Composting Education Program Composting Calculator – Iteration 2

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Abstract

Our Composting Calculator, in collaboration with the University of California Cooperative Extension (UCCE) Composting Education Program (CEP) aims above all to promote composting within the Santa Clara community. We undertook this project with the objective of enhancing the functionality and contextualization of the former team's calculator, providing both meaningful visual and numerical context for composting contributions and inspiring users to engage in composting activities. By leveraging conversion formulas from the Environmental Protection Act (EPA) Greenhouse Gas Equivalencies Calculator, our tool successfully converts composting data into CO2 emissions and offers users a more complete understanding of their environmental impact. To address issues of user navigation and data reliability, a "How to Track Accurately" was created to guide users in accurately reporting their composting habits and better comprehend the direct correlation of these habits with climate change. Recommendations for future enhancements primarily include optimiming data management and privacy measures, as well as enhancing user engagement through additional interactie features. Ultimately, our goal is to empower individuals who visit the site to make informed, meaingful decisions about composting and environmental conservation efforts.

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1. Introduction

In this introduction we will discuss background and motivation, literature review, and project objectives. Within this section we will be covering information about the organization we partnered with, an overview of current tools like ours that is currently available online, and the purpose of our website. Additionally, we will describe our definition of our project success that we used to measure how well we accomplished our goals.

1.1 Background and Motivation

Our project for our community-based engineering design project is in collaboration with the University of California Cooperative Extension (UCCE) Composting Education Program (CEP) with the intent of encouraging as many residents as possible to compost within the Santa Clara County region, as well as attend the CEP's free community workshops for compost-education. With climate change on the rise, composting education is more important than ever, and the UCCE seeks a means to encourage Santa Clara residents and any visitors to their website to become active composters.

1.2 Literature Review

While there exist many online tools to assess the carbon dioxide savings of various activities, there is a noticeable lack of less easily accessibly online resources dedicated to contextualizing the impact of composting in the reduction of greenhouse gases and climate change. Currently the Environmental Protection Act (EPA) hosts a carbon calculator (Sources of Greenhouse Gas Emissions | US EPA, 2023) on their website that converts emissions or energy data into different representations. In contrast to the EPA carbon calculator, which lacks conversions for food waste or yard waste into carbon dioxide savings, our calculator tool provides users with the means to

convert their composting data into CO2 emissions, which is then translated into different measurements like gallons consumed or miles driven.

1.3 Project Objectives

Our primary objective is to provide users with an understanding of the benefits of composting to their community. We aim to enhance the functionality of the calculator by providing meaningful numerical and visual context for the conversions and inspire users to potentially expand their compost education with the UCCE. Currently, while the calculator offers functionality in converting inputted composting amounts into potential carbon dioxide saved and providing percentiles for average compost saved throughout Santa Clara County, it lacks accurate user input effective user engagement with meaningful visual representation or explanations for conversions (calculations like “tree seedlings grown in 10 years” hold little weight with users). Additionally, we plan to create a “How to Track Accurately” page in response to UCCE concerns about data accuracy, serving to guide users in accurately reporting their composting habits. By improving user comprehension and data accuracy, this calculator strives to enrich the impact assessment of composting workshops conducted by the UCCE.

UCCE Composting Education Program requires a “How to Track Accurately Page” to enable users can report their composting data more accurately in their surveys. This enhancement will allow program managers to assess the impact of their workshops and derive insights for improvement. By providing clear, descriptive explanations for each conversion and offering statistics on collected data in comparison with their community, we aim to encourage composters to increase their composting.

Our project thus involves the creation of two pages: one which builds upon the previous UCCE group calculator and incorporates visuals and other aids, as well as a “How to Track

Accurately" page which, along with instructing users on how to accurately report their composting data, aims to underline the environmental context of their contributions.

Over a ten-week period, January 8th to March 5th, our collaboration with the UCCE will focus upon finding ways to ensure reliable data sourced from Qualtrics, correctly calculate averages, medians, and means of individual composting contributions throughout Santa Clara County and implementing meaningful visual representation for individual composting contributions. Despite encountering several challenges in access to data and a limited team size of four, we recognize the scope of our project and have opted to leverage the existing website from the previous quarter and iterate on it. Additionally, we have encountered minor security issues concerning the former team's use of Google's API and the API keys which pull live data from Google Sheets, prompting us to develop workaround solutions allowing us to use essential data and prevent potential breaches. Our definition of success includes the seamless integration of our tool into the UCCE platform, providing real-time data accessibility – a task the previous group required assistance to accomplish. We aim to enhance user comprehension by integrating helpful visuals into both web pages, ultimately facilitating a clearer understanding of the displayed data.

1.4 Critical Customer

Our critical customers include site users, primarily Santa Clara Valley residents, and anyone interested in the UCCE, such as CEP workshop attendees. According to the essential goal of our project, one of the significant potential benefits is reducing landfill waste and educating residents about composting knowledge through our website. From the calculator on our website, the user can learn the specific details related to the amount of their composition. Suppose the users and residents are encouraged to use our website and follow their composition routine. In that case, it

will benefit the communities and individuals economically by reducing management costs on composting waste. Nonetheless, this project aims for long-term results to help the environment and younger generations by integrating environmental protection responsibilities into their daily lives.

1.5 Report Roadmap

The first part of the report details the project from the fall of 2023. As it was their data collection tool which our current project with the UCCE is built upon, the design strategies utilized by the front-end and back-end teams from last year are discussed in depth, as well as an analysis of both teams' successes and challenges. The report establishes our revised primary project goals and civic considerations for 2024, focusing on meaningful visual representation, user navigation, and community impact. The report then summarizes the research and discussion after establishing our project plan with the UCCE. A results and analysis section contains more technical details of the revised website and the completed final product. Towards the end of the report, we reflect on the project in the conclusion section. We also include an appendix section with additional information, including details for future teams updating the project.

