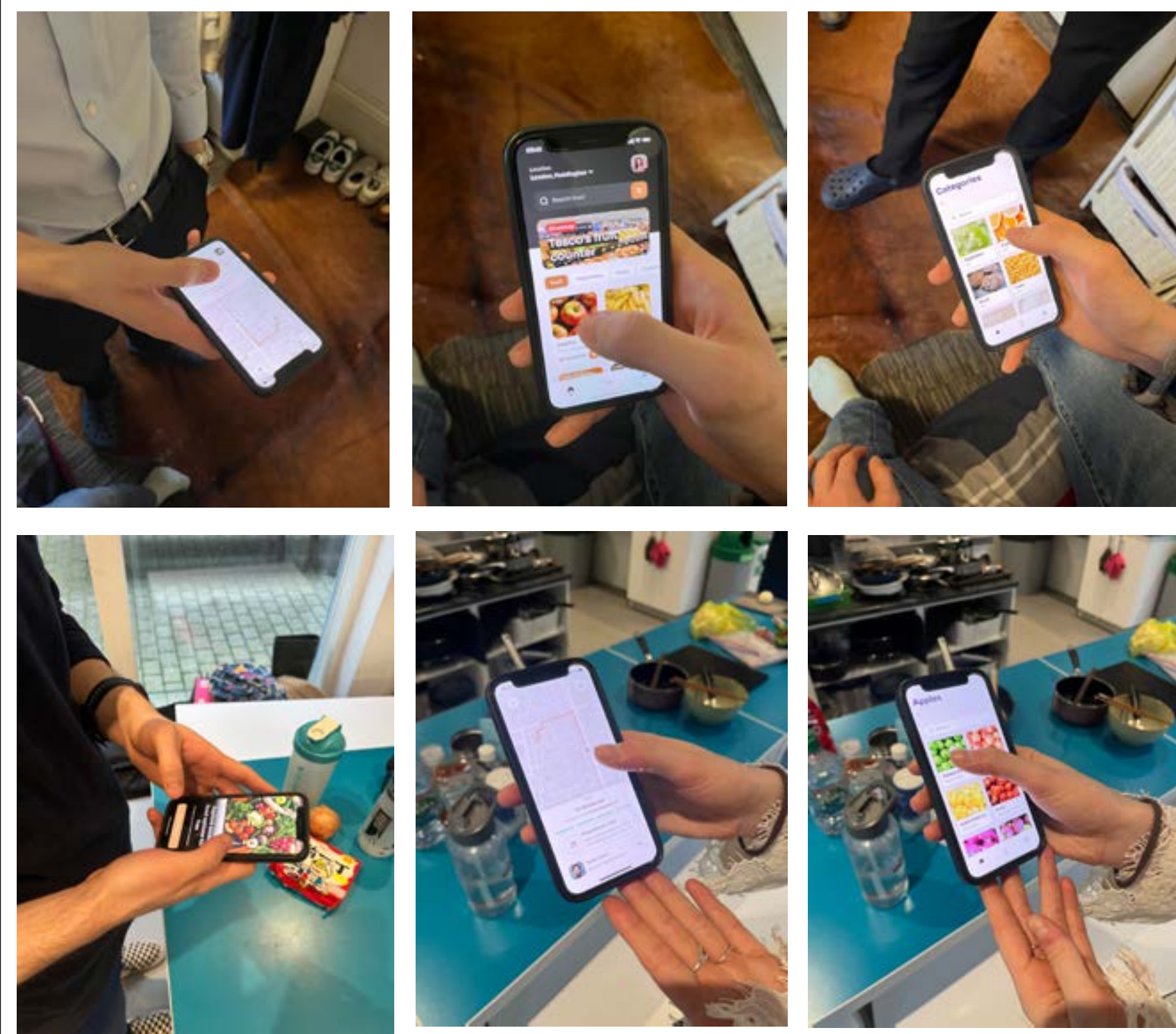
1

Current Concept:

An app that allows businesses or people to advertise any leftover food, as well as people struggling with food shortages to then locate the produce.

3

User Testing + Feedback:



I sampled the User Interface with 4 different people with different hand sizes and genders. They found the interface easy to navigate and the button locations suitable with recognizable symbols and images. Feedback suggested making the buttons larger for users with bigger hands.

