

ВАСК ТО НОМЕ

Mission Folder: View Mission for 'Pantry Patrol'

State	North Carolina
Grade	9th
Mission Challenge	Food, Health and Fitness
Method	Engineering Design Process
Students	Siddharth Maruvada (PantryPatroller)
	Abhinav Meduri (NewTon2)
	Arnav Meduri (Darwinner)

Team Collaboration

(1) How was your team formed? Was your team assigned or did you choose to work with each other?

Please refer to section 7.1 of Team_Collaboration.pdf

(2) Provide a detailed description of each team member's responsibilities and jobs during your work on the Mission Folder.

Please refer to section 7.2 of Team_Collaboration.pdf

(3) Did your team face any problems working together? If so, how did you solve them? If not, why do you think you were able to work together so well?

Please refer to section 7.3 of Team_Collaboration.pdf

(4) What were some possible advantages to working together as a team on this project? How would working as individuals have made this project more difficult?

Please refer to section 7.3.1 and 7.3.2 of Team_Collaboration.pdf

Uploaded Files:

• [View] Team Collaboration (By: Advisor, 03/10/2021, .pdf)

This document contains all sections of Team Collaboration documentation.

Engineering Design

Problem Statement

(1) What problem in your community will your team attempt to solve using the engineering design process? Why did your team choose this problem to try to solve?

Please refer to section 1.1 of Use_of_Engineering_Design.pdf

(2) Research your problem. You must learn more about the problem you are trying to solve and also what possible solutions already exist. Find AT LEAST 10 different resources and list them here. They should include books, periodicals (magazines, journals, etc.), websites, experts, and any other resources you can think of. Be specific when listing them, and do not list your search engine (Google, etc.) as a resource.

Please refer to section 1.2 of Use_of_Engineering_Design.pdf

(3) What did you find out about your problem that you didn't know before? What kinds of possible solutions already exist? Be sure to put this in your OWN words, do not just copy And paste information. Also, be sure to cite your sources.

Please refer to section 1.3 of Use_of_Engineering_Design.pdf

Design Development

(4) What MUST be a part of your solution? These are called the criteria. Explain what criteria are needed to solve the problem. Make sure your criteria are measureable, connected to the problem, and related to your research.

Please refer to section 2.1 of Design_Development.pdf

(5) What limits are there on your solution? These are called constraints. Does it need to be a certain size? A certain weight? Is the cost a factor? Write down all of the limits on your solution.

Please refer to section 2.2 of Design_Development.pdf

(6) Based on your criteria and constraints, what is your proposed solution to the problem you chose? Explain what it will look like and how it will work. If you can, include a detailed, labeled drawing.

Please refer to section 2.3 of Design_Development.pdf

(7) How will you test your solution? The BEST way to test your solution is to build a working model or a prototype that you can actually use. Or you can guess how your solution will work BASED ON your research. Which method will you use and why?

Please refer to section 2.4 of Design_Development.pdf

Build Model or Prototype

(8) If you built a prototype or model, explain how you built your prototype or model, step-by-step including ALL SAFETY PRECAUTIONS. If you guessed how your solution would work BASED ON your research, explain important information from your research that you used to prove how your solution would work and be sure to cite your sources.

Please refer to section 3 of Design_Development.pdf

Test Model or Prototype

(9) Explain how you tested your prototype or model. Be sure to include every step of your testing including all safety precautions that were taken. If not stated it will be assumed no safety precautions were taken. If you are using research to guess how your solution will work, explain step-by-step how it will work and why.

Please refer to section 4 of Design_Development.pdf

(10) What problems did you find with your solution? Be specific since you will need to redesign based on these problems.

Please refer to section 4.2 of Design_Development.pdf

(11) Describe all of the changes you made to your prototype or model (or proposed prototype) after your first test. Why will these changes improve your solution?

Please refer to section 4.3 of Design_Development.pdf

(12) Present the data you collected from your tests or from your research. If you tested a prototype or model then include all of the numbers you gathered during your testing and all observations you made. Use of graphs and charts is HIGHLY encouraged. If you used research to prove how your solution would work, be sure to include all of the numbers, charts, and graphs you used to make your case. Be sure that all data is related to your solution.

Please refer to section 4.4 of Design_Development.pdf

(13) What are your potential sources of error? Remember, this doesn't mean "Did everything work?", all tests have potential sources of error, so make sure you understand what that means. Explain how these sources of error could have affected your results.

Please refer to section 4.5 of Design_Development.pdf

Drawing Conclusions

(14) What conclusions can you draw based on the data you gathered during your tests? Your conclusion should be related to your original problem and your testing, include the data you collected, and refer to your proposed solution.

Please refer to section 5 of Design_Development.pdf

Uploaded Files:

• [View]	Use of Engineering Design (By: Advisor, 03/10/2021, .pdf)
	This document covers all sections related to the Use of Engineering Design
• [View]	Referral Letter - First Lady of NC (By: Advisor, 03/10/2021, .pdf)
	Attached is a referral letter from Ms. Kristin Cooper, First Lady of the State of North Carolina
• [View]	Referral letter - FBCENC (By: Advisor, 03/10/2021, .pdf)
	Attached is the referral letter from Mr. Gideon Adams, Vice President of Food Bank of Central and Eastern North Carolina
• [View]	Referral Letter - Dr. Ammerman (By: Advisor, 03/10/2021, .doc)
	Attached is a referral letter from Dr. Alice Amerman, Director, Center for Health Promotion and Disease Prevention? Mildred Kaufman
	Distinguished Professor, Department of Nutrition? Gillings School of Global Public Health and School of Medicine ? University of North
	Carolina at Chapel Hill ?
• [View]	Referral letter - Mayor Weinbrecht (By: Advisor, 03/10/2021, .pdf)
	Referral letter from the mayor of Cary, NC, Mr. Harold Weinbrecht
• [View]	Referral letter - Angela Nesius (By: Advisor, 03/10/2021, .pdf)
	Attached is the referral letter from Ms. Angela Nesius, Records and Data Collection Coordinator, Food Bank of Central & Eastern North
	Carolina
• [View]	Design Development (By: Advisor, 03/10/2021, .pdf)
	This document contains all Design and Development sections

Community Benefit

(1) Explain how investigating the problem your team chose will help the community. Be sure to include the impacts your research will have on individuals, businesses, organizations, and the environment in your community (if any). Make it very clear why solving this problem would help your community.

Please refer to content in Benefits_to_Community.pdf

Uploaded Files:

• [View] Benefits to Community (By: Advisor, 03/10/2021, .pdf)

This document contains all sections related to Benefits to Community.

Mission Verification

We have reviewed the eCYBERMISSION Rules and Guidelines

Yes

We have worked with our Team Advisor and we have discussed the possible risks involved in the project and completed the Risk Assessment Form (and attached it

2 of 3

to our Mission Folder).

Yes

The project involves hazardous chemicals, activities, or devices.

No

The project involves potentially hazardous biological agents (If yes, complete this form and attach to your Mission Folder).

No

We acknowledge that we followed proper safety precautions during the work on our project.

No

The project involves testing one or more of the following and requires prior approval by an Institutional Review Board (IRB):

Humans

No

Non-Human Vertebrates

No

You will need to include an abstract of 250 words or less. As part of the abstract you will need to describe your project and explain how you used STEM (Science, Technology, Engineering and Mathematics) to improve your community

Food insecurity remains to be a problem in many parts of the world. This problem is even more rampant during the current COVID-19 pandemic. During the height of the pandemic, more than 50 million households in the USA alone were food insecure. Despite food insecurity issues, food waste is a major problem in the USA. According to the United States Department of Agriculture (USDA), approximately 30-40% of food produced is wasted in the United States. Reducing food losses by only 15 percent would be enough food to feed more than 25 million Americans each year. Also, wasted food is a huge tax on the environment and contributes to greenhouse gases. Food Banks, Food Pantries, and other community initiatives are actively combating this problem. Food Pantries are the front line of the fight against food insecurity that could use several tools to reduce food waste and help more people in the community.

Food banks generally do not have any visibility into the food waste that is happening at their affiliate food pantries. They can operate more efficiently if they have the food waste data and can put it to good use. Our solution to this problem is PANTRY PATROL - an intuitive and easy-to-use application primarily focused to help food pantries track, monitor, identify the sources of food waste and eliminate them. The application includes several food pantry management features that help simplify the day-to-day operations of food pantries so volunteers can focus on their core mission - serving their communities.

Uploaded Files:

• [View] Risk Assessment form (By: Advisor, 03/10/2021, .pdf)

Risk assessment form

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 missioncontrol@ecybermission.com







February 12, 2021

To Whom It Concerns:

The student team at Enloe, Abhinav Meduri, Arnav Meduri, and Siddharth Maruvada, approached our office to present their food waste project. During our meeting, the students demonstrated the "Pantry Patrol" app that they have been working on. The application has features to help food pantries track, monitor, and eliminate food waste. The app has several food pantry management features, helping food pantries with daily operations such as inventory and client management. The application also considers clients' dietary preferences at the food pantry, allowing food pantries to cut down on food waste. The application can generate automatic monthly reports on food waste for partner food banks, thereby allowing them to be more efficient in distributing food to the pantries. The application has built-in analytics and dashboards with comprehensive graphs, charts, and tables to display food waste by date, category, and reason. These features enable food pantries to review this data and look back at the improvements that can be made in their daily operations.

Cary has a rich history of supporting grassroots initiatives that include the quality of life for all our citizens, like the one that is summarized above. These students presented their material in a very professional way, and their project is well-research so that it can be easily implemented in our community. I know they will represent Cary well and will have success in future endeavors.

Sincerely,

Handle Weinbrech Je

Harold Weinbrecht Jr. Cary Mayor

7. TEAM COLLABORATION

7.1 Team Formation

How was your team formed? Was your team assigned or did you choose to work with each other?

The three of us have been close friends since the beginning of middle school. We are all freshmen at the same high school and participate in various school clubs together, including Science Olympiad and Speech and Debate. Our collective passion for STEM and love for doing team projects is what brought us together during last year's (2019-2020) eCYBERMISSION competition. With the success of last year's project in terms of collaboration, pioneering, aptitude, passion, enthusiasm, and leadership that each of us demonstrated, we decided to team up again for this year (2020-2021) eCYBERMISSION competition.

While we share similar interests, each of us has our own view on topics and our own unique strengths. For instance, Arnav is good at technical writing, Abhinav is our technology expert, and Siddharth's communication skills proved to be an asset during our project's outreach. The shared love for science and technology was the basis of us working together. The team spirit, flexibility, interest, and compassion displayed by each member made the project more pleasurable and indispensable, as well as an invaluable learning experience. Despite having different perspectives on topics, we are always considerate and willing to listen to each other's ideas - one example is, each one of us came up with 3-5 topics that we want to work together and after listening to each other's viewpoints, we sorted top five and voted for the project we wanted to move forward with. The diverse set of interests and opinions that each member brought to the table turned out to be our team's strength as we progressed throughout this project. Working together with respect, excellent team spirit and enthusiasm, we ensured a successful project and a meaningful contribution to society.

7.2. Team Member Responsibilities

Provide a detailed description of each team member's responsibilities and jobs during your work on the Mission Folder.

Since we are a reasonably small team with three members, our responsibilities and roles are very dynamic, with each member stepping up in real-time on an as-needed basis to focus on our project's needs. The subsequent sections provide a broad overview of how our team operated individually and as a group.

7.2.1. Communication & Outreach

Each member of our team had unique roles and responsibilities while working on the Mission Folder. Siddharth organized the team meetings and utilized various technological platforms to help ease team collaboration and communication. He extensively used productivity tools implemented into the Google Workspace, a collection of productivity tools developed by Google, to simplify the seemingly daunting tasks associated with sharing and editing files. He created a Discord server for real-time communication to allow our team members to communicate through instant messaging. Siddharth reached out to some of the experts in the field of food insecurity/nutrition and coordinated meeting times and Zoom invitations for the team to meet with these experts. Siddharth also designed and maintained the Pantry Patrol website, which contains information about the work we have done over the course of this project.

Our Communication on Discord Server



Google Workspace Collaboration



Abhinav was the main "scribe" of our team, taking notes during important meetings with officials and local experts in our area. As a great technical writer, Abhinav helped organize the mission folder sections and used his experience as a coordinator to make sure our team met essential deadlines.

Arnav served as our team motivator, encouraging the team to explore new ideas within the realm of food insecurity and food waste. He also communicated with the team advisors to develop a set of "action items" each week. This allowed our team to be more transparent about what tasks we were completing each week and how we were completing them. This also stimulated team collaboration, as it strengthened bonds and relations between team members and advisors. Arnav also reached out to our partner food pantries, sending them periodic updates about the work we have done with our app. He sent emails detailing our app in the deployment process, sent links for our application's tutorial videos, and maintained close communication with partner food pantries.

7.2.2. Project Collaboration

Each team member had their own roles with respect to the development of the application as well. Abhinav and Siddharth, being very technology-oriented, focused on coding the application. Using their knowledge from creating an application last year, they developed an application consisting of a wide array of pantry-management features. These features simplify the processes associated with running a food pantry, allowing food pantries to revise their day-to-day operations. Working together this year, Abhinav and Siddharth explored and integrated advanced auto-generation features into the application.

Arnav focused more on the conceptual aspects of the application. He was concerned with designing an application to best suit the partner pantries' needs. He came up with a plan for the application, as well as the various sections of the application, and communicated with partner food pantries to receive their feedback on the application. He also worked with Siddharth and Abhinav to help code and develop the application.

Roles were not set in stone, and we often modified tasks and responsibilities based on each team member's area of expertise. This general sense of flexibility made team communication and collaboration so effective and enjoyable.

We all took the responsibility to write up different sections of the Mission Folder. Once one team member finished his section, the other two were responsible for reviewing that section to ensure all points were captured and no errors were made.

Project Activity/Deliverable	Siddharth	Abhinav	Arnav
Communication with experts	Responsible	Informed	Informed
Communication with partners	Informed	Accountable	Responsible
App design	Accountable	Responsible	Consulted
App development	Responsible	Accountable	Consulted
App deployment	Consulted	Consulted	Responsible
Outreach materials (flyers, website, etc.)	Responsible	Informed	Informed
Mission Folder contribution	Responsible	Responsible	Responsible

RACI Matrix Showing responsibilities of All Team Members

The diagram above is a <u>RACI matrix</u>, a tool used by professionals to map out the roles that are involved in the completion of a project. Our team used this tool for the purpose of understanding the general distribution of the components of our project (essentially the allocation of roles among team members).

In the matrix above,

- → "responsible" indicates that the team member was responsible for completing the work associated with the task
- → "accountable" indicates that the team member was accountable for the success of the task (decision maker)
- → "consulted" indicates that the team member needed to be consulted with for details and additional information/requirements
- \rightarrow "informed" indicates that the team member was informed of major updates.

Arnav	Abhinav	Siddharth
Maintained close	Took notes/recorded	Helped to guide the team
communication with partner	information during meetings	meetings (along with team
food pantries.	with experts (specialists).	advisors)
Strong writing and communication skills; enthusiast	Logical and hard-working	Strong communication skills; very organized and dedicated
Dedicated to coding the	Dedicated to coding the	Dedicated to coding the
application, communicating	application, committed to	application, communicating
with partner food pantries to	designing the application and	with experts in the area of
deploy the application	coding its features	food insecurity/health

Cross-Functional Tasks & Skillset

Each team member had their own roles/responsibilities while working on the project, mainly based on individual strengths. The cross-functional tasks that our team performed can be seen in the table above.

7.3. Working Together

Did your team face any problems working together? If so, how did you solve them? If not, why do you think you were able to work together so well?

We had no problems working together, primarily because of our experience with eCYBERMISSION last year. All of us have been close friends since middle school, which has allowed us to build a relationship based on trust. We knew that we could count on each other, despite the difficult and challenging circumstances we are facing today. Communicating through online platforms such as Discord and the Google Workspace allowed us to keep each other updated with important project deadlines and kept us organized. Through meeting platforms like Zoom, we were able to conduct team meetings and exchange ideas.

While we managed to work well as a team, we faced some other problems caused by the COVID-19 pandemic. One obstacle we faced was developing a community problem that we would address without access to a lab or other facilities. Last year, we enjoyed the process of working in a lab-based setting and creating a scientific solution. Given that we didn't have any access to labs or any laboratory equipment this year due to school closures, we had to approach the process of identifying a problem in our community and developing a solution differently.

Some of our partner food pantries were also not very well versed in virtual conferencing platforms such as Zoom, creating an unforeseeable challenge for us to come up with a way to present our work to them in a virtual format. In the end, we were able to present our work in an engaging manner through a diverse set of graphs and live app demonstrations.

7.3. Team Work

What were some possible advantages to working together as a team on this project? How would working as individuals have made this project more difficult?