4

Improvements:

- As suggested in user feedback and in shown by the image, larger buttons such as the home, search and order icons would make the app more accessible
- The offerer side of the app is still yet to be developed to allow businesses to upload their spare food
- As questioned in the concept evaluation, the incentive for businesses such as Tesco to use the app can be marketed as a cost-effective way to dispose of leftover food

2

Prototyping: What would the UI and UX look like?

I used Figma to prototype the User Interface and User Experience for the app

It features pages to filter through available products and their distances from you

It allows you to select the number of food items you require

It then tells you that your order has been prepared and gives the directions and ETA for collection

CONCEPT 3: NUTRIENT DENSE SNACK OPTIONS

// 012

1

Current Concept:

Snack options that are densely packed with macro-nutrients and calories to provide a low-cost option for those struggling to achieve their recommended daily intake

2 Prototyping: Can the required macro-nutrients be packed into a snack size bar?



I decided to experiment with a basic snack bar recipe that included high levels of nutrients:

- 2 scoops of protein powder; 220 kcal, 48g Protein
- 200g Wholegrain Sultana Bran: 680 kcal, 17.2g Protein
- 100g honey: 290 kcal
- 1 immune support tablet: 1g Vitamin C
- 1 ultra tablet: 1000 iu Vitamin D

Total nutritional values:

1190 kcal: Over half the daily required intake
65.3 g protein: Over the suggested daily intake
26g fibre: 87% of the suggested daily intake (30g)
Over 100% Nutritional Reference Value (NRV) in Vitamin C, Vitamin D, Vitamin E, Folic Acid, Iron

Cost: approximately £1.20 in ingredients



After weighing out the ingredients and mixing them with the honey, they were formed into a bar. This was then placed in the oven at 180°C for around 10 minutes. It was allowed to cool and set for a further 10 minutes. The result was a solid cereal bar containing large amounts of nutrients, carbohydrates and protein.

3

User Feedback:

User test feedback included:

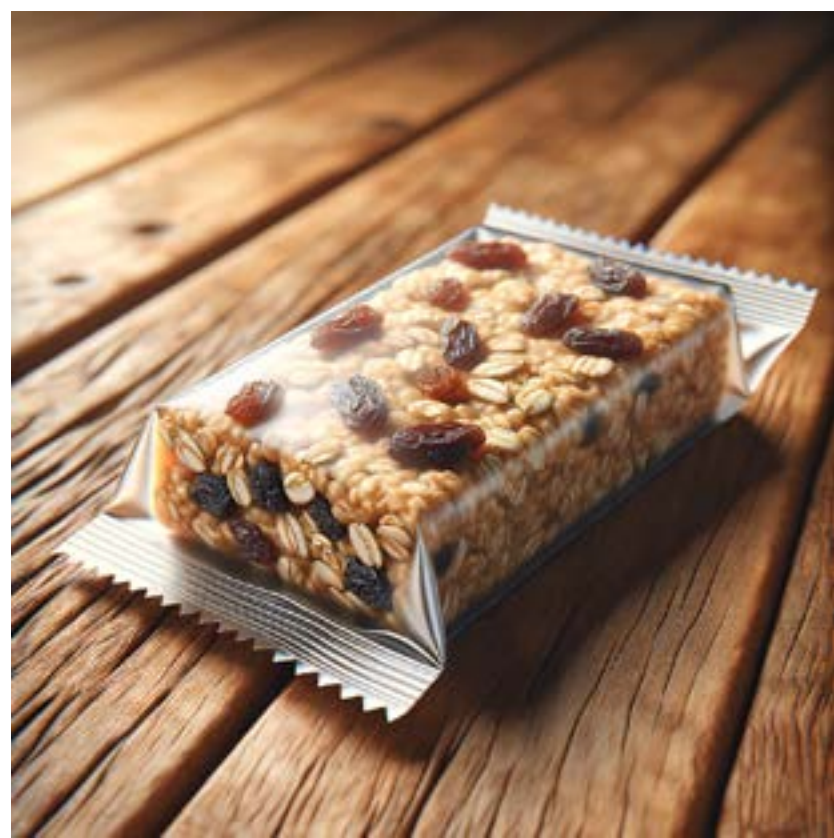
- + The flavour was sweet and the vanilla from the protein powder added a nice touch
- + The fact that most of the daily required macros is in it is a big incentive to choose it as a snack option
 - The bar could have been cooked longer inside to make it firmer
 - The flavour could be improved by the addition of spices such as cinnamon
 - A well designed packaging would add a lot to the user experience

4

Improvements:

User test feedback included:

- + The flavour was sweet and the vanilla from the protein powder added a nice touch
- + The fact that most of the daily required macros is in it is a big incentive to choose it as a snack option
 - The bar could have been cooked longer inside to make it firmer
 - The flavour could be improved by the addition of spices such as cinnamon
 - A well designed packaging would add a lot to the user experience



5

Final Concept (12):

Features simplistic, biodegradable and see through plastic packaging

Improved recipe to make it more firm and easier to eat

Could have the nutritional information as a paper label on the back

Produced in mass to bring the cost per unit down making it more accessible to lower income members of society

References:

1) [HTTPS://WWW.FAO.ORG/HOME/EN](https://www.fao.org/home/en)

2) [HTTPS://WWW.WFP.ORG/](https://www.wfp.org/)

3) [HTTPS://WWW.UNICEF.ORG/](https://www.unicef.org/)

4) [HTTPS://WWW.WHO.INT/PUBLICATIONS/I/ITEM/9789240025257](https://www.who.int/publications/i/item/9789240025257)

5) [HTTPS://WWW.FAO.ORG/3/I2697E/I2697E.PDF](https://www.fao.org/3/I2697E/I2697E.PDF)

6) [HTTPS://WWW.IPCC.CH/SITE/ASSETS/UPLOADS/SITES/4/2019/12/02_SUMMARY-FOR-POLICYMAKERS_SPM.PDF](https://www.ipcc.ch/site/assets/uploads/sites/4/2019/12/02_summary-for-policy-makers_spm.pdf)

7) [HTTPS://WWW.FAO.ORG/3/I3301E/I3301E.PDF](https://www.fao.org/3/I3301E/I3301E.PDF)

8) [HTTPS://OURWORLDINDATA.ORG/FOOD-SUPPLY](https://ourworldindata.org/food-supply)

9) [HTTPS://TWITTER.COM/IMPERIALCOLLEGE/STATUS/1590388847635996678](https://twitter.com/imperialcollege/status/1590388847635996678)

10) [HTTPS://FARESHARE.ORG.UK/](https://fareshare.org.uk/)

11) DALL-E GENERATED IMAGE ‘CAN YOU MAKE AN IMAGE OF A CLEAR PLASTIC RECTANGULAR TUPPERWARE CONTAINER WITH FOOD IN, A UV LIGHT SHINING INSIDE AND SUNLIGHT SHINING IN’

12) DALL-E GENERATED IMAGE ‘MAKE ME A PHOTO OF THIS SNACK BAR IN PACKAGING’ + IMAGE OF PROTOTYPE ATTACHED

Miro Board:

HTTPS://MIRO.COM/APP/BOARD/UXJVNZQ-VCM=/

User Research

Food Banks/The Pantry

What is their food storage process?

Who do the food donations come from?

What sort of people rely on food banks?

How much food goes out of date before it is redistributed?

What is the nutritional value of the food provided to people?

Observe and document their storage process

Interview the staff running it

University Student

What is their budget per week for food?

Do they ever find themselves struggling to afford food?

How often do they achieve their 5 a day?

Do they feel that they have a balanced diet?

What times of year do students struggle most with food costs?

What food items are people looking for most often?

Diary of their daily eating habits

How do you balance cheap food with ensuring students purchase nutritious food and are eating a balanced diet?

Is there stigma around purchasing food from here?

Interviews

Q1: How do you balance cheap food with ensuring that students get nutritional food and eat a balanced diet?

How It cheap? Of course if you cook at home its getting cheaper. Some vegetables very cheap.

Q2: Do you think there is any stigma around purchasing food from here for students?

No, but I hear some students complaining - they send mails complaining that eggs are too expensive. But yeh no, no pressure.

Q3: What food items do people look for most in here?

Muesli, cornflakes. Eggs also. Rice. Vegetables.

Survey

What do you buy most of your food from?

100%

100%

100%

100%

100%

100%

Do you think there is any stigma around purchasing food from here for students?

100%

100%

100%

100%

100%

100%

Do you think you have enough money to afford a balanced diet?

100%

100%

100%

100%

100%

100%

What food items do people look for most often?

100%

100%

100%

100%

100%

100%

How do you balance cheap food with ensuring students purchase nutritious food and are eating a balanced diet?

100%

100%


100%

100%


100%

100%

Observations



We photographed the insides of 7 student fridges on different days to better understand their eating habits, as well as to understand if they are eating a balanced diet.



We photographed the interior of The Pantry food supply store to see what foods they stocked as well as to better understand the association between presentation and stigma around shopping there.