7.3.1. Advantages of Working as a Team

There were several advantages to working as a team. We knew that we could all enjoy the process of developing a solution, and the idea that we would have a tangible solution to the food waste problem motivated us along the way. We have been close friends since 6th grade, which has allowed us to communicate with each other on a deeper level. Being aware of each team member's strengths allowed us to delegate specific tasks to people they knew they could complete to the best of their ability. In our app development, we collaborated by assigning different parts of the app to other people. Since none of our roles were set in stone, we rotated some of the jobs and tasks that needed to be complete. In our meetings with community leaders and local officials, we each had a specific part to present. At the end of our presentations, if anyone had difficulty answering a question, another team member would jump in to ensure that people would better understand our project. This mutual understanding between our team members ensured that we could. Even though we could not meet in person, we still knew we could count on each other, mostly because of our experience working as a group last year. The confidence that we had in each of our team members allowed us to pursue difficult challenges.

7.3.2. The Downside of Working as Individuals Instead as a Team

The success of a project is associated with three parameters - scope, schedule, and resources, as shown in the triangle below called the "iron triangle". 'Scope' refers to the total amount of work involved in delivering the project. 'Resources' refers to the sum of cost, budget and humans required to deliver that work and 'schedule' reflects the time estimated or allotted to the project's delivery. If all the three parameters work well, the output is a good Quality project. Any compromise on any of the three parameters, affects the quality of the project.

The Iron Triangle



The scope of our project was huge. There were lots of moving parts and details we needed to take care of in a limited time frame (September 2020 - February 2021). The three of us were the 'resources' in this project. Had we worked as individuals instead of a team, the 'resource' part of the triangle would have been disturbed, which in turn would have compromised the quality of our project. Working as individuals would have definitely taken us more time and we would have missed idea sharing. Additionally, had we worked individually, we would have missed the most important aspect of the project - having FUN. Three brains do work better than one :)

6. BENEFIT TO THE COMMUNITY

Explain how investigating the problem your team chose will help the community. Be sure to include the impacts your research will have on individuals, business, organizations, and the environment in your community (if any). Make it very clear why solving this problem would help your community.

Unfortunately, most people do not realize the extent to which food waste is a problem in the United States. The impacts of food waste are manifold, negatively affecting food security, the environment, and climate change. Reducing food waste is crucial to solving America's food insecurity problem; by reducing food waste at the source, the impacts associated with food waste can be mitigated.

6.1 How our project helps the community

(Indicates how this project can help the community)

Our solution helps food pantries and food banks in the following areas:

- It allows food pantries to monitor, track and eliminate food waste.
- It makes food pantry operations more efficient.
- It simplifies the process of information-sharing between food banks and food pantries.
- It provides an affordable (no-cost) solution.

6.1.1 Track, monitor, and eliminate food waste

- Using the **Food Donation** feature, food pantries can **track** the inventory of the food donations.
- Using the **Food Inspection** feature, food pantries can **track** potential food waste items. Food pantries can also track reasons for food waste using this section of the app.
- Using the **Household** feature, food pantries can **track** dietary and allergy information unique to each household. Using the **Prepare a Box** feature, food pantries can **eliminate** food waste by customizing the boxes they distribute to households.
- Using the **Food Waste Statistics** feature, food pantries can **analyze and categorize** reasons and sources of waste and address underlying problems to avoid future waste.

6.1.2 Food Pantry Operational Efficiency

- Using the **Household** feature, food pantries can **easily onboard** new households that they serve and **keep their information** up-to-date instead of having to use traditional pen and paper methods.
- Using the Volunteer feature, food pantries can quickly onboard volunteers, track volunteer hours, and generate reports for volunteer hours.
- Using the **Prepare a Box** feature, food pantries can **efficiently** create a box for a household by referencing specific household information. The food pantry can also call or text the household directly from the application if needed.
- Using the **Donations** feature, food pantries can **easily send solicitation messages and seasonal greetings** to their patrons and donors.
- Provide a handy reference of **Extension Dates** for various food items conveniently accessible for food pantry volunteers.

6.1.3 Simplify information sharing

- Using the **Report Generation** features, food pantries can automatically **generate** and **share** food waste reports with their partner agencies via email, without any manual intervention. Food pantries can send out these reports periodically.
- Using the **picture-taking** capability of the **Food Inspection** section, food pantry volunteers can share photographs of food items with their partner agencies to better visualize food spoilage/wastage.

6.1.4 Affordable no-cost technology solution (low-cost/no-cost)

• We built the **PANTRY PATROL** application using freely available cloud services from Google. We decided to use Google cloud services because we wanted to develop a low-cost solution that food pantries could experiment with.

6.2. Impact of the project on members of the community

(Indicates the impacts of the project on members of the community)

The PANTRY PATROL application broadly impacts the following three categories of communities: Food Pantries, Food Banks, and Households.

6.2.1. Food Pantries

- Food pantries will be able to track, monitor and avoid food waste.
- Food pantries will be able to stretch food donation resources to larger community members.
- Food pantries can serve their community households better by factoring in specific needs.
- Food pantries will be able to streamline day-to-day operations and comply with regulatory requirements.
- Food pantries can automatically share food waste reports with their partner food banks and other agencies.

6.2.2. Food Banks

- Food banks can get insight into potential food waste happening at affiliate food pantries.
- Food banks will be able to reduce food waste by understanding the demographic and cultural preferences of the communities food pantries are serving.

6.2.3. Households

- Food pantries can serve households better since food pantries understand their cultural needs.
- Households do not need to worry about receiving and throwing away types of food they may not consume due to dietary restrictions, cultural preferences, or allergies.
- Households are better served as food pantries can account for the household's size when preparing a food donation box for them.

6.3 Explanation of benefits to the community

(Provides clear explanation of benefit to the community)

Our goal is to make PANTRY PATROL very versatile and easy to use for food pantries in our mission to help the problem of food waste. We wanted to make this application easy to use for food pantries to remove some of the logistical burdens they deal with and, most importantly, allow them to monitor, track, and eliminate their food wastage with our application's food waste tracking features.

In our journey, we have considered food banks, food pantries, and subject matter experts as stakeholders, and we actively solicited their input and feedback during use case development, design and implementation of our application.

We believe that our application will be tremendously useful to small and medium-sized food pantries to streamline their operations and stretch their resources to better help communities by avoiding food wastage. We would like to present our stakeholder feedback as evidence to demonstrate the benefits to the community. The complete letters are attached later for references.

"As First Lady, I meet and work with food banks across North Carolina, and I believe the app Pantry Patrol will help bridge a communication gap and transition food tracking to the digital era. The app itself is skillfully designed to be user-friendly while containing beneficial information and statistics. Food insecurity and food wastage are significant problems in our community, and this app will help food pantries identify and eliminate sources of wastage."

- Ms. Kristin Cooper, First Lady of the State of North Carolina

"Siddharth Maruvada, Abhinav Meduri and Arnav Meduri, who all make up The Pantry Patrol. conceived of the idea to work with food pantries, in our service area, to develop a user-friendly app to track and, monitor, and reduce food wastage at food pantries, with the goal of ultimately reducing the overall waste, thus increasing the amount of consumable product to clients and their families.

Outside of the benefits of the final goal, the team has been very conscious of the audience and has worked to create a solution that meets the needs of the Food Bank, with regards to data, and meets the included pantries with regard to their skill base, resources and schedules."

- Mr. Gideon Adams, Vice President of Community Health & Engagement Food Bank of Central & Eastern North Carolina (FBCENC) "While I was skeptical at first about what a team of rising ninth graders could possibly do to address food insecurity, I have been extremely impressed by their passion for the issue, their creative approach in addressing it, their responsiveness to feedback, their initiative in tackling a difficult problem, and ultimately the utility of their final product!"

"I'm so pleased with the work of the Pantry Patrol. These students demonstrated tremendous insight and thoughtfulness in reaching out to community partners and organizations to really understand the underlying issues. In good entrepreneurial fashion, they "pivoted" as needed as they gained more information from their conversation with people who have "boots on the ground." The skills they have gained will likely serve them and their community very well in the future!"

- Dr. Alice Ammerman DrPH, Director, Center for Health Promotion and Disease Prevention, Mildred Kaufman Distinguished Professor, Department of Nutrition Gillings School of Global Public Health and School of Medicine

"The application has built-in analytics and dashboards with comprehensive graphs, charts, and tables to display food waste by date, category, and reason. These features enable food pantries to review this data and look back at the improvements that can be made in their daily operations."

"Cary has a rich history of supporting grassroots initiatives that include the quality of life for all our citizens, like the one that is summarized above. These students presented their material in a very professional way, and their project is well-researched so that it can be easily implemented in our community. I know they will represent Cary well and will have success in future endeavors."

- Mr. Harold Weinbrecht Jr., Mayor, Town of Cary, North Carolina

"I wanted to take a moment to congratulate you on a job well done. You are to be applauded for your awareness of hunger in our communities and your desire to help food pantries ensure that food is not wasted. While many may be well intentioned to help reduce hunger and waste, you set out on a mission to help answer this problem by using technology to record this type of data. You developed an app that can assist food pantries in learning what practices they can implement to better serve their communities. In addition, the data would also provide a way to observe patterns over time and solve underlying problems.

During our brainstorming meetings, I felt that you all were genuinely interested in our ideas and suggestions, and you showed this by making adjustments to the app prior to the next meeting. Your questions throughout the process made it clear that you had done your research on food pantry operations and food wastage."

- Angie Nesius, Records and Data Collection Coordinator, FBCENC

Reference Letters



State of North Carolína Office of the Governor

> Krístín B. Cooper Fírst Lady

North Carolina Executive Mansion 200 N. Blount Street Raleigh, North Carolina 27601

To Whom It May Concern:

It is an honor to recommend Siddharth Maruvada, Arnav Meduri, and Abhinav Meduri from Enloe Magnet High School. Their app Pantry Patrol is a promising tool that will help many North Carolina food banks track and monitor food. My Husband (Governor Cooper) and I met with Siddharth, Arnav, and Abhinav earlier this year, and they gave a special report explaining the functionality of their app. We were very impressed by their creativity, passion, and determination to help North Carolinians fight to eliminate hunger.

Siddharth, Arnav, and Abhinav were clear and concise throughout their presentation of the app Pantry Patrol. They worked with leaders in nutrition and management to get helpful feedback on their project, and it is clear that their application is designed specifically to address the needs of food pantries.

As First Lady, I meet and work with food banks across North Carolina, and I believe the app Pantry Patrol will help bridge a communication gap and transition food tracking to the digital era. The app itself is skillfully designed to be user-friendly while containing beneficial information and statistics. Food insecurity and food wastage are significant problems in our community, and this app will help food pantries identify and eliminate sources of wastage.

I know that Siddharth, Arnav, and Abhinav will continue to do significant work to support North Carolinians.

Sincerely,

Kristin B. Cooper

Kristin B. Cooper



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Susan Yaggy, Retired, NC Foundation for Advanced Health Programs

George S. York, Jr., York Properties, Inc.

PRESIDENT & CEO Peter Werbicki

Community Volunteer

foodbankcenc.org

Raleigh (Main Office): 1924 Capital Blvd., Raleigh, NC 27604 Phone: 919.875.0707 Fax: 919.875.0801 Re. ENLOE HS Pantry Patrol

1/26/2021

I write in support of the efforts of the Pantry Patrol team from ENLOE High School in Raleigh, North Carolina.

Siddharth Maruvada, Abhinav Meduri and Arnav Meduri, who all make up The Pantry Patrol. conceived of the idea to work with food pantries, in our service area, to develop a user- friendly app to track and, monitor, and reduce food wastage at food pantries, with the goal of ultimately reducing the overall waste, thus increasing the amount of consumable product to clients and their families.

Outside of the benefits of the final goal, the team has been very conscious of the audience and has worked to create a solution that meets the needs of the Food Bank, with regards to data, and meets the included pantries with regard to their skill base, resources and schedules.

The team has been inclusive, patient and transparent in their dealing with all involved and have advocated for themselves and those they wish to serve.

I could not more highly recommend supporting this group of dedicated youth and feel more confident in our ability to serve those in need and, generally, for the future, having been involved with their work.

Yours, sincerely,

Gideon Adams VP of Community Health & Engagement

1712 Union Street Greenville, NC 27834 Phone: 252.752.4996 Fax: 252.752.1821

Vinam Branch 200 Anglier Avenue urham, NC 27703 hone: 919.956.2513 ax: 919.956.7083 New Bern Branch 205 S. Glenburnie Road New Bern, NC 28560 Phone: 252.577.1912 Fax: 252.577.1915 Sandhills Branch 195 Sandy Avenue Southern Pines, NC 283 Phone: 910.692.5959 Fax: 910.692.5910

Wilmington Branch 1314 Marstellar Street Wilmington, NC 2840 Phone: 910.251.1465 Fax: 910.251.3591



CENTER FOR HEALTH PROMOTION AND DISEASE PREVENTION

THE UNIVERSITY of NORTH CAROLINA of CHAPEL HILL

1700 MARTIN LUTHER KING JR. BLVD. CAMPUS BOX 7426 CHAPEL HILL, NC 27599-7426 T 919.965.6080 F 919.965.6264 www.hpdp.unc.edu

February 28, 2021

To whom it may concern,

The team at Enloe High School, consisting of Arnav Meduri, Abhinav Meduri, and Siddharth Maruvada, approached me a few months back as they were exploring the issues surrounding food insecurity. Over the course of several meetings, the team came to understand that eliminating food waste is an important factor in reducing food insecurity across the United States. They also realized that food pantries need the most help in this space, so the team wanted to build a solution specifically for food pantries.

While I was skeptical at first about what a team of rising ninth graders could possibly do to address food insecurity, I have been extremely impressed by their passion for the issue, their creative approach in addressing it, their responsiveness to feedback, their initiative in tackling a difficult problem, and ultimately the utility of their final product!

Over several months, the Enloe team developed "Pantry Patrol," explicitly designed to help food pantries monitor, track, and address food waste. The features of the application allow food pantries to consider dietary preferences and allergy information of households as they distribute food, in turn, minimizing food waste. The application, which uses data analytics, makes it easy to track sources of food waste via dashboard visualizations provided through graphs, tables, and other formats. Additionally, the application has a variety of food pantry management features that simplify the processes involved in running a food pantry, allowing food pantries to revise their day-to-day operations. The application has built-in features to automatically generate monthly food waste reports for use by partner food banks so they can be more efficient in the distribution of food items.

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Please let me know if you have any questions or would like additional information.

Sincerely,

alice Ammeman

Alice Ammerman DrPH Director, Center for Health Promotion and Disease Prevention Mildred Kaufman Distinguished Professor, Department of Nutrition Gillings School of Global Public Health and School of Medicine University of North Carolina at Chapel Hill Chapel Hill, NC 27599 Phone: (919) 966-6082 FAX: (919) 966-3374 E-Mail: <u>alice_ammerman@unc.edu</u> Website: <u>http://www.hpdp.unc.edu</u>



Harold Weinbrecht Jr. Cary Mayor From: <u>Angela Nesius</u> Sent: Wednesday, January 27, 2021 2:34 PM To: <u>Siddharth Maruvada</u> Cc: <u>Gideon Adams</u> Subject: Letter of Recommendation

Dear Team Pantry Patrol,

With our regular meetings coming to an end, I wanted to take a moment to congratulate you on a job well done. You are to be applauded for your awareness of hunger in our communities and your desire to help food pantries ensure that food is not wasted. While many may be well intentioned to help reduce hunger and waste, you set out on a mission to help answer this problem by using technology to record this type of data. You developed an app that can assist food pantries in learning what practices they can implement to better serve their communities. In addition, the data would also provide a way to observe patterns over time and solve underlying problems.

You also added in supplemental data gathering tools for food pantries who may benefit from having volunteers and donors logged into a system. Having volunteer and donor information in one place would allow food pantry staff to access their network of support when needed.

During our brainstorming meetings, I felt that you all were genuinely interested in our ideas and suggestions, and you showed this by making adjustments to the app prior to the next meeting. Your questions throughout the process made it clear that you had done your research on food pantry operations and food wastage.

This experience was very educational for me as well, to see the behind-the-scenes work that is involved with creating an app, and I am very grateful for having learned something new.

Best of wishes to you, Team!

With gratitude, Angie

Angie Nesius

Records and Data Collection Coordinator Food Bank of Central & Eastern North Carolina 1924 Capital Boulevard, Raleigh, NC 27604 PHONE 919.865.3040 FAX 919.954.8427 foodbankcenc.org



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April 11, 2021

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Mildred Kaufman Distinguished Professor, Department of Nutrition Gillings School of Global Public Health and School of Medicine University of North Carolina at Chapel Hill Chapel Hill, NC 27599 Phone: (919) 966-6082 FAX: (919) 966-3374 E-Mail: <u>alice_ammerman@unc.edu</u> Website: <u>http://www.hpdp.unc.edu</u>



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FW: Letter of Recommendation

1 message

Siddharth Maruvada

<u>Wed. Ja</u>n 27, 2021 at 2:50 PM

Kind Regards,

Siddharth Maruvada

From: Angela Nesius Sent: Wednesday, January 27, 2021 2:34 PM To: Siddharth Maruvada Cc: Gideon Adams Subject: Letter of Recommendation

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Best of wishes to you, Team!

With gratitude,

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Angie Nesius

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2. Design Development

During our conversations with the staff of the Food Bank of Central and Eastern North Carolina, we concluded that creating a solution to help food pantries would be a great community problem to address. A solution directed towards food pantries would help address the interrelated issues of food waste and food insecurity. Food Pantries are the **last-mile food distribution points** for food banks. With the right **food waste tracking tools** on hand, food pantries can operate most efficiently and **drastically** reduce food wastage.

2.1. Solution Criteria

What MUST be a part of your solution? These are called the criteria. Explain what criteria are needed to solve the problem. Make sure your criteria are measurable, connected to the problem, and related to your research.

Based on our conversations with Food Bank of Central and Eastern North Carolina, A Touch of Father's Love Food Pantry, and Zion Christian Center, we concluded the following criteria as requirements for our solution:

- 1. The solution should **not create a financial burden**. Food pantries are generally non-profit organizations run by neighborhood churches or other community organizations and are usually cash-strapped for resources. Hence, the solution must be available for zero cost wherever possible. A small nominal fee may be charged for a hosted solution if the hosting provider does not have any special incentives for non-profit organizations.
- 2. The solution must **allow food waste tracking** based on a food pantry interactions with food donors, partner food banks, and the households the food pantry is serving. Furthermore, the task of waste tracking should not create a significant burden on their day-to-day operations. The solution should naturally fit in with any processes food pantries already follow.
- 3. The solution should allow for **food waste reporting**. Food banks like to understand and monitor the potential food waste that could be happening at food pantries and the reasons for the wastage so that they can be more efficient in their engagement. As a part of ongoing engagement, food pantries are generally expected to provide monthly reports to their partner food banks information such as:
 - \rightarrow Pounds of food they are serving each month.
 - \rightarrow The households they are serving.
 - → Demographic information regarding households (e.g., ethnicity, income range)
 - \rightarrow Qualification for subsidized meals and food stamps.

Some Federal government programs such as The Emergency Food Assistance Program (<u>https://www.fns.usda.gov/tefap/emergency-food-assistance-program</u>) (also known as TEFAP) require food pantries to qualify households before they serve them certain types of donations. These requirements create a burden on food pantries and take valuable resources away from their central business: serving people. The solution must simplify the process by generating automatic reports wherever possible, to reduce the burden.

- 4. The solution must provide food waste statistics. By identifying the sources of waste and reasons for food waste, both food pantries and partner food banks can take corrective action to minimize food waste. It is a commonly accepted practice to assess a food donation value to be \$1.72 per pound. Our application will use the same conversion factor while estimating the value of food donated and the value of food spoiled. Donors typically use the same conversion factor for tax write-off purposes as well.
- 5. The solution should **streamline the most common tasks** routinely performed by food pantries, be simple to use, and provide comprehensive value so food pantries are motivated to use the solution. While building a one-off solution could be simpler and appealing in some ways, it may be of less value from a practical standpoint. We want the solution to be real, practical, and useful for the pantries.

2.2 Constraints and limits

What limits are there on your solution? These are called constraints. Does it need to be a certain size? A certain weight? Is the cost a factor? Write down all of the limits your solution has.

Based on the criteria listed above, we analyzed food pantries' day-to-day operations, identifying areas where food wastage can be identified and eliminated. The following constraints applied to the application solution that we wanted to create.

- 1. The **application must run on multiple platforms**. We cannot assume food pantries have specific IT resources. The solution must run on the most commonly available hardware **mobile phones, tablets, or PCs**. However, given mobile phones' ubiquity with connected Internet, we think that **mobile applications** would be the best vehicles for delivering the solution.
- 2. The **application must be user-friendly and intuitive**. We cannot expect food pantries to have in house IT experts to train their volunteers. The application should naturally lend itself to a food pantry's day-to-day operations and how they conduct business.
- 3. The **application data must be secure.** Given that the application will be collecting sensitive public information (SPI) such as name, address, household income, etc. any data collected as part of the application must be **secured**, and should **only be accessible and visible** to the Food Pantry designated administrators and users.
- 4. The **application must be customizable** Food pantries depend on several guidance factors and indicators in their day-to-day operations. For example:
 - a. The criteria for whether a household is **eligible for TEFAP** based food distribution may change over time.
 - b. The criteria for the **extension dates** for certain types of food could be appended, or new types could be added.
 - c. The criteria for assessing the value of donated food could change over time, etc.

Considering these factors, the application must allow for easy and dynamic customization. Furthermore, not every use case of the application could be useful to every food pantry's situation. The application should allow for features to be enabled and disabled to simplify the interactions based on a particular food pantry's needs.

5. The **application must be updatable independently** - Any software application will need changes over time. It should be possible to update one pantry's application instance without affecting another food pantry's operations.

6. The **application must support the needs of a typical** food **pantry.** Scalable applications require a higher level of infrastructure support and are expensive to build and maintain, and ultimately could not be offered for free. A typical neighborhood food pantry has fewer than 25 volunteers serving no more than 1000 households. We want our application to be usable by a typical food pantry for **optimal performance** and at **near zero cost**.

2.3. Proposed Solution

Based on your criteria and constraints, what is your proposed solution to the problem you chose? Explain what it will look like and how it will work. If you can, include a detailed, labeled drawing.

2.3.1 Use Cases

After several conversations with the Food Bank of Central and Eastern North Carolina, A Touch of Father's love Ministry and Food Pantry and Zion Christian Center Food Pantry, we developed the following use cases:

1. **Household information collection:** As a food pantry volunteer, I need to record and update a household's information my food pantry is serving.

We learned from A Touch of Father's Love Ministry and Food Pantry that they use a paper form to collect customer information. As a part of the information collection process, food pantries have the customer fill this information out by hand. Keeping this information on paper is cumbersome and challenging. We want our application to **digitize** the collection of this information to be stored, accessed, searched, and updated as needed.

A typical paper form a food pantry uses for tracking client information.

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In addition to the paper information, our application allows food pantries to collect:

- The dietary preferences of the household
- Allergies that the household members may have

This is an instrumental piece of information to ensure food waste is minimized during food distribution.

2. **TEFAP Qualification:** As a food pantry volunteer, I need the ability to qualify if a household is eligible to receive TEFAP food donations.

The paper form used by the food pantries has a field that uses both income range and the number of people living in the household to determine if a household is eligible for **The Emergency Food Assistance Program** (TEFAP). This qualification will help food pantries determine if a particular type of food donation should be distributable to individual households. Our application can make this determination automatically based on household information.

Above is a typical paper form used at the food pantry to determine TEFAP qualification.

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3. **Food donation information collection:** As a food pantry volunteer, I need to track the types of food donations made by food banks, donor organizations, and local grocers (such as Food Lion, Walmart, Kroger, etc.). I also need to track the amount of food that is donated to the food pantry.

With the help of national organizations such as **Feeding America Inc.** or through partner Food Banks, food pantries establish relationships with grocery chains so they can pick up food donations on a regular (typically weekly) basis. Local grocers donate food for various reasons such as **excess inventory**, food that is **past the best by date**, or **food that is not aesthetically appealing** to be on a grocer's shelf but is still perfectly consumable. It costs local grocers money to send food to the dump. **Instead of spending money disposing of perfectly consumable food, they could donate it and take a tax writeoff.** It is a win-win situation for everyone. The tax write-off value depends on the currently accepted national standard of \$1.72 per pound of food donated. So food banks need to track the weight of the food they are taking in as donations.

Our application allows for tracking.

- 1. Category of food
- 2. Weight of the food in pounds
- 3. Food donation date
- 4. An extension date for the donated item

Keeping the inventory of all the food allows a food pantry to make intelligent decisions on what batch of food to distribute first before it becomes unusable (e.g., expires). It also gives them insights into the storage requirements such as refrigerators and freezers they need to have on hand to store the donated food efficiently and avoid food spoilage.

4. **Food inspections:** As a food pantry volunteer, I need to inspect food periodically so spoiled food isn't inadvertently distributed.

A food pantry performs an inspection once they receive a donation. A food donation could be spoiled for reasons such as:

- 1. Package damage during transport
- 2. Temperature mishandling
- 3. Food that has simply gone bad for other reasons
- 4. Food that is past the **extension date**

Basic **visual** and **smell** tests are performed to assess whether parts of the donation are unusable. Large food banks provide broad guidelines to partner food pantries on how to perform such checks and determine if a food item can be donated or not.

In addition to the inspection during initial donation, food pantries must inspect food periodically until the food is wholly distributed to their customers. Our application allows the recording of food inspections by tracking:

- 1. The volunteer that performed the inspection.
- 2. The date of the performed inspection.
- 3. The type of food wasted.
- 4. The weight (in pounds) of spoiled food
- 5. The most likely reason for spoilage
- 6. On a camera-enabled device, the food pantry should be able to take and upload a picture of the spoiled food. Such photos can be shared readily with other partner agencies when describing the problem.
- 5. **Preparing a donation box:** As a food pantry volunteer, I need to create a food donation box for a household that serves them well and eliminates any potential food waste.

Food pantries typically create a one-size food donation box for every household and pack similar items in each box. Due to the COVID-19 pandemic, food pantries have minimum customer contact, and they will load the donation box directly in the truck of the household's vehicle. Using the additional household information collected in the application, food pantries are able to create the donation box much more efficiently and avoid food wastage. For example:

- Food pantries can pack more food in a box for larger families.
- Food pantries can also avoid packing food items using dietary preferences and allergy information available for the household.

This information is vital to ensure that sufficient food is provided for each family based on their needs, and food is not given out that will end up being wasted.

6. **Food waste statistics:** As a food pantry volunteer, I need to see statistics on food inventory and food waste.

Understanding the current inventory levels helps food pantries determine which batch of food to distribute first, which is essential for efficiency and avoiding future waste.

Understanding the sources and reasons for food waste can help food pantries to plan better for future donations and ensure their communities are served more efficiently.

Using the data collected by food pantries, our application can generate statistical visualizations as a dashboard in our application.

For example, our application can show pie charts for:

- Food waste by category
- Food waste by reason
- Food waste that occurred within a specific time frame or specified date range.
- Food waste in terms of dollar value.

These powerful visualizations are easy to understand and can help food pantries see where the waste is occurring very easily.

7. Auto-generating of waste reports: As a food pantry volunteer, I need to provide a monthly report to our partner food bank detailing information about the wastage in our facility. The PANTRY PATROL application automatically generates and sends these reports to the partner food banks on a monthly schedule.

Food pantries generate monthly reports to their partner food banks on various factors such as:

- The number of households they served in a month
- Ethnicity make-up of the households
- Number of pounds of food donations they collected for the purpose of generating a tax-writeoff for the donors

Our application can analyze **food waste data**, **generate reports**, and send emails to a configured email address automatically on a specific date within a month. Ms. Angela Nesius at the Food Bank of Central and Eastern North Carolina told us that this is a handy feature as she does not need to call affiliate food pantries every month, prompting them to send reports.

8. **Volunteer information tracking:** As a food pantry administrator, I want to track information regarding volunteers that work for the food pantry.

Food Pantries are typically volunteer-run organizations. A food pantry may need to track volunteer information for:

- 1. Performing background checks.
- 2. Logging the number of hours worked for student volunteers.
- 3. Reason for volunteering (e.g., community service, school club, criminal redemption, etc.) so they can issue a letter of recommendation after their service.

Our application allows for creating, updating, and deleting volunteer information along with the number of hours they worked. The application can also generate an email to a volunteer quoting the number of hours they volunteered based on a template email the food pantry administrator created. **Dorcas Ministries** food pantry told us that this is one of the most useful features they can use.

9. Cash donors and cash donations: As a food pantry administrator, I would like to track any cash donations we receive, along with the donor's information, and have a way to contact them for periodic solicitations.

In addition to food donations, sometimes food pantries receive cash donations from their patrons. **A Touch Of Fathers Love and Zion Christian Church Food Pantry** told us that they would like to track monetary donations from their patrons and periodically go back to them with solicitation requests.

Our application allows for tracking information about donors (name, contact information) as well as donations (amount of money donated, date of donation). It can generate donation solicitation requests to food pantries based on a food pantry template and send them automatically to select donors. Food pantries have told us that this feature will be useful for them to automatically solicit their regular patrons and donors during holidays and special occasions, rather than having to call them individually.

We did not consider payment processing capabilities as use cases for our applications as our investigation found that protecting financial information is a complex problem and requires multiple layers of security. Perhaps we will consider those scenarios for a future update.

2.4. Testing the solution

How will you test your solution? The BEST way to test your solution is to build a working model or a prototype that you can actually use. OR you can guess how your solution will work BASED ON your research. Which method will you use and why?

Since our engineering solution is a software application, we plan to follow general principles and methodologies for testing software applications.

- We plan to use iterative testing throughout the development testing process. Developing features in small increments helped us validate the contents of the app much more efficiently.
- We will use mock data in Google spreadsheets and verify the data to make sure it shows up correctly.
- We will use Agile development in our app by showing our progress on a biweekly basis to the Food Bank of CENC team to get their feedback and comments.
- We will use our own iPhone and Android smartphones, iPads, and laptop browsers (Chrome and FireFox) to perform multi-platform testing and validation.
- We plan to invite a few of our friends and family to beta test our application so we could get external feedback on usability.

3. Build Model or Prototype

If you built a prototype or model, explain how you built your prototype or model, step by-step including ALL SAFETY PRECAUTIONS. If you guessed how your solution would work BASED ON your research, explain important information from your research that you used to prove how your solution would work and be sure to cite your sources.

3.1. Safety Precautions

Our solution is primarily a **software application**, and we did not require any special safety precautions as far as creating the application is concerned. We all have laptops that we use for our school work. We used google docs to share files so did have to share any physical resources. However, given that we are in the midst of COVID-19 pandemic,

- 1. We completely avoided in-person meetings, and had all our team meetings, including meetings with the experts virtually on Zoom.
- 2. We followed COVID-19 safety guidelines during our tour of the Food Bank of Central and Eastern North Carolina by wearing masks and maintaining social distance during the visit.

3.2. Platform choice

Using the use cases outlined in section 2.3, we built our application **PANTRY PATROL** on the AppSheets platform (<u>https://www.appsheet.com/</u>). We chose AppSheets as the target platform for several reasons:

- It provides a convenient way to build cross-platform applications that can run on mobile phones, tablets, and PCs.
- It provides a convenient way to model data using simple schemas from Google Sheets as a backing store without setting up databases.
- It provides a way to build production-grade applications. Our team already has experience building applications using the platform.
- It provides powerful widgets for taking pictures, collecting signatures, creating maps based on geographic data, etc., in a relatively intuitive and straightforward manner.
- It provides a cheap way for hosting and running applications for non-profit organizations.

All our team members spent a couple of weeks getting familiar with the platform's capabilities by taking the free tutorial that helped us accelerate the application modeling and development process. <u>https://www.udemy.com/course/create-business-applications-with-appsheet/</u>

3.2.1 Hardware and Software requirements

PANTRY PATROL will be supported on

- Mobile devices (iPhones and Android)
- Tablet computers such as iPads and Android devices
- Google Chrome, Firefox, Safari browsers on laptop computers running Windows 10 or MacOS

Other requirements:

- The application will use Google drive for storage, and users are required to have a valid google ID for authentication purposes.
- The users of the application **must be connected to the Internet** in order to access data from google drive and store updates.

3.3. Modeling Entity Data

Describing a software project is particularly challenging as the concepts are abstract in nature. While we made every attempt to describe the entities in these sections, we recommend watching the instructional (demo) video to get a comprehensive idea of how the application works to get a better understanding of the description.

We modeled our application **entities** in Google Sheets (<u>https://www.google.com/sheets/</u>). Google Sheets is our backing store (database) for our application. A single spreadsheet is used to keep all the data together, and each of the entities of the application are modeled as a sheet inside the spreadsheet. The attributes of each entity become columns in the corresponding Google Sheet. This is a pretty standard way to model applications under AppSheets users platform.

An added benefit of modeling data as **Google Sheets** is that the raw data can be viewed and updated directly in google sheets if needed. You can see various entities with sheet names in the spreadsheet image below.

A	0	0	D	6	F.	G	H		3	ĸ	6	M	N	0
ae71be80	llet	Pearson	474-567-3434	No	Jeff.jeff@gmail. com	336 Food Lane, Raleigh, North Carolina, 27513	Wake	3	Asian	No		Yearly	none	None
15156a61	Sally	Jones	332-334-4567	Yes	sally.raleigh@g mail.com	453 Pantry Road, Raleigh, North Carolina, 27602	Wake	3	Black or African American	Yes	\$25,000-\$34,00 0	Monthly	Halai	Gluten-free
b12d4c1c	Billy	Miller	333-333-333	TRUE	billy.miller@gm ail.com		Durham	7	Hispanic/Latino	TRUE	>\$87,000		Halal , Dairy-free , Eggless , Gluten Free	Eggs, Fish (e.g. Bass, Flounder, Cob) , Fish
6														

3.4. Entity relationships and application model

The following diagram describes the application model and various relationships between entities:

- The blue rectangle represent Entities in our application model
- The light green rhombi represent Slices a subset of an entity or two Entities merged together
- The yellow circles represent Views of our model
- The arrows represent References and Cardinality relationships between Entities and Views.



Entity Relationship and Application Model

3.5. Entities & Menus

The next few sections describe in detail the **attributes** of each of these entities in our application model and **menu features** exposed by those entities. These entities described here are modeled leveraging the capabilities of **AppSheets** platform. While we describe the design here, we highly encourage you to watch PANTRY PATROL App Tutorial videos to get an idea of how various menus work together. https://youtube.com/playlist?list=PLGBzh8kxPhapqCxfQvOlySBrNvfPsI9ZE

3.5.1. Household

Entity description

The household entity represents information about a customer household a food pantry serves on a regular basis.

Following attributes are taken from paper forms currently used by food pantries:

- 1. Name (required)
- 2. Address
- 3. County they live in (required)
- 4. Ethnicity
- 5. Phone number and/or email for contact
- 6. Number of people living in the household
- 7. Income range (required)
- 8. Currently on food stamps?
- 9. Additional authorized people that can pick up food

Attributes added to support to reduce food waste during distribution:

- 1. Dietary preferences of the household
- 2. Allergies of the household members

Automatically calculated:

1. TEFAP Qualified?

Menus:

The Household menu is accessible as a *primary view* from the bottom menu bar. Access this menu to create a new household entry or update an existing household's information.



Household menu features:

- 1. Mandatory fields are designated by a star. Fields without a star are optional.
- 2. Click on the "+" icon to add a new entry.
- 3. Click on the pencil icon to edit an existing entry in the list view.
- 4. Click on the recycle bin icon to delete an entry.
- 5. The Phone, message, and email icons provide mechanisms to call, text, or email the client on mobile phones.
- 6. Ethnicity selection select from a predefined list, or add new categories.
- 7. Dietary preferences select from a predefined list, or add new categories.
- 8. Allergies select from a predefined list, or add new categories.



TEFAP Calculator rule:

The platform provides a mechanism to create a **virtual column** and set its values dynamically based on the values of other entities. We modeled **TEFAP Qualified** as a virtual column and set it to **Y** or **N** by evaluating the following rule inside the application.

```
OR (
     AND (
         STARTSWITH([Household income], "$0-$25,000"),
          ([Number of People] >= 1)
     ),
     AND (
        STARTSWITH([Household income], "$25,000-$34,000"),
          ([Number of People] >= 2)
     ),
     AND (
         STARTSWITH([Household income], "$34,000-$43,000"),
          ([Number of People] >= 3)
     ),
     AND (
         STARTSWITH([Household income], "$43,000-$52,000"),
          ([Number of People] >= 4)
     ),
     AND (
         STARTSWITH([Household income], "$52,000-$60,000"),
```

```
([Number of People] >= 6)
),
AND(
    STARTSWITH([Household income],"69,000-$78,000"),
        ([Number of People] >= 7)
),
AND(
    STARTSWITH([Household income],"$78,000-$87,000"),
        ([Number of People] >= 8)
),
AND(
    STARTSWITH([Household income],">=$87,000"),
        ([Number of People] >= 9)
)
)
```

3.5.2. Extension Dates

Entity description:

Grocery stores routinely remove food items that are approaching their best by date or items that are not cosmetically appealing, such as dented cans, from shelves. See the section on Extension dates for an in-depth discussion on **Extension Dates** subject.

The Extension Dates entity encapsulates the images representing extension dates for various food item categories advocated by the Food Bank of Central and Eastern North Carolina.

<u>Menus:</u>

The **Extension dates** menu can be accessed from the **Menu View**, available by clicking the **hamburger menu** (three lines) at the top left corner of the application. It serves as a handy reference when a volunteer at the food bank is creating a **food donation**. This will be described in subsequent sections.



3.5.3. Volunteers

Entity description:

A Volunteer entity represents information about a food pantry volunteer in the system.

Responsibilities of volunteers include:

- Picking up donated food from partners
- Helping to distribute food items
- Performing periodic food inspection etc.

The volunteer entity is implicitly referenced when performing those above actions.

The following attributes are supported:

- Name
- Address
- Phone number
- Email address
- Photo
- Hours volunteered
- Reasons for volunteering

- Background checks completed?
- Letter of recommendation needed?

<u>Menus:</u>

The **Volunteer** menu is accessible as a *primary view* from the bottom menu bar. Access this menu to create a new volunteer entry or update existing volunteer information.

Features:

- 1. Mandatory fields are designated by a star. Fields without a star are optional.
- 2. Click on the "+" icon to add a new entry.
- 3. Click on the pencil icon to edit an existing entry in the list view.
- 4. Click on the recycle bin icon to delete an entry.
- 5. The Phone, message, and email icons provide mechanisms to call, text, or email the volunteer on mobile phones.
- 6. The **selfie** feature allows camera-enabled devices to record a volunteer's picture and upload it to Google drive as part of application data.
- 7. Use the text field to note the **Reasons for Volunteering**
- 8. If Background Check is completed, select Y
- 9. If Letter of Recommendation is requested, select Y
- 10. Click an entry row to get a detailed view of a **Volunteer** entry.

Volunteers Q 🗹 C		× ← Volunteer Form
Elvis Presley	► Details	Selfie
LeBron James iii C	25	Hours Logged* 0 — +
Bill Nye		Reason for Volunteering
Elon Musk m C 🛛 😂	Wish	Background Check Completed?* N Y
+	First Name LeBron Last Name James	Letter of Recommendation Needed?*
Households Volunteers Cash Donation Food Waste Statistics	Address 789 Cavaliers Drive	Cancel Save
	Housenoids Volunteers Cash Donation Statistics	

To send an email to a volunteer on the hours they worked, click on the floating "Report" icon above the "pencil" icon. This action will automatically open a default email client on your system and generate the following template to fill out conveniently.



3.5.4 Food Donation

Entity description:

A Food Donation event happens when a Food Pantry receives food from a partner agency such as Food Bank or a local grocer. After the food item is delivered, a food bank volunteer takes inventory of the food items received and creates a **Food Donation** entry. The volunteer also performs the visual food inspection at the same time, checking for damaged packages and identifying any food that is spoiled during transit. The volunteer is responsible for weighing the food received and weighing the food that is discarded due to spoilage and entering those numbers into the system.

The following attributes are supported:

- 1. Name of the donating agency
- 2. Donation date
- 3. Category of food donation
- 4. Quantity (in pounds) of the food received
- 5. Extension date for when the food item is considered expired
- 6. Volunteer that performed the check
- 7. A "Distributed by" flag is used to track if the donation content is fully distributed, so it doesn't need to be inspected in future.

<u>Menus:</u>

A Food Donation entry can be created from the Menu view available by clicking the hamburger menu (three lines) at the top left corner.

				Bakery 430		
Name Whole Foods		Name Good Samaritan		Good Samaritan	1	/13/2
whole Foods		Donation Date		1/5/2020		
		17572020			e i	ji (
Donation Date*		Category		Whole Foods	1	1/1/20
12/15/2020		Durity		12/15/2020		
		255			la l	
Category		Extension Date				(20./2
Bakery	~	1/13/2021	/	Spice Hut	1	/28/2
		Inspected By				
Quantity (lbs.)*		Elvis	Ø		6	9
25	- +	Distributed?		Aldi's	2	/25/2
		Y		2/1/2021		
Extension Date						
01/01/2026				Beverages 300		1
				Food Lion		<u> </u>
Cancel	Save	A 4 2	Ecod Wasto	* *	\$	Ē

Features:

- 1. Mandatory fields are designated by a **star.** Fields without a **star** are optional.
- 2. Click on the "+" icon to add a new entry.
- 3. Click on the pencil icon to edit an existing entry in the list view.
- 4. Click on the recycle bin icon to delete an entry.
- 5. The donation date is automatically set to the current date. It can be changed by clicking on the **calendar** icon next to it if needed.
- 6. Select a **food category** from the drop-down menu, or create a new food category.
- 7. Record the number of pounds of food received by weighing the food. If a weighing scale is not available, record approximate weight.
- 8. Record an extension date for the food category by consulting **Extensions date** information available from the **Menu View.**
- 9. Pulling down the **Inspected by** field should bring up a list of **volunteers** to choose from. Select the volunteer that is responsible for overseeing the food donation activity.
- 10. The **Distributed** flag is used for tracking whether a food donation item is completely distributed. This is set to **NO** by default. After a food item is completely distributed, edit the entry to set **Distributed** to **YES** to indicate that **Food Inspection** no longer needs to be performed on this Food Donation entry.

3.5.5. Food Inspection

Entity description:

A food inspection entity describes a food inspection event performed by a volunteer. Food pantries periodically inspect stored food for spoilage and food that is past the **Extension Date**.

The following attributes are supported:

- 1. Date when the food inspection was performed
- 2. Weight in pounds of the food spoiled
- 3. Category of food spoiled
- 4. Reason for food spoilage
- 5. Volunteer that performed the inspection
- 6. Photo of the spoiled food

Attributes automatically calculated:

1. Dollar value of the food spoiled

<u>Menus:</u>

A Food Inspection can be created from the Menu view available by clicking the hamburger menu (three lines) at the top left corner.

Features:

- 1. Mandatory fields are designated by a **star.** Fields without a **star** are optional.
- 2. Click on the "+" icon to add a new entry.
- 3. Click on the pencil icon to edit an existing entry in the list view.
- 4. Click on the recycle bin icon to delete an entry.
- 5. Select a **food category** from the drop-down menu, or create a new food category.
- 6. Record the **number of pounds** of food **spoiled**. If a weighing scale is not available, record approximate weight.
- 7. Select **spoilage reason** from the drop-down menu, or create a new spoilage reason.
- 8. **The inspection date** is automatically set to the current date. Use the calendar icon next to the field to adjust the date as needed.
- 9. Select the volunteer name that performed the inspection by using the **drop-down list box** for **Inspected by** field.
- 10. Take a photo of the spoilage using the **photo** feature of the application. The application will automatically save the images to google drive of the application.
- 11. The **Spoiled dollars** field is automatically set based on the number of pounds of food wastage using the rule:

=[Spoiled (lbs)] * USERSETTINGS(WeightToDollarConversion)



3.5.6. Prepare a Box

Preparing a food donation box for a household is a common task performed by a food pantry.

Entity description:

The entity is a **Slice** on top of **Household** entity that includes only a subset of attributes.

The following attributes are supported:

- 1. Name
- 2. Number of people living in the household
- 3. Dietary preferences
- 4. Allergies
- 5. Contact phone number
- 6. Authorized persons for food pickup

<u>Menus:</u>

The **Prepare a Box** menu can be accessed from the **Menu view** available by clicking the **hamburger menu** (three lines) at the top left corner.



3.5.7 Cash Donors

Entity description:

Used to keep track of information regarding cash donors in the system.

The entity supports the following attributes for a donor:

- 1. Name
- 2. Email
- 3. Phone number
- 4. Donor type (Person, organization or anonymous)
- 5. Confidentiality requested?
- 6. Receive text?

<u>Menus:</u>

A **Donor** item can be created from the **Menu view** available by clicking the **hamburger menu** (three lines) at the top left corner.

Features:

- 1. Mandatory fields are designated by a **star.** Fields without a **star** are optional.
- 2. Click on the "+" icon to add a new entry.
- 3. Click on the pencil icon to edit an existing entry in the list view.
- 4. Click on the recycle bin icon to delete an entry.
- 5. Select a **Donor Type** from the drop-down menu, or create a new category if needed.
- 6. Select **Confidentiality Requested** to **Y** if the donor opted his name not be disclosed. This ensures that the donor will not receive solicitation requests in future.
- 7. Select **Receive Text** to **Y** if the donor is OK to receive text messages in future.

Rest for	Cash Dor	nors		Q	✓	G	🗶 🔶 Donor Form	Donor Type
George								Add or search
	ľ	>	2	•	Ē	Ø	First Name*	O Person
Elon								O Organization
WUSK		\geq	2	•	Î	Ø	Last Name*	O Anonymous
Joesph								
Biden			,		ŵ	9	Confidentiality Requested?	
Anonymous	Ľ		~	-	ш	~	N	
					Ē	Ø	Donor Type 🔻	
John								
DUE	ľ	\geq	J	•	4	- }-	Email*	
A Households	Volunteers	Cas	h Dona	ation	Food	Waste	Cancel Save	Done

3.5.8 Cash Donations

Entity description:

A cash donation event describes a monetary donation made to the food pantry. Food pantries track information regarding the date, frequency, and amount of the cash donation, which allows them to keep a log of all of the previous donations made by a specific donor.

Following Attributes supported:

- 1. Donor name
- 2. Donation amount
- 3. Donation date

4. Frequency of donation (weekly, monthly, annually, non-recurring one-time)

Menus:

A **Donation** entry is accessible as a *primary view* from the bottom menu bar. Access this menu to create a new Donation entry or update an existing household's information.

Features:

- 1. Mandatory fields are designated by a star. Fields without a star are optional.
- 2. Click on the "+" icon to add a new entry.
- 3. Click on the pencil icon to edit an existing entry in the list view.
- 4. Click on the recycle bin icon to delete an entry.
- 5. Use **Donor ID** drop-down list to select a donor
- 6. Use the **Date** field to set the date of donation. By default, it is set to current date
- 7. Use **Amount** field to enter the dollar value of the donation
- 8. Use **Frequency** field to select the frequency of contribution (weekly, monthly, yearly, one-time or create another category)

🏝 🚍 Cash Donatio	on Q		P ← Moneta	ary Donations Form	📩 🔶 Details	面 C' :
George \$123.00		0	Donor ID*		Date 4/4/2021	
Elon \$310.00		0	Date*		Joesph	۲
	Ľ	Ø	12/25/2020		\$500.00	
Joesph \$500.00		0	Amount*	- +	Frequency Monthly	\rightarrow
Anonymous \$1,000,000.00	ľ	0	Frequency Weekly	~	Pantry Pa	
John \$10,000.00	ľ	+)		Enloe Magnet Hig	h School
Households Volunteers Cas	ash Donation	Food Was Statistic	ste Cancel	Save	Households Volunteers Cash	Food Waste

3.5.9 Food Waste Statistics

Food Waste Statistics provide insights into where food waste could be happening.

Entity description:

There are two entities in play for this feature:

- 1. **Date Filter** is an entity that holds a **start date** and **end date** to denote a date range. The input validation process ensures that the Start date is always earlier than the end date but never later than the end date.
- 2. Food Waste by Date is a slice of Food Inspection data, using Date Filter. It inherits all of its attributes from Food Inspection data.

The following **rule** evaluates specific rows to be selected in the Food **Inspection** table when creating the **Food Waste by Date** slice.

Row filter for slice Food Waste by Date

```
IN([Inspection Date], SELECT(Food Waste[Inspection Date], AND (
[Inspection Date]>=ANY(Date Filter[Start Date]), [Inspection
Date] <=ANY(Date Filter[End Date]))))</pre>
```

<u>Menus:</u>

The Food Waste Statistics menu is accessible as a *primary view* from the bottom menu bar. It brings up a dashboard showing various **Food Waste Statistics** for a given date range.

Features:

- 1. Use the **Date Filter** menu to select a range of dates for which you like to see waste statistics reports.
- Waste by Reason A pie chart showing the number of pounds of food spoiled by Reason (Excess moisture, Dented Can, etc. as set during food inspection)
- 3. Waste by Category A pie chart showing number of pounds of food spoiled by Category
- 4. **Waste by Dollar value -** A pie chart showing the value of food spoiled by category. The dollar value is calculated based on the industry consensus valuation of \$1.72 per pound of food spoiled. This value can be changed in the **Application Settings** section in future as needed.

The **dashboard** is highly **dynamic.** Updating the date range will automatically update the views.





Food Waste Statistics in a Browser or on Tablet Device

3.5.10 Application Settings

Entity description:

The Application Settings entity supports the following attributes:

- 1. WeightToDollarConversion
- 2. EmailReports

Menus:

Application settings are accessible from **Menu view** available by clicking the **hamburger menu** (three lines) at the top left corner.

Features:



3.5.11. Automatic report generation

Entity description:

Automatic report generation has been an important feature to eliminate manual steps a food pantry needs to perform. The application can generate automatic reports for the following:

- 1. Monthly food waste reports
- 2. Volunteer hour reports
- 3. Donor solicitation emails

Email body generation text expression:

```
(email body for action 'Monthly Food Waste Reports') (Text)
```

```
"Greetings,
Attached is our monthly food wastage report. Please let us know if
you need anything.
Thank you,
Pantry Patrol team"
```

Sample monthly food waste report email

4	Monthly Food Waste Report.pdf			Open with 🗸			-	C +	•	¥	:
(+	Compose						2				
19	Seience Ölympind										
10	Speech and Debate Club										
10	Summer Turoring	Monthly	Food Was	te Report							
1.46	Less?										
0	Chate 4										
20	Scheduled	Food Dona	tions This Mo	onth							
	Alt Mbit						. ►				
Mein	Seare	Category	Quantity(lbs)	Spoiled(lbs)	Spoilage Reason	Name					
100	New meeting	Bakery	25	2	Excess Moisture	Whole Foods	Sec. 2 (2011)				
in the second se	daine mining										
Han	caute										
	Selate the second s										

Email body generation text expression:

(email body for action 'Volunteer Hours Email') (Text)

```
"Greetings Volunteer,

Thank you for volunteering at the food pantry. You are receiving

this email because you have requested to receive a log of the

number of hours you have volunteered. In the month of _____ you

have volunteered _____ hours. We thank you for your service to the

food pantry.

Kind Regards,

The Food Pantry

Registered 501 (c)(3) non-profit organization"
```

Monthly food waste report email task-configuration:

Task name Unique name for this task	Monthly Food Waste Report:Monthly Food Waste Report Ema	ail		
Table name What entity table does this task work against?	Food Inspections Last Month (slice) View Definition			
Via channel The messaging channel to use.	System Default			*
To Send email to these email addresses. (Expressions that yield email addresses are supported.)	Bantry.patrol2021@gmail.com	Т	Д	
	USERSETTINGS(EmailReports)	Т	因	
	Add			
Use default content? If enabled, the task constructs a sensible default message. If disabled, you should define the content explicitly.				
Email Content				
Email Subject Subject line for the email. (Template that yields text is supported. Leave empty for default email subject.)	Monthly Food Wastage Reports			1,
Email Body The email body. (Template that yields text or HTML is supported. Leave empty for default email body.)				
Greetings,				
Attached is our monthly f	ood wastage report. Please let us know if you need anything.			
Thank you, Pantry Patrol team				
				11

Volunteer hours email task-configuration:

Volunteer

- Volunteer Hours Email		
effect: External: start an email		
Action name A unique name for this action	Volunteer Hours Email	
For a record of this table This action applies to rows of	Volunteer -	
which table?	View Definition	
Do this The type of action to perform	External: start an email	¥
To Who is the email going to?	= [Email]	Д
Subject The email subject	= "Food Bank Volunteer Hours"	Д
Body The email body	= "Greetings Volunteer, Thank you for volunteering at the food pantry. You	а Д
Appearance		
Display name The name shown for this action in the app. Leave this empty to just use the action name. Or give it a text value (double quoted) or a formula.	Click Here to Send a Volunteer Hours Log Email	T Z

Sample volunteer hours email:

From:		
To:	8	Cc & Bcc
Food Bank Volunteer Hours		

Greetings Volunteer,

Thank you for volunteering at the food pantry. You are reciving this email because you have requested to recieve a log of the number of hours you have volunteered. In the month of ______ you have volunteered ______ hours. We thank you for your service to the food pantry.

Kind Regards,

The Food Pantry Registered 501 (c)(3) non-profit organization

Email body generation text expression:

(email body for action 'Donor Solicitation Email') (Text)

"Greetings gracious patron of the food pantry, The holidays are just around the corner and we would really appreciate it if you could make a donation to us to put a meal on a family's plate this holiday season. We thank you for your donation in advance. Kind Regards, The Food Pantry Registered 501 (c)(3) non-profit organization EIN #56-1283426"

Donor solicitation email task-configuration:

3.22		
Action name A unique name for this action	Send an email to donors from the "Donor" spreads	heet
or a record of this table his action applies to rows of	Donor 👻	
hich table?	<u>View Definition</u>	
oo this he type of action to perform	External: start an email	*
0 /ho is the email going to?	= [Email]	Δ
ubject he email subject	= "Holiday Season Donation Request"	۵
3ody The email body	= "Greetings gracious patron of the food pantry,Th	e holidays are just aroun: ${f \Delta}$
Appearance		
Display name The name shown for this action in the app. Leave this empty to just use the action name. Or give it a	Click Here to Request a Donation	т

Sample donor solicitation email:

From:		
To:	R	Cc & Bcc
Holiday Season Donation Request		
Greetings gracious patron of the food pantry, The holidays are just around the corner and we would really appreciate if you could make a donation to us to put a meal on a family's plate this holiday season. We thank you Kind Regards, The Food Pantry Registered 501 (c)(3) non-profit organization EIN #56-1283426	J for your donation in advance.	

3.5.12. Startup menus and About Box

Entity description:

Properties of the application itself. Defined inside the application in AppSheets

<u>Menus:</u>

Application startup screen and About dialogs. Set from inside AppSheets

Pantry Patrol	C'		Pantry Patrol
Prepare a Box			faces regard and between
Food Donation		\sim	Pantry Patrol
Q Food Inspection		Siii	Authored By: Abhinav Meduri, Siddharth
Cash Donors		\times	Maruvada, and Arnav Meduri
Extension Dates			Raleigh, NC. We are passionate about the solvin the problem of Food Waste and eliminating Foo
Assistant		Pantry Patrol	Insecurity in our community. We created PantryPatrol app in an effort to help Food
Settings	•	Enloe Magnet High School Syncing the app	Pantries manage logistics and help track and reduce Food Waste.
About			
arnav.meduri@gmail.com		Cancel	Ok
Log Out	i Waste		Terms - Privacy - Licenses - Version 1.000357

3.6. Deployment Model and Deployment Plan

We have developed a **deployment model** to help ease the process of rolling out our application. Under our deployment plan:

- 1. Each food pantry will have its own instance of the application that can be customized according to its needs. For example, if the food pantry didn't find it necessary to track information regarding volunteers, our app's volunteer section could be disabled.
- 2. A separate Google account will be created for each food pantry. The application instance will be tied to a google account. This gives each application instance 15 GB of storage for storing google sheets data, photos and signature images. Because all of the food pantry data is stored in google sheets, the data is accessible directly by food pantry administrators if needed.
- 3. Because each application instance uses a separate google account, data for each application instance will be kept private.
- 4. Because each application instance is independent, it can be updated independently of other application instances.



Deployment Model

Deployment steps:

- 1. The Pantry Patrol team (our team) will create a brand new google account for the food pantry.
- 2. The Pantry Patrol team will clone the application from a template into the newly created google account to copy application data and template files into the new application.

- 3. Our team will send an invitation to one or more food pantry staff members to onboard them as users of the application.
- 4. Our team will customize the app instance as per the needs of the food pantry.

3.7. Application Documentation

To train food pantry volunteers to get familiar with the features of PANTRY PATROL application, our team created a series of instructional videos. The playlist can be accessed here: <u>https://www.youtube.com/playlist?list=PLGBzh8kxPhapqCxfQvOlySBrNvfPsI9ZE</u>

4. Test Model or Prototype

Explain how you tested your prototype or model. Be sure to include every step of your testing including all safety precautions that were taken. If not stated it will be assumed no safety precautions were taken. If you are using research to guess how your solution will work, explain step-by-step how it will work and why

Our solution is a software application, so we used general principles and testing methodologies applicable for testing software applications. We wanted our application to be more than just a prototype, and we wanted to deploy the application with food pantries to provide a free, useful resource that will not only allow them to track, monitor, and eliminate food wastage, but also provide them with a wide range of digitized pantry management features.

- We used iterative testing throughout the development testing process. Developing features in small increments helped us validate the contents of the app much more efficiently.
- We used mock data in Google spreadsheets and verified the data to make sure it shows up correctly.
- We recruited our friends to volunteer to help test the application by entering mock data into the application and try application features.
- The Food Bank of CENC (Central and Eastern North Carolina) is a stakeholder in our application. We used Agile development in our app by showing our progress on a biweekly basis to the Food Bank of CENC team to get their feedback and comments. Once we received their feedback, we incorporated new features into our next two-week development cycle. We learned that this process is known as Playback in the software development cycle.
- We used our own iPhone and Android smartphones, iPads, and laptop browsers (Chrome and FireFox) to perform multi-platform testing and validation.

- We invited a few of our friends and family to beta test our application so we could get external feedback on usability.
- We presented our working prototype to food pantry and food bank teams on a regular basis. From our meetings, we gained a lot of feedback that we used in our development and testing cycles.

4.1. Safety Precautions

Be sure to include every step of your testing including all safety precautions that were taken.

As described in section 3.1, our solution is primarily a **software application** and did not require special special safety precautions during testing.

4.2 Testing process

What problems did you find with your solution? Be specific since you will need to redesign based on these problems.

During our testing, we found several software issues that needed to be addressed.

4.2.1 Mandatory fields were not clearly designated

The early revisions of the application did not clearly define mandatory and optional fields. This caused the users to submit incomplete data that sometimes corrupted the application model.

4.2.2 Incomplete input validation

The application did not always perform data validation before saving. This allowed users to input incorrect data either deliberately or accidentally. For example:

- The user could type a string when the field required a number.
- Boundary conditions are not always checked, allowing users to enter data outside the valid range.
- The start date of a date range is allowed to be later than the end date.

4.2.3 Data Integrity violations

The application sometimes failed to store data into google sheets correctly. As a result, the wrong data was being retrieved, which was later displayed in the application.

4.2.4 Data labels are not intuitive

Based on the feedback we received from our stakeholders, for a couple of fields, the text labels and field names are not always intuitive and optimally placed in the UI.

4.2.5 Inconsistent display on devices

Because the form factor of a phone is different from a tablet, and due to differences in operating systems such as iOS vs Android, we found that application fields are sometimes misaligned and did not correctly adapt to the device's form factor.

4.3. Addressing Problems

Describe all of the changes you made to your prototype or model (or proposed prototype) after your first test. Why will these changes improve your solution?

We attempted to address the problems we found in section 2.4.2 by taking the following remedial actions.

4.3.1. Designate and enforce mandatory and optional fields

We made changes to the application to clearly designate required fields (indicated by a * next to the item) from our application's optional fields. The application enforced that a user could not submit a form in the application when mandatory fields are incomplete. This ensured that our entity data would always stay consistent and correct.

We also made changes based on feedback from our stakeholders. As an example, we learned that fields such as **Address and Contact Phone** could not be mandatory. Food pantries also told us that they wanted to obtain county information for each household, which we added as a required field based on their input.

4.3.2. Validate user input

We made changes to the application to perform data validation and range checks wherever needed. We also made extensive use of calendars, drop-down boxes, and other widgets capable of conducting automatic data validation and consistency checks to ensure that users will not submit erroneous data by accident. For example, we made sure that the user could not type a string in a field where a number was required.

4.3.3. Perform data integrity checks

Using mock data, we verified that:

- 1. The data into the application is consistent with what is saved in google sheets.
- 2. Data in google sheets is retrieved and displayed by the application UI.

4.3.4. Validate the application is easy to use and intuitive

We invited a few of our classmates and technology operators at the food bank to help beta test our application. We also shared early versions of the application with our stakeholders. Based on the feedback we received:

1. We renamed several labels in the application to make them more intuitive

2. Moved items between the Primary menu (bottom bar) and secondary menu (Side Menu) based on most commonly used operations.

4.3.5. Testing on multiple devices

We requested a few of our friends to try the application on different devices and report issues. We also made it a point to use different devices when giving demos to our stakeholders to exercise the functionality on all the devices we wanted to support. By consciously using multiple devices, we could extend the test coverage across mobile phones, tablets, laptops, and multiple operating systems.

4.4. Data Gathering and Analytics

Present the data you collected from your tests or from your research. If you tested a prototype or model then include all of the numbers you gathered during your testing and all observations you made. Use of graphs and charts is HIGHLY encouraged. If you used research to prove how your solution would work, be sure to include all of the numbers, charts, and graphs you used to make your case. Be sure that all data is related to your solution.

We are currently piloting PANTRY PATROL application with two food pantries:

- 1. A Touch of Father's Love and Ministries
- 2. Zion Christian Center

The initial feedback and user experience have been positive. Both of them told us that it will take a couple of months before they can adapt to using the new system, as they need to onboard their existing household data currently in binders. Once they start using the application for tracking food inventory and food wastage, we expect to see real data generated and reports created automatically.

We requested the Food Bank of CENC team to provide us with real food waste data that they collect in their systems, and they kindly offered us the waste report from September 2020. We entered this spoilage data into the application, and the application generated the spoilage reports as shown by the screenshots below. This is the closest thing to real data we are able to experiment with.

Food Waste Data from the Food Bank of CENC

Item Details by Reason Code

Food Bank Central & Eastern North Carolina

First(Fields!FilterString.Value, "DataSet_Result")

Posting Date	Entry Type	Document No.	item No.	Description	Location Code	Lot No.	Quantity	Unit of Measure	Gross Weight	User ID
Reason Code:	OUTDATED									
9/9/2020	Negative Adjmt	TEFAP SEPT	BN175	MILK WHOLE FRESH	R	L148101	-51	CS	-1,754.4	FA\JAMILAJ
9/11/2020	Negative Adjmt	DURWASTE	CVPR01	COVID-19 MIXED PRODUCE	D	L147631	-12,790	LB	-12,790	FA\KWILKI
9/11/2020	Negative Adjmt	DURWASTE	CVPR01	COVID-19 MIXED PRODUCE	D	L148216	-15,312	LB.	-15,312	FAWKWILKI
9/21/2020	Negative Adjmt	CHE	CP004	HEALTHY CHOICE MENU 1	R	L055625	-5	CS	-95	FAJJAMILAJ
				Total for Reason Code: OUTDATED	2		-28,158		-29,951.4	
Reason Code:	WASTE									
9/1/2020	Negative Adjmt	WASTE AUG	CVMI01	COVID-19 ASSORTED DRY FOOD	w	L141234	-993	LB	-993	FA\GCASA
9/8/2020	Negative Adjmt	WASTE	CVPR01	COVID-19 MIXED PRODUCE	G	L147972	-1,119	LB	-1,119	FA\TPENLA
9/8/2020	Negative Adjmt	WASTE	CVPR01	COVID-19 MIXED PRODUCE	G	L148080	-526	LB	-526	FA\TPENLA
9/8/2020	Negative Adjmt	WASTE	GVPR01	COVID-19 MIXED PRODUCE	G	L148221	-12	LB	-12	FA\TPENLA
9/8/2020	Negative Adjmt	WASTE	CVPR01	COVID-19 MIXED PRODUCE	G	L148227	-352	LB	-352	FA\TPENLA
9/8/2020	Negative Adjmt	WASTE	CVPR01	COVID-19 MIXED PRODUCE	G	L148231	-88	LB	-88	FA\TPENLA
9/10/2020	Negative Adjmt	WASTE	CVPR01	COVID-19 MIXED PRODUCE	G	L149962	-10,560	LB	-10,560	FA\TPENLA
9/11/2020	Negative Adjmt	DURWASTE	PU1080	CHICKEN NOODLE SOUP	D	L135341	-1	CS	-19	FA\KWILKI
9/17/2020	Negative Adjmt	WASTE	CSF048	PARBOILED BROWN RICE	G	L134369	-32	BAG	-32	FAITPENLA
9/17/2020	Negative Adjmt	WASTE	CSF048	PARBOILED BROWN RICE	G	L127789	-18	BAG	-18	FA\TPENLA
9/17/2020	Negative Adjmt	WASTE	CSF018	CORN CEREAL	G	L127781	-14	CS	-14	FA\TPENLA
9/17/2020	Negative Adjmt	WASTE	CSF003	PEANUT BUTTER	G	L134509	-14	CS	-14	FA\TPENLA
9/17/2020	Negative Adjmt	WASTE	CSF001	MILK UHT FLUID 1%	G	L140369	-16	CS	-32	FA\TPENLA
9/28/2020	Negative Adjmt	CSFP WAST	CSF010	JUICE, APPLE	G	L151852	-1	CS	-4	FA\TPENLA
9/28/2020	Negative Adjmt	CSFP WAST	CSF028	WHITE CHUNK CHICKEN	G	L151858	-10	CS	-10	FA\TPENLA
9/28/2020	Negative Adjmt	CSFP WAST	CSF043	KIDNEY BEANS, CAN	G	L151861	~1	CS	-1	FA\TPENLA
9/28/2020	Negative Adjmt	DURHAM	KC066	CHICKEN AND DUMPLINGS	D	L073548	-4	CS	-84	FAVAPRICH
9/28/2020	Negative Adjmt	DURHAM	KC067	MAC & CHEESE	D	1.073546	-4	CS	-88	FAVAPRICH
9/28/2020	Negative Adjmt	DURHAM	KC068	SPAGHETTI SAUCE BEEF AND TV	D	L073547	-4	CS	-84	FAVAPRICH
9/28/2020	Negative Adjmt	DURHAM	CVKSM02	BLAST FROZEN MEALS	D	L148054	-7	CS	-7	FAVAPRICH
				Total for Reason Code: WASTE			-13,776		-14,057	
				Report Total			-41,934		-44,008.4	

10/1/2020 10:50 AM Page 1 FA\JAMILAJ








4.5. Potential Sources of Errors

What are your potential sources of error? Remember, this doesn't mean "Did everything work?" since all tests have potential sources of error, so make sure you understand what that means. Explain how these sources of error could have affected your results.

4.5.1. Inaccurate inventory data

The accuracy of analytical charts shown in the application largely depends on the accuracy of data entered by volunteers during food donation, food inspection and food distribution phases. Food Pantries operate on volume and move a lot of food quickly to meet the needs of their communities. Some food pantries are not even equipped to measure the actual weight of food donations, as they receive food by truck loads. In those situations, they are likely going to enter an estimated weight of a donation, or estimated weight of spoiled food.

We learned from the Food Bank of CENC that even broad estimates of these numbers are of practical value for them to understand what percentage of food is actually wasted and for what specific reasons, and from a practical standpoint, are still helpful to gain insights into making the distribution process efficient.

4.5.2. Inaccurate or outdated household data

If the allergy information, dietary preferences and household size data for a household in the system is not up-to-date, a pantry may serve food items to households that they will likely not consume, resulting in food wastage.

4.5.3. Outdated extension dates

The Food Bank of CENC and other food banks may periodically revise guidelines around the Extension Dates for various food items. The application must be refreshed periodically to pick up new extension dates to ensure that food pantries are using the most recent guidelines for their operations.

4.5.4. Inaccurate TEFAP qualification

The income limit guidelines around TEFAP qualification could be revised by government agencies over time. The application must be refreshed periodically to ensure the TEFAP qualification criteria continues to be accurate.

4.5.5. Inaccurate estimation of value of food waste

The industry accepted conversion factor value of \$1.72 per pound could change over time. Food pantries can update this value in the application settings.

5. Drawing Conclusions

What conclusions can you draw based on the data you gathered during your tests? Your conclusion should be related to your original problem and your testing, include the data you collected, and refer to your proposed solution.

PANTRY PATROL provides an easy and intuitive way to track and monitor food pantries' food inventory and food wastage. A few of the app's features, such as the Food donation section, Food inspection section, Prepare a box section, Food Waste statistics section, and Auto-generated waste reports sections, are all designed to prevent food wastage. On the other hand, features such as the Household section, TEFAP Qualification algorithm, Volunteer section, Cash donors and Cash donations section are all designed to help ease the day-to-day operations of food pantries so they can efficiently manage their time to do their core business of serving people. With these use cases fully implemented as part of our application, we are confident that PANTRY PATROL satisfies the use cases to solve the intended problem.

Our long term plans are to roll out this app to numerous food pantries in our area and gather data and provide the information to food banks. This is an ongoing process. To get a feel for our app's effectiveness, functionality, and practicality, we requested our stakeholders who are experts in this field, to provide their feedback, which is captured below. Based on the positive feedback of our stakeholders we are confident in it's functionality. We are optimistic and excited to see our application roll out and witness the effectiveness in practice.

Stay tuned for the upcoming exciting new features and updates regarding our ongoing work. Please visit <u>https://pantrypatrol.wixsite.com/pantrypatrol2021</u>



Find more about our app PANTRY PATROL by visiting https://pantrypatrol.wixsite.com/pantrypatrol2021

5.1. Our presentation to the industry experts and their opinion about PANTRY PATROL

5.1.1 First Lady of NC Mrs. Kristin B. Cooper and her staff -

Brief presence of NC Governor Roy Cooper made our presentation even more exciting.

• Recording of our presentation <u>https://youtu.be/_gwDzq8iXQ0</u>



• Letter of Recommendation



State of North Carolina Office of the Governor

Krístín B. Cooper Fírst Lady

North Carolina Executive Mansion 200 N. Blount Street Raleigh, North Carolina 27601

To Whom It May Concern:

It is an honor to recommend Siddharth Maruvada, Arnav Meduri, and Abhinav Meduri from Enloe Magnet High School. Their app Pantry Patrol is a promising tool that will help many North Carolina food banks track and monitor food. My Husband (Governor Cooper) and I met with Siddharth, Arnav, and Abhinav earlier this year, and they gave a special report explaining the functionality of their app. We were very impressed by their creativity, passion, and determination to help North Carolinians fight to eliminate hunger.

Siddharth, Arnav, and Abhinav were clear and concise throughout their presentation of the app Pantry Patrol. They worked with leaders in nutrition and management to get helpful feedback on their project, and it is clear that their application is designed specifically to address the needs of food pantries.

As First Lady, I meet and work with food banks across North Carolina, and I believe the app Pantry Patrol will help bridge a communication gap and transition food tracking to the digital era. The app itself is skillfully designed to be user-friendly while containing beneficial information and statistics. Food insecurity and food wastage are significant problems in our community, and this app will help food pantries identify and eliminate sources of wastage.

I know that Siddharth, Arnav, and Abhinav will continue to do significant work to support North Carolinians.

Sincerely,

Kristin B. Coper

Kristin B. Cooper

• Our Zoom meeting



• NC First Lady's tweet about our project presentation

Will Chavis @wchavis · 18h

This may have been a snow, asynchronous day for many, but some of our scholars at Enloe used this opportunity to engage with @FLONC and @NC_Governor regarding a very important topic in our community! Couldn't be any prouder of these young people!

🚯 Kristin Cooper @FLONC · 18h

We had a great meeting today with @EnloeMagnetHS students to learn about their project assisting food banks. @NC_Governor also briefly joined us! You can learn more about their work here: pantrypatrol.wixsite.com/pantrypatrol20...



5.1.2. Meeting with Cary Mayor Harold Weinbrecht

We thank Mayor Weinbrecht for his willingness to listen to our presentation and provide valuable feedback. He has recommended our application to Dorcas Food Pantry in Cary. During our meeting with Ms. Kathy, Manager of Dorcas Food Pantry, she was so impressed with our work and was willing to partner with us to try the useful features of our application.

- Recording of our presentation
 - Youtube link (Presentation to Mayor of Cary)- https://youtu.be/yqOlnuBH3ic
 - Youtube link (Presentation to Dorcas Food Pantry)- <u>https://youtu.be/9hr4UvJVoxo</u>
- Letter of Recommendation



Harold Weinbrecht Jr. Cary Mayor

• Picture(s)



5.1.3. Meeting with Dr. Alice Ammerman and Center for Health Promotion and Disease Prevention (HPDP) Staff

As part of outreach, making people aware of our app and obtaining feedback from the area subject matter experts, we gave a demo of our application to Dr. Alice Ammerman, Director of the UNC Center of Health Promotion and Disease Prevention and Professor in the Department of Nutrition, Gillings School of Global Public Health as well as colleagues from Center for Health Promotion and Disease Prevention (HPDP).

• Recording of our presentation Youtube link - <u>https://youtu.be/H8mYa5B66v4</u>

Letter of Recommendation



• Picture(s)







Food insecurity remains to be a problem in many parts of the world. This problem is even more rampant during the current COVID-19 pandemic. During the height of the pandemic, more than 50 million households in the USA alone were food insecure. Despite Food Insecurity issues. "Food Waste" is a major problem in the USA. According to USDA, approximately 30-40% of food is wasted in the United States. Reducing food losses by only 15 percent would be enough food to feed more than 25 million Americans each year. Also, wasted food is a huge tax on the environment and contributes to greenhouse gases. Food Banks, Food Pantries and other community initiatives are actively combating this problem. Food Pantries are the front line of the fight against food insecurity that could use several tools to reduce food waste and help more people in the community. Food banks generally do not have any visibility into the food waste that is happening at their affiliate food pantries. They can operate more efficiently if they have the food waste data and can put it to good use. PANTRY PATROL is an intuitive and easy to use app primarily focused to help food pantries track, monitor, identify the sources of food waste and eliminate it. The app includes several food pantry management features and helps simplify day-to-day operations of food pantries so volunteers can focus on their core mission - serving people.

5.1.4. Meeting with Mr. Gideon Adams (VP), Ms. Angela Nesius (Records and Data Collection Coordinator) and other staff at Food Bank of Central & Eastern North Carolina

• Recording of our presentation - <u>https://youtu.be/5h8wGdgSb5Q</u>

• Letter of Recommendation from Mr. Gideon Adams



• Letter of Recommendation from Ms. Angela Nesius

Dear Team Pantry Patrol,

With our regular meetings coming to an end, I wanted to take a moment to congratulate you on a job well done. You are to be applauded for your awareness of hunger in our communities and your desire to help food pantries ensure that food is not wasted. While many may be well intentioned to help reduce hunger and waste, you set out on a mission to help answer this problem by using technology to record this type of data. You developed an app that can assist food pantries in learning what practices they can implement to better serve their communities. In addition, the data would also provide a way to observe patterns over time and solve underlying problems.

You also added in supplemental data gathering tools for food pantries who may benefit from having volunteers and donors logged into a system. Having volunteer and donor information in one place would allow food pantry staff to access their network of support when needed.

During our brainstorming meetings, I felt that you all were genuinely interested in our ideas and suggestions, and you showed this by making adjustments to the app prior to the next meeting. Your questions throughout the process made it clear that you had done your research on food pantry operations and food wastage.

This experience was very educational for me as well, to see the behind-the-scenes work that is involved with creating an app, and I am very grateful for having learned something new.

Best of wishes to you, Team!

With gratitude, Angie

• Picture(s)



5.1.5. 2021 NC Child Hunger Leaders Conference

The NC Child Hunger Leaders Conference is an annual day of celebration and inspiration for everyone in North Carolina interested in making sure kids have access to healthy food. The 2021 conference was their 10th annual event and was held on February 17 and February 18, 2021. The event was presented by Carolina Hunger Initiative, after 9 years of the conference being hosted by No Kid Hungry NC (which is a partnership between UNC and Share Our Strength and is supported by the same team as Carolina Hunger Initiative). This was an effort from our end to connect with the experts to gain knowledge and learn about different initiatives dedicated to addressing food insecurity in our community. Our work was also presented at the conference. Please see the link below for our Pivot Video.



- Recording of our presentation (Pivot Video) - <u>https://www.youtube.com/watch?v=93kYUOxe29I&list=PLpNMDWw_hcZzMoNMAuv</u> <u>6YaqD8A6ibr_eR&index=15</u>
- Picture(s) Siddharth and Arnav with WRAL-TV (local news channel) anchor Gerald Owens, who hosted the 2021 NC Child Hunger Leaders Conference. This year's conference was held virtually due to the pandemic, but that didn't stop us from having fun!









Certificate of Attendance
This is to certify that Abhinar Meduri attended the
2021 NC CHILD HUNGER LEADERS CONFERENCE "Pivot to the Future"
Held virtually on Feb. 17 and Feb. 18, 2021 by the Carolina Hunger Initiative UNC Center for Health Promotion and Disease Prevention
Lou Anne Crumpler, Director, Cordina Hunger Initiative Date Date
UNC CENTER FOR HEALTH PROMOTION AND DISEASE PREVENTION



5.1.6. Final Thoughts

When we first started this project, our goal was to identify and work on a community problem to showcase in the eCYBERMISSION competition. Throughout our journey, we were able to conduct research, talk to experts, and go on various field trips to learn more about the issues of food waste and food insecurity in our community. These experiences have shaped how we look at the food waste and food insecurity problems in America, and we are very passionate about helping to make a difference. We are passionate about making a difference in our community, and we plan to continue our project after the completion of the eCYBERMISSION competition. We are currently piloting our app with two food pantries in NC:

- A Touch of Father's Love Ministry and Food Pantry (https://atouchofthefatherslove.org/)
- Zion Christian Community Center (https://www.zionchristiancenter.net/).

In the future, we plan on gathering and analyzing important food waste data to share with food banks. We plan on obtaining their feedback for further growth and improvement of PANTRY PATROL. We also plan on partnering with more food banks and pantries in our area to improve their management systems with an underlying goal of reducing food wastage. By reaching out to more pantries in our vicinity, we will be able to help food pantries in maximizing their outreach. We have several other plans to expand this project and look into developing a suite of apps oriented towards tracking food wastage beyond food banks and pantries. We are now on a mission, and we thank eCYBERMISSION for getting us started!

5.1.7. Presentation Slides

We presented the following information to the experts in the community. The presentation also involved a live demo of our app, **PANTRY PATROL**.



Why Are We Doing This?

- Address food insecurity issue during COVID-19 pandemic
- Witnessed the problem firsthand in our community and wanted to take action
- Motivated to solve real world community problems

What is Pantry Patrol?

- Pantry Patrol is an app that aims to track and eliminate food waste at food pantries
- Pantry Patrol also has food pantry management features that aid food pantries in their outreach/data collection



How Are We Doing This?

- Deployment plan: How we plan to roll out our application.
- Each pantry will run a separate application instance in its own google account, copied from *template*.
- A separate Google account will be created for each pantry (15 GB space)
- ✤ App data private to each app instance
- Each instance can be customized & update independently for each Pantry





App Deployment Model

Pantry Patrol (Template app)

Pantry Patrol (instance) **A Touch of Fathers Love** Google account + storage Customizations X users + our team admin to support app

Pantry Patrol (instance) Zion Christian Center Google account + storage Customizations X users + our team admin to support app

Pantry Patrol (instance) Pantry Pantry

Google account + storage Customizations X users + our team admin to

support app

Conclusion

- We are very excited to pilot our app at food pantries in the coming months!
- Questions or thoughts?
- ✤ Feedback is welcome!

THANK YOU!

Arnav, Siddharth, Abhinav (Enloe High School)

Pantry Patrol: Track, Monitor, and Eliminate Food Waste!

Contact Us: pantry.patrol2021@gmail.com Website: https://pantrypatrol.wixsite.com/pantrypatrol2021

- Dr. Alice Ammerman (UNC Chapel Hill)
- Mr. Gideon Adams (Food Bank of Central and Eastern North Carolina)
- Ms. Angela Nesius (Food Bank of Central and Eastern North Carolina)
- Ms. Caitlin Cohn (Food Bank of Central and Eastern North Carolina)
- Ms. Jessica McConnell (Food Bank of Central and Eastern North Carolina
- A Touch of Father's Love Food Pantry & Ministry
- ✤ Zion Christian Center



State of North Carolína Office of the Governor

Krístín B. Cooper Fírst Lady

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Siddharth, Arnav, and Abhinav were clear and concise throughout their presentation of the app Pantry Patrol. They worked with leaders in nutrition and management to get helpful feedback on their project, and it is clear that their application is designed specifically to address the needs of food pantries.

As First Lady, I meet and work with food banks across North Carolina, and I believe the app Pantry Patrol will help bridge a communication gap and transition food tracking to the digital era. The app itself is skillfully designed to be user-friendly while containing beneficial information and statistics. Food insecurity and food wastage are significant problems in our community, and this app will help food pantries identify and eliminate sources of wastage.

I know that Siddharth, Arnav, and Abhinav will continue to do significant work to support North Carolinians.

Sincerely,

Kristin B. Cooper

Kristin B. Cooper

Executive Mansion, 200 N. Blount Street, Raleigh, NC 27601 27699-0301 Phone: (919) 733-3070

1. USE OF ENGINEERING DESIGN

1.1. Problem Statement

What problem in your community will your team attempt to solve using the engineering design process? Why did your team choose this problem to try to solve?

1.1.1. Community Problem

Food insecurity continues to be a major problem in the United States and has become even more rampant during the COVID-19 pandemic. Despite food insecurity, billions of pounds of food are wasted every year, and **food waste** continues to be a significant problem. Our team is attempting to reduce **food insecurity** by eliminating **food waste**, particularly in the context of food pantries.

1.1.2. Project Abstract

During the height of the pandemic, more than 50 million households in the United States were food insecure. Despite food insecurity issues, **food waste** is a major problem in the United States. According to the United States Department of Agriculture (USDA), approximately 30-40% of food produced is wasted in the United States. Reducing food losses by only 15 percent would be enough food to feed more than 25 million Americans each year. Wasted food is also a huge tax on the environment and contributes to greenhouse gases. Food banks, food pantries, and other community initiatives are actively combating this problem. Food pantries are the front line of the fight against food insecurity, and it is clear that they need better tools to combat food waste.

Food banks generally do not have any visibility into the food waste at their affiliate food pantries. They can operate more efficiently if they have food waste data available to put into good use. Our solution to this problem is **PANTRY PATROL**: an intuitive and easy-to-use application primarily focused on helping food pantries **track**, **monitor**, **identify**, **and eliminate sources of food waste**. Our application includes several **food pantry management features** that simplify the day-to-day operations of food pantries and allow volunteers to focus on what they do best: serving food to those in need.

1.1.3. Background

(What problem in your community will your team attempt to solve using the engineering design process?)

Millions of children and families living in America face hunger and food insecurity every day. According to the USDA's Household Food Insecurity in the United States report, more than 35 million people in the United States struggled with hunger in 2019 (https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statisticsgraphics.aspx). In 2018, 14.3 million American households were food insecure, with limited or uncertain access to food. Households with children are more likely to experience food insecurity. A family is considered **food insecure** when they do not know where their next meal is coming from.

Before the coronavirus pandemic, more than 10 million children lived in food-insecure households. Due to the effects of the coronavirus pandemic, more than 50 million are at risk of experiencing food insecurity, including a potential 17 million children. Food insecurity was even higher among households with young children; 40.9% of households with children ages 12 and under reported experiencing food insecurity since the beginning of the COVID-19 pandemic in 2020, which was a 170% increase from 2018. As the United States (U.S.) continues to cope with high unemployment and economic uncertainty, food insecurity rates are expected to increase drastically. In response to the pandemic, families turn to the charitable food system in greater numbers to help meet their needs. Of the 200 food banks in Feeding America's national food bank network, 98% reported increased demand for food assistance, and 59% reported having less inventory since the beginning of the COVID-19 crisis in March 2020.

Despite the food insecurity issue, food wastage continues to be an environmental, social and financial problem. According to USDA, approximately **30-40% of food is wasted in the United States. Reducing food losses by only 15 percent would be enough food to feed more than 25 million Americans each year.** America throws out more than 1,250 calories per day per person or more than 400 pounds of food per person annually. That's a loss of up to \$218 billion each year, costing a household of four an average of \$1,800 annually. Less than one-third of the food we throw out would be enough to feed Americans that face food insecurity. To place this in a global context, the average American consumer wastes ten times as much as his or her counterpart in Southeast Asia or sub-Saharan Africa.



(Source: <u>https://www.nrdc.org</u>)

In 2015, the USDA joined hands with the U.S. Environmental Protection Agency (EPA) to set a goal to cut down our nation's food waste by 50 percent by 2030. The announcement propelled the topic of food waste into a national conversation, eventually leading to the Food & Wine Magazine naming food waste as **the most discussed food-related topic of the year**. The USDA and EPA created the food recovery hierarchy to show the most effective ways to address food waste. According to this hierarchy, the best approach to reducing food loss and waste is not creating it in the first place.

EPA Food Recovery Hierarchy



1.1.4. Our Project

(Why did your team choose this problem to try to solve?)

The statistics described above clearly indicate that food insecurity is a significant problem in our community. As high school students, we have experienced the problem firsthand during the COVID-19 pandemic. Many of our schoolmates who depend on subsidized or free meals in the school cafeteria no longer have access to meals provided at schools with school closures. As we started to research food insecurity, we learned about the food waste issue's scope at the national level. While many people are going hungry, we are also throwing away a lot of food that people in need could have consumed. Wasted food is a problem because it impacts the economy, our society, and the environment. As stated previously, reducing food losses by only 15 percent would be enough food to feed more than 25 million Americans each year. Wasted food is a massive tax on the environment and contributes to greenhouse gases. The solution to this problem is reducing the amount of wasted food, depicted as the **Source Reduction** at the top of the EPA Food Recovery Hierarchy.

We knew that food pantries and food banks are actively helping to solve the problem of food insecurity. After witnessing the food insecurity problem firsthand, we decided to take action. As we delved more into the issue, we found out that food pantries, which are the primary distributors of food to people in need, still use traditional methods to track their inventory. Even

so, food pantries have no means of monitoring the amount of food wasted. For food banks that distribute food to food pantries, tracking the reasons for food wastage may significantly help them redistribute their inventory. Keeping these issues in focus, our team developed an application (app) **PANTRY PATROL (https://pantrypatrol.wixsite.com/pantrypatrol2021),** which is explicitly designed to help food pantries monitor, track, and address food waste. The application includes features that allow food pantries to consider **dietary preferences** and **allergy information** of households as they distribute food, minimizing food waste in turn. The application's data analytics features make it easy to track **sources of food waste** via dashboard views provided through graphs, tables, and other formats. Additionally, the application has various food pantries to revise their day-to-day operations. The application has built-in features to automatically generate **monthly food waste reports** and **automatically share them with partner food banks** to be more efficient in distributing food items.



1.2. Research and Resources

Research your problem. You must learn more about the problem you are trying to solve and also what possible solutions already exist. Find AT LEAST 10 different resources and list them here. They should include books, periodicals (magazines, journals, etc.), websites, experts, and any other resources you can think of. Be specific when listing them, and do not list your search engine (Google, etc.) as a resource.

1.2.1. Problem Research

(Research your problem. You must learn more about the problem you are trying to solve.)

Our research started with a brainstorming session, where the three of us met virtually and started thinking about problems prevalent in our communities. Each of us decided to come up with 4-5 different project ideas, and in the end, we voted on the top three. Hunger and food insecurity were a few topics that the three of us recognized as an area of concern that needed to be addressed. As we started to conduct more research on the web, we were impressed with how much work had already been done to address the food insecurity issue and how people and organizations are working hand in hand to help people who are food insecure.

1.2.1.1. Food Waste in the U.S. Food System

Each year in the United States, we leave between 125 and 160 billion pounds of food uneaten, amounting to up to 40 percent of our food supply. Food waste occurs at multiple levels in the food supply chain. Food is lost on farms, during processing, distribution, storage, retail stores, food service operations, and households. Food waste is also a waste of labor, vehicle miles, water, and fertilizers. We're wasting money, trashing resources, and accelerating climate change. Not only is that irresponsible—it's expensive. Growing, processing, transporting, and disposing of that uneaten food has an annual cost estimated at \$218 billion—or 1.3 percent of our GDP, as estimated by the 2016 ReFED report (Rethink Food Waste Through Economics and Data). This multi-stakeholder analysis is one of the few attempts at a full-supply-chain estimate of food waste. As shown in the ReFED estimate, households collectively generate the largest amount of the food waste share, followed by restaurants and other food service institutions, and then farms and supermarkets.

Breakdown of food waste generation by supply chain stage, as estimated by ReFED for 2015



1.2.1.2 Losses at home

Households are responsible for the most considerable portion of all food waste. ReFED estimates that U.S. household food waste totals 76 billion pounds or 238 pounds of food per person annually. This costs \$450 per person or \$1,800 per year for a household of four. The USDA estimates that 21 percent of the total food supply is lost at the consumer level, amounting to 90 billion pounds. However, the agency's definition includes both households and "out of home" consumption (e.g., in restaurants), as mentioned earlier. Furthermore, total consumer-level losses may be even higher if we include surplus from home gardens, which one survey estimated at an additional 11.5 billion pounds. Perishables make up most household food losses due to the high volume of consumption and the tendency to spoil. In terms of total mass, fresh fruits and vegetables account for the largest household losses, followed closely by meat, poultry, fish, and dairy products. By rate of loss, fish and seafood rank highest for consumers, with 31 percent of available pounds going uneaten.

<u>The USDA'S Estimate of Consumer Food Loss by Weight as a Percentage of</u> <u>Total Consumer Level Food Supply in the United States</u>



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1.2.1.3. Ecological Impacts of the Wasted Food

For us, the associated cost of wasted food is just the food itself. However, as we researched more about food waste, we learned about the underlying ecological impacts associated with wasted food. One of the most shocking aspects of wasted food is the enormous loss of "embedded resources"—that is, those that were required to get that food from the seed to the table. The vast majority of these resources are used in the food's production, by far the most resource-intensive stage of the supply chain. Moreover, a dramatic amount of climate pollution is created in producing all of that uneaten food. The EPA's Food Recovery Hierarchy, described above, rests on the logic that preventing surplus food in the first place will ultimately reduce demand for products that are currently being wasted, thus conserving more resources than donating or recycling food. Food waste in the United States is responsible for at least 2.6 percent of all U.S. greenhouse gas emissions. Food accounts for 21 percent of municipal solid waste, adding more waste to landfills and incinerators than any other product. Food waste consumes the equivalent of 19 to 27 percent of fertilizer used in the United States. Food waste accounts for the equivalent of 21 to 33 percent of U.S. agricultural water use.
1.2.1.4. Our Journey

We reached out to **Dr. Alice S. Ammerman**, *DrPH Director of Center for Health Promotion and Disease Prevention as well as Mildred Kaufman Distinguished Professor at Department of Nutrition, Gillings School of Global Public Health at University of North Carolina at Chapel Hill.* We consider ourselves really fortunate to have worked with a scholar like her over the course of our eCYBERMISSION journey. During our periodic virtual meetings, she taught us more about the problem of food insecurity and introduced us to many new concepts and connected us with experts in this field.

- <u>Reducing Food Waste at the Consumer Level</u> We met with Dr. Christopher M. Shea, (Associate Professor at the Department of Health Policy and Managementat University of North Carolina, Chapel Hill) and learned about his research on reducing food wastage at the consumer level. Dr. Shea also introduced us to various initiatives such as GoodR, LeanPath, Spoiler Alert, Food Cowboy, and Food Rescue that are trying to help the problem of food insecurity.
- <u>Nutrition at Food Banks</u> Ms. Sara Clement (Registered dietician at Food Bank of Central and Eastern NC) taught us more about **Extension Dates**, nutrition, and creating well-balanced meals.
- <u>Outreach and Access to Healthy Meals</u> We learned from Dr. Christopher Long (Assistant Professor at the University of Arkansas for Medical Sciences) about how food pantries could maximize their outreach to clients and improve access to healthy fruits and vegetables. He also gave us suggestions on how we could better suit food pantries' needs through our app, which helped us in the app development process.
- <u>Food Bank Operations</u> Mr. Gideon Adams, Vice President for Community Health and Engagement at Food Bank of Central & Eastern North Carolina (FBCENC) Mr. Adams gave us an overview of food bank operations. He was our guide and a **stakeholder** throughout our project.

The problem of food wastage concerned us, and we decided to pursue a solution to help reduce the food waste problem by collaborating with Mr. Gideon Adams and Ms. Angela Nesius at Food Bank of Central & Eastern North Carolina. Mr. Adams offered us a tour of the food bank so we could appreciate firsthand the operations inside a food bank. During our food bank tour, he showed and explained the entire food distribution process to us, and the tour helped us put things in perspective. We started virtually meeting with him periodically. During one of our meetings, he explained that food banks currently have a system to track their food inventory and food wastage, but food pantries currently lack this system. Having information on wasted food and the underlying reasons could help the Food Bank of CENC make informed decisions on how to efficiently distribute food to their affiliate food pantries. Mr. Adams also mentioned that reducing food waste would benefit the environment and the economy. It was after this trip that we realized we had found a mission to pursue. Touring the food bank sparked an interest about the issue, and we decided to schedule weekly meetings with Mr. Gideon Adams and Ms. Nesius. During our first few meetings, Mr. Adams and Ms. Nesius (Food Bank of Central and Eastern North Carolina) helped us understand the inventory management process at food banks. We were further introduced to two food pantries who helped us understand their operations and the challenges faced by food pantries.

- Ms. April Baker, Executive Director at A Touch of the Father's Love Ministry and Food Pantry
- Ms. Garland, at Zion Christian Center food pantry, Roxboro, NC.

In addition to gathering information and learning from the experts in the field, we also learned a lot from different websites, TED talks and journals listed in the references section.Below is a timeline of Pantry Patrol, detailing information about when all these events took place.

Project Timeline



<u>Tour of Food Bank of Central & Eastern North Carolina (CENC) with Mr.</u> <u>Gideon Adams</u>









1.2.2. Existing Solutions

(What possible solutions already exist?)

These websites and apps below are just some of the many great resources available to help reduce and recover wasted food:

- USDA Center for Nutrition Policy and Promotion (CNPP) has developed a new infographic, "Let's Talk Trash" (<u>https://www.usda.gov/media/blog/2015/10/20/how-can-we-support-affordable-nutritious-diets-reduce-wasted-food/</u>), to inform American consumers about food loss and waste. CNPP is raising awareness about how individuals and families can reduce food loss and waste, in support of larger USDA efforts.
- Waste No Food (<u>www.wastenofood.org</u>) is a website that was started, with a mission to reduce food waste. This website works by creating an online marketplace where food pantries and shelters can locate excess food from farms, restaurants, and grocery stores that may otherwise end up in the landfill.
- Ample Harvest (<u>www.ampleharvest.org</u>) allows anyone to help donate extra food from their pantry or garden. They have a mission of connecting individuals with food banks and food pantries.

- Food Cowboy (<u>www.foodcowboy.com</u>) is an application that allows trucks filled with food that has been rejected but are still safe to find a better home than the landfill. Truck drivers are able to quickly report what they have, and find a charity or compost site in their local vicinity that can accept the product.
- Love Food Hate Waste (<u>www.lovefoodhatewaste.com</u>) and Green Egg Shopper are two phone apps that use modern technology to help shoppers reduce their carbon footprint by reducing food waste. It helps shoppers become more efficient in their shopping and storing tactics, and helps to incorporate leftovers into meals for the next day.
- Food and Agricultural organizations of the United Nations (<u>http://www.fao.org/international-day-awareness-food-loss-waste/en/</u>) declared September 29th as *International Day of Awareness of Food Loss and Waste* to raise awareness on the subject of food waste.

1.2.3. Resources

(Find AT LEAST 10 different resources and list them here. They should include books, periodicals (magazines, journals, etc.), websites, experts, and any other resources you can think of. Be specific when listing them, and do not list your search engine (Google, etc.) as a resource.)

1.2.3.1 Experts Contacted for Outreach

1. Mrs. Kristin B Cooper First Lady of NC State of North Carolina, Office of the Governor (https://governor.nc.gov/about-first-family/north-carolina-first-lady-kristin-cooper) 2. Mayor Harold Weinbrecht District C Cary Mayor (https://www.haroldweinbrecht.com/) 3. Ms. Lou Anne Crumpler Director Carolina Hunger Initiative (https://hpdp.unc.edu/about-us/people/research-fellows/current-hpdp-research-fellows/lou-anne-c rumpler/) 4. Andrew Harrell **Communications and Program Specialist** Carolina Hunger Initiative No Kid Hungry NC

(https://hpdp.unc.edu/fforc/fforc-meet-our-team/andrew-harrell/)

5. Ms. April Baker

Executive Director A Touch of the Father's Love Ministry and Food Pantry (<u>https://atouchofthefatherslove.org/</u>)

6. Ms. Garland

Office Assistant Zion Christian Center, Roxboro, NC (https://www.zionchristiancenter.net/)

7. Kathy Goldston Food Pantry Manager Dorcas Ministries (<u>https://dorcascary.org/contact/staff-contact/</u>)

1.2.3.2. Experts Contacted for Project Guidance

8. Dr. Alice Ammerman

Alice S. Ammerman DrPH Mildred Kaufman Distinguished Professor Department of Nutrition, Gillings School of Global Public Health Director, Center for Health Promotion and Disease Prevention University of North Carolina at Chapel Hill (https://hpdp.unc.edu/about-us/people/leadership/alice-ammerman/)

9. Dr. Christopher M. Shea

Associate Professor at the Department of Health Policy and Management Adjunct Professor in Medicine Gillings School of Global Public Health University of North Carolina at Chapel Hill (<u>https://sph.unc.edu/adv_profile/christopher-shea-phd/</u>)

10. Ms. Sara Clement

Registered Dietician Food Bank of Central & Eastern North Carolina (https://foodbankcenc.org/about-us/leadership-board/)

11. Dr. Christopher Long

Division of Health Services Research, Department of Psychiatry, College of Medicine, University of Arkansas for Medical Sciences (https://psychiatry.uams.edu/research/center-for-health-services-research/chsr-research-faculty-an

(https://psychiatry.uams.edu/research/center-for-nealth-services-research/chsr-research-faculty-an d-staff/christopher-long-ph-d/)

12. Mr. Gideon Adams

Vice President of Community Health & Engagement Food Bank of Central & Eastern North Carolina (CENC) (https://foodbankcenc.org/about-us/leadership-board/)

13. Ms. Angela Nesius

Records and Data Collection Coordinator Food Bank of Central & Eastern North Carolina

(https://foodbankcenc.org/)

1.2.3.3. References - Websites, Books and Scholarly Articles

<u>Websites</u>

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- <u>www.wastenofood.org</u>
- <u>www.ampleharvest.org</u>
- <u>www.foodcowboy.com</u>
- <u>www.lovefoodhatewaste.com</u>
- <u>https://eatrightfoundation.org/wp-content/uploads/2016/09/The-State-of-Americas-Food-Waste-Report.pdf</u>
- <u>https://foodwastealliance.org/wp-content/uploads/2020/05/FWRA_BSR_Tier3_FINAL.p</u> <u>df</u>
- <u>https://www.refed.com/downloads/Executive-Summary.pdf</u>
- <u>https://www.epa.gov/sites/production/files/2015-08/documents/r5_fd_wste_guidebk_020_615.pdf</u>
- <u>http://www.recyclingworksma.com/wp-content/uploads/2015/11/How-to-Reduce-Food-Waste.pdf</u>
- <u>https://www.feedingamerica.org/</u>
- <u>https://www.foodandwine.com/</u>
- <u>https://blog.leanpath.com/?page_id=618</u>
- <u>https://foodwastealliance.org/wp-content/uploads/2020/05/FWRA_BSR_Tier3_FINAL.p</u> <u>df</u>
- <u>https://www.nrdc.org/sites/default/files/wasted-2017-report.pdf</u>
- https://wasteharmonics.com/waste-management-monitoring-tracking-analytics/

<u>Books</u>

- Food Loss and Food Waste, Causes and Solutions; By Michael Blakeney
- Saving Food Production, Supply Chain, Food Waste and Food Consumption; 2019 Edited by Charis M. Galanakis

<u>Ted Talks</u>

- What we're getting wrong in the fight to end hunger Jasmine Crowe <u>https://www.ted.com/talks/jasmine_crowe_what_we_re_getting_wrong_in_the_fight_to_end_hunger?language=en</u>
- Peter Lehner A Recipe for Cutting Food Waste <u>https://www.youtube.com/watch?v=UwOHpWTRsbE</u>
- Food Insecurity is a Public Health Concern Rayna Andrews https://www.youtube.com/watch?v=DHBpWM0rNZI
- Why food drives contributes to hunger in America Gary Oppenheimer <u>https://www.youtube.com/watch?v=VkdLPgx2HPw</u>
- What can we do to reduce food waste? Ali Jackson

https://www.ted.com/talks/ali_jackson_what_can_we_do_to_reduce_food_waste

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1.3. Problem Research, Existing Solutions and References

What did you find out about your problem that you didn't know before? What kinds of possible solutions already exist? Be sure to put this in your OWN words, do not just copy and paste information. Also, be sure to cite your sources.

1.3.1. Project Specific Research

What did you find out about your problem that you didn't know before?

We have heard our parents say multiple times to finish the food served in our plates and how fortunate we are to get to eat what we want. We were all raised to not waste food. But as we started working on this project and learning more through reading articles, visiting websites, reading books, listening to TED talks and talking with the experts, we learned many things as summarized below.

- 1. Food Banks and Food Pantries are the frontline organizations in the fight to solve hunger and food insecurity.
 - Food Pantries are a non-profit distribution center where hungry families can receive food. Supplied with food from a food bank, pantries feed hundreds of people per week. Because every community is different, there are many different types of pantries. Typical food pantries are organized by local churches or other community organizations often run by volunteers.
 - Food Banks is a non-profit organization that collects and distributes food to hunger-relief charities. Food banks act as food storage and distribution depots for smaller front line agencies and usually do not give out food directly to people struggling with hunger.
 - Feeding America Network is the nation's largest domestic hunger-relief organization. They work together with individuals, charities, businesses and the government by establishing guidelines and processes across various non-hierarchical entities in their mission to end hunger. They work with multiple food banks and food pantries across the nation to serve food to people who need it the most.

Pictorial Representation of the Feeding America Network

How does the Feeding America network of food banks work?



The Feeding America Network

200 food banks and 60,000 food pantries and meal programs strong.



FOOD BANKS

A food bank is the warehouse for millions of pounds of food and other products that go out to the community.



FOOD PANTRIES

A food pantry functions as the arms that reach out to that community directly. Some use mobile food pantries, which reach people in areas of high need. 2. Not all food waste is equal.

Pantry Patrol

The Food Recovery Hierarchy established by EPA demonstrates that the actions at the top of the Food Recovery Hierarchy have much greater environmental, financial and social benefits. We learned that **we can create a much bigger impact by addressing Source Reduction** compared to other recovery areas.



EPA's Food Recovery Hierarchy

Our app PANTRY PATROL was carefully developed to help reduce food at "source" by tracking and monitoring food inventory. Features of our app also help better food distribution so more people can be fed and less food wasted.

3. Food Pantries can't afford IT systems despite having needs for one.

Food banks generally have resources and money to afford IT systems for their operations. We learned that the Food Bank of CENC uses CERES and FoodLink systems to track their inventory, prescribed by **Feeding America** for sharing information at a global level. On the other hand, food pantries are typically not for profit volunteer organizations run by local churches and community organizers.

- Food pantries have requirements and obligations to track a number of their operations. For example:
 - Food pantries are obligated to track demographic information of the households they serve and provide broad statistics to their affiliate food banks.
 - Regulatory requirements such as The Emergency Food Assistance Program (TEFAP) require food pantries to qualify households based on their size and income before they serve certain types of food in the form of government aid.

Food pantries today mostly use pen and paper systems to track their customers and they can be more efficient in their day-to-day operations if they can leverage IT systems and automation.

- In our research, we found out that solutions generally available for food pantries are commercial in nature and come at a high cost that they cannot afford.
- Unlike food banks that can afford dedicated IT staff, volunteers at a food pantry are not IT savvy, and training them on complex software is not a practical solution. The solutions available to them must be intuitive, easy to use and run on most common hardware such as mobile phones.



4. Food Banks do not have visibility to food wastage at partner food pantries

Food banks recognize that food waste is a serious problem. Also, it costs money to dispose of spoiled food by sending it to a waste dump. We learned that the Food Bank of CENC spends close to \$120,000 yearly just for disposing spoiled food. They have IT systems in place to track food waste and actively try to minimize those costs.

However, food banks currently **do not** have any visibility into food waste happening at their partner pantries. **There is no formal mechanism to report this information.** Food distribution is often driven by what is donated by charitable organizations or what is

available as inventory at a food bank. Here are some examples where waste could happen:

- The food may need to be transported across a distance, and spoilage could occur during transportation due to temperature mishandling or packaging being compromised or damaged.
- The partner food pantry may not have the appropriate storage facilities. Dairy and meat products will need to be stored at a certain temperature, and if food pantries receive excess food, they may not be able to efficiently store and preserve those items.
- Food banks may choose to send a truckload of sweet potatoes because they got excess inventory. However, there are only so much sweet potatoes households can consume, and a food pantry may end up having to discard a type of food that they cannot simply distribute.
- Households of certain demographics and cultures may not consume certain types of foods (e.g., pork) and it would be wasteful to distribute those foods as they are going to be thrown out anyway.

The Food Bank of CENC team told us food wastage information from their partner pantries is extremely useful and they can be very efficient in their operations if they had insights into such information.



5. Food pantries can improve service with small changes.

Food pantries move a lot of food, and they are focused on serving their communities and are often strapped for resources. The COVID-19 pandemic created even more difficult situations for them to safely recruit volunteers and serve their communities effectively. Based on our conversations with A Touch of Father's Love Food Pantry and Ministries and Zion Christian Center, we learned that they create a one-size box with almost identical items for equitable distribution among all households. They also recognize that they could improve service better if they have more information about households readily available. For example:

- If the food pantry knew the size of a particular family, they could add more food to a box to help satisfy the needs of the whole family.
- If the food pantry is aware of **dietary preferences** (e.g., vegetarian, vegan, kosher) of the household they are serving, they may choose not to package certain items in their box, since the household is likely going to discard those items anyway. Instead, they could package other items that the family **will use.**
- If the food pantry is aware of **allergy information** of a household, they may choose to not package certain types of foods. Instead, they could package alternate items to ensure the family's needs are met.

By collecting and leveraging household-specific information, food pantries can make **smart choices** about the food they distribute through the "Prepare a Box" section. The "Prepare a Box" section of our app will help food pantries stretch resources and efficiently serve more households in the process.



6. Food Date Labeling issues

Food manufacturers have traditionally used various labels on food items such as **best-by dates**, **sell-by dates**, **use-by dates** etc. With the lone exception of infant formulas, none of these date labels are federally regulated and are simply manufacturer suggestions for peak quality. Studies have shown that a majority of consumers often misinterpret these dates as **expiration dates**. They often err on the side of caution and discard food as soon as it reaches the labeled date even though the food is perfectly consumable past its **best by** date. In December 2016, the USDA Food Safety and Inspection Service released new guidance for manufacturers and retailers. In January 2017, the two largest food industry associations announced voluntary guidelines to limit date labels to

- Best if Used By to describe product quality
- Use By for the few highly perishable products or those that may present food safety concerns over time.

On the other hand, manufacturers and retailers have a business incentive to keep selling more food for consumers. Retailers typically take food off the shelf as the Sell by/Best by

date approaches to make consumers feel safe. A study done by NRDC and Harvard Food Law and Policy clinic concluded:

"The waste of edible food by consumers, retailers, and manufacturers poses a significant burden to the American food system. Wasted food costs consumers and industry money; squanders important natural resources used to grow, process, distribute, and store America's food supply; and represents a missed opportunity to feed the millions of food-insecure households in the United States that are struggling to access healthy, affordable food. Misinterpretation of the date labels on foods is a key factor leading to this waste."

Over the years, food banks and organizations such as Feeding America have successfully persuaded and collaborated with retailers to donate such food to food pantries. It turned out to be a win-win situation for all parties involved:

- Disposing food by sending to the dump costs money for retailers. Instead, they can donate food and save money.
- Retailers get to take a tax write-off on their donation which can add to their bottomline.
- Helping the communities will improve the retailer's standing in their respective communities.
- The Good Samaritan laws and protections enacted over time helped retailers and other donors immunity from potential exposure due to accidental bad donations.

In light of these developments, organizations such as Feeding America and several food banks have adopted alternate **Extension Dates** for food items to provide further guidance for food pantries for how far out beyond the normal **Best by** date they can continue to donate food items. Partner food pantries are trained to use these dates as guidance in their operations.



7. Assessing the dollar value of food donations and wastage

Food banks and retailers use a simple conversion factor rule for assessing the dollar value of donated food. It is \$1.72 per every pound of food donated, and the value could be adjusted for inflation in future.



Our app PANTRY PATROL offers a feature that can calculate dollar value of the amount of food wasted.

8. Technology can help solve the hunger problem

Even with many social programs that aim to end hunger, the food supply chain ecosystem in the United States has failed to solve the problem of hunger, which has grown into a national epidemic. This hunger epidemic is being combated by organizations such as **Goodr**. At Goodr, people believe that hunger isn't a scarcity issue, it's a logistics issue. The Goodr model aims to provide a triple-win solution by improving an organization's bottom line through charitable tax donations, reducing its greenhouse emissions from landfills and getting its edible surplus food to local communities in need.

Learning about technology and how it can help businesses with food waste tracking inspired us to work along the same manner.



The above described factors were good enough reasons to undertake a project that helps prevent food loss. Our research continued and we also acquired understanding of the following additional topics related to food waste.

Pantry Patrol

The "Food Waste Statistics" feature of our app PANTRY PATROL tracks the sources and reasons of waste allowing both food pantries and partner food banks to take corrective action to minimize food waste.

1.3.2. Current Solutions

(What kinds of possible solutions already exist?)

We have come across a number of initiatives and consumer technology solutions that promise to address the issue of food waste. Our analysis puts these existing solutions into these categories:

- Peer-to-peer applications that help connect food producers (e.g., restaurants) with people with a need with a goal to prevent food wastage.
- Technical solutions that help with tracking food waste but focussed on **food waste** happening in the kitchen
- **Commercial solutions** that are used by large conglomerates and food banks for inventory management, logistics and support.

1.3.2.1. Existing Solutions

- 1. <u>Too Good to Go</u> is one app that gives shops and restaurants in many cities a platform to sell their surplus food at reduced prices at the end of the day.
- 2. The Feeding India The Feeding India app, instead, focuses on donations of food for those in need. Restaurants and individuals can sign up on the app to donate food, which is then collected and distributed by this non-profit's network of more than 4,500 volunteers.
- 3. Twiga Foods In Kenya, the Twiga Foods platform connects 3,000 food outlets a day with fresh produce through a network of 17,000 farmers and 8,000 vendors, allowing restaurants to buy only what they need and farmers to deliver more efficiently.
- 4. <u>Feedie</u> turns food photography into a charitable donation. Users visit a participating restaurant in the United States or South Africa and take a photo of their meal. Then, they share the photo on Facebook or Twitter and the restaurant makes a donation to The Lunchbox Fund, a nonprofit donating meals to impoverished schoolchildren in South Africa.
- 5. Flashfood A family member's horror after catering an event that disposed of \$5,000 worth of food inspired the creation of <u>Flashfood</u>. The app prevents food waste in the United States and Canada in two ways: It re-sells grocery foods approaching their best-before date at a discount, and it saves "not good enough" retail items and ships them to customers. Farmers and growers also can give Flashfood items that were rejected by grocers, to be sent to environmental-conscious consumers.
- 6. <u>Food Cowboy</u> arranges efficient communication between food donors and charities and fast delivery of excess food in the United States. Delivery drivers, caterers and anyone working with large volumes of edible but rejected food create alerts in the app. Food pantries, processors and composters immediately receive these alerts and contact the source for delivery arrangements. Food Cowboy charges a small commission for the

service. For instance, a food bank can buy as much as they can store for 10 cents per pound

- 7. <u>Food for All</u> eliminates last-minute restaurant food waste in Boston and New York City. It connects customers to restaurants one hour before they close, for meal discounts as high as 80 percent. Customers can enter their location and explore nearby deals, and they pick up their order at a time specified by the restaurant. Users also can donate food to people in need through the app.
- 8. <u>Food Rescue Hero</u> turns average eaters into food heroes. The app connects users with nonprofits who serve those who are food insecure.
- 9. <u>Food Rescue US</u> app fights food insecurity by connecting food donors with hunger relief organizations. The app targets anyone who wants to donate or receive food. Users answer a few questions and then request a food pick-up. The algorithm matches surplus food to a nearby shelter and sends a driver to transport the food. More than 2,200 registered volunteers have rescued and delivered 23.1 million meals to people in need.
- 10. <u>Foodfully</u> aims to inspire thoughtful consumption of food before its expiration date. Foodfully has a connection to more than 14 grocery stores in the U.S. and their loyalty cards. Every time a user makes a purchase with a loyalty card, the app records the transaction. The app also can scan receipts and record manually entered purchases. Users manage their food items on the app by entering them in the fridge and freezer, deleting the consumed ones and throwing food away. Foodfully arranges items by perishable dates and sends the user notifications before they go bad. Additionally, the app suggests recipes based on what is available in the user's fridge.
- 11. In New York City, <u>goMkt</u> connects restaurants that have unsold food with customers looking for discounts. By purchasing food as take-out through the app, customers save up to 75 percent off the original price and reduce potential food waste. The business-to-consumer platform plans to expand to larger food businesses and connect them to charities, composters and anaerobic digestion facilities.
- 12. With a 24/7 service in Atlanta, <u>Goodr</u> picks up excess food from businesses and delivers it to nonprofits. Goodr perceives hunger not as a scarcity but as a logistics issue. Restaurants, catering and events companies end up with a lot of leftover food, but rarely have the time to make donations, so surplus food ends up in landfills. Goodr allows businesses to schedule food pick-ups, and the company currently generates about \$30,000 of revenue a month.
- 13. <u>ImpactVision</u> combines the topics of food safety and food waste to enable a transparent food system. The app uses advanced imaging technology to assess the quality of food. For example, their Fruitcam assesses the ripeness of fruits, so wholesalers decide which ones to ship abroad and which to sell at local stores, and their Fishcam can mark the difference between fresh and frozen fish fillets. ImpactVision enables fast decision making on food quality. With this in mind, businesses can reduce waste and deliver high-quality products to buyers.

- 14. <u>NoFoodWasted</u> aims at reducing food waste in the Netherlands by 50 percent in the next five years. This app stimulates demand for discounted products with a best before date. It alerts supermarket shoppers which items are approaching their expiration date. Users do not even need to go to the supermarket to explore the deals, as they can check them online. So far, more than 77,000 users downloaded the app, which achieved 13 percent of its waste reduction goal
- 15. OLIO For some, food waste is an inevitable part of modern life, but research indicates that throwing food away causes a feeling of physical pain for others. OLIO taps into the conscious consumer mindset to offer a food-sharing platform, connecting people with neighbors and local shops all over the world. Users add a photo and description of their item, indicating when and where to pick it up. Customers frequently donate fresh garden vegetables, bread from bakeries and unwanted household food.
- 16. <u>Transfernation</u> diverts 1.8 to 2.26 metric tons of food per week from landfills to homeless shelters, soup kitchens and church feeding programs in the New York City metro area. Volunteers, Uber drivers and Lyft drivers pick up leftover food from offices, receptions and film sets to redistribute to those in need. The system provides benefits to each type of user: Donors receive a tax write-off for their food donations and redirect their disposal costs towards a good cause; transporters earn \$15 per pick-up; and feeding programs receive free high-quality food.

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www.epa.gov/smm/advancing-sustainable-materialsmanagement-facts-and-figures. In 2014, the United States disposed of more than 36.5 million tons of food. Of that, 29.3 million tons were sent to landfills, and 7.2 million tons were incinerated.

We analyzed the existing solutions, and concluded that these solutions do not directly help food pantries manage their day to day operations, with specific emphasis on avoiding food waste, and are affordable.

After having conversations with the Food Bank of Central and Eastern North Carolina and food pantries pantries in our area, we built **PANTRY PATROL**, an application that helps food pantries **track**, **monitor**, **and identify sources of food waste**. We wanted to ensure that we created an application that met food pantries' needs, affordable, and simple and easy to use.



PANTRY PATROL is a versatile app with multiple features for food pantries such as monitor and track food wastage, cash donations, food donations, food inspections, dietary preferences, food waste statistics and extension date guidance.