2. Discussion

In this section we will be covering our project specifications and civic engagements that apply to our project. Within Project Specifications, we talk about our initial plans and what we decided to include in the final project. In the Civic Engagement section, we discuss the different organizations that play a role in the rules and policies concerning the implementation of our project.

2.1 Project Specifications

Initially we wanted to design a website that had a lot of interactive elements such a moving car, and customized animations whose quantity changed as different values were inputted into the calculator. We got this inspiration from the Ecological Footprint Calculator (footprintcalculator.org). Unfortunately, due to time restraints and our sparse experience with front end programming, we understood that these types of visual representations were not realistic. We also wanted to incorporate a type of map that showcased different communities' composting efforts. The idea was to use google maps API and be able to display the different statistics per each area within Santa Clara County. The reason we passed on this idea was due to our unfamiliarity with CEP's dataset. To represent different places within the Santa Clara County, we would need a decent amount of data per each region, and it was apparent that there was not enough data from each region that make this possible. Similarly to the custom animations, we also understood that this would take a significant amount of time to figure out due to the complexities of API, and we wanted to prioritize the main aspects of the site that needed improvement. We would encourage future iterators to implement that map feature on the website to further drive more interest for the calculator, but for our project we thought this idea was a great bonus but there were other aspect of the site that were in more dire need of attention, such as the lack of information displayed on the website and the improving the visual interest of the interface.

Figure 1: Fall 2023 CEP Calculator

Finally, when we spoke to our partner Victoria, it was clear that the biggest contribution she wanted to add to the site was more context to calculator. To both ours and Victoria's impression of the website, the site was lackluster as seen in Figure 1. The computations provided calculations but with no context, which made the calculator itself uninspiring. For example, the conversion to "tree seedlings grown for 10 years" as seen in Figure 1, is not intuitive to users. Within the cite there is no explanation as to what this means and there is no citation to the EPA

calculator which is the source of the conversion. On the EPA calculator, they provide short descriptions to what this conversion means, saying “A medium growth coniferous or deciduous tree, planted in an urban setting and allowed to grow for 10 years, sequesters 23.2 and 38.0 lbs of carbon, respectively” (epa.gov), but this is not show on the previous site. Our objective was for people to be visually stimulated by the website and want to click around or continue looking around the page to learn and find out new information. Thus, we decided that on the calculator page, we were going to incorporative better visual representation of the data as well as providing context, so the calculator provides more use than only converting carbon dioxide to miles driven or gallons of gas consumed. When people click onto the site, they will be informed on the process of how composting affects CO_2 emissions and what this means in their day to day lives.

In addition to updating and creating new visuals for the calculator, our team planned to create a second website called “How to Track Accurately”. During the first mock-ups of the website the plan was to create an infographic looking site that would provide information on composting in a visual, effective way.

The goal of this page would be to educate and provide users with more information regarding how to compost and the impact that composting has on the environment. The page goes over how to effectively use the calculator to ensure that the data inputted into the calculator is accurate. In talking to Victoria and our team members, we concluded that one of the main roadblocks to composting is that people do not know the amount that they are supposed to compost in a week. This is why the “How to Track Accurately” page is very visual to ensure that users can get a visual sense of how much waste to compost. After researching, how much waste a person produces in a week, we concluded that, on average, a local Santa Clara resident produced 4.4 pounds of waste a week (UCRRA, 2021). With this information, we were able to make

comparisons in relation to the size of an average organic waste bin to give residents an idea of how much waste they should compost a week. To gather inspiration to create this page we researched other climate change and carbon footprint calculators such as the one from Global Footprint Network. From this site we gathered how critical visual aids were in keeping the user engaged and better displaying the data. Overall, the design and solution of the site stayed consistent throughout the coding process, and there was a minor change to the first solution of creating an infographic-like site.

2.2 Civic Engagement

Many organizations play a role in determining public policy issues raised by our project. For our project specifically, one of the main concerns is data privacy. The UCCE collects composting data from their workshop attendees, which is then stored in their Qualtrics Data Base. To access the data necessary for displaying quantifiable composting contributions in Santa Clara (ie. percentiles and averages), we need top-level clearance, which we cannot have. The Federal Trade Commission (FTC) requires businesses to implement reasonable data security measures in order to protect sensitive information from unauthorized access. This would discourage us from posting all their data onto a Google Sheet, which the Google Sheets API could retrieve from. To continue researching the privacy and data security standards for our project we could find more information from organizations like the International Standards Organization (ISO), Electronic Frontier Foundation (EFF), and the National Institute of Standards and Technology (NIST). Many local organizations focused on environmental conservation, sustainability, and waste reduction may also provide valuable insights as to promoting composting initiatives, such as environmental nonprofits and community gardens. Local Santa Clara agencies responsible for waste management and environmental sustainability may also offer support for composting

initiatives. By exploring partnerships with these organizations, our team may potentially broaden the impact of the composting tool and address interconnected environmental challenges more effectively.

Our design addresses several civic issues pertaining to the protection of the environment, including climate change and pollution concerns. The idea behind the Composting calculator and its accompanying “How To Track Accurately” Page is to inform and encourage Santa Clara Residents to compost more instead of throwing organic material into landfills. Organic waste in landfills leads to the slower decomposition of material and more dangerous gasses related to pollution concerns; as landfills expand or become fuller of garbage, they become more hazardous to residents living around the landfill. This issue can only be solved by creating a new way to get rid of waste, which is an unrealistic solution; our website instead encourages people to throw away less waste and informs them of the benefits of composting, positively impacting the environment. Reducing landfills and encouraging people to compost and create less waste also falls into the bubble of climate change as reducing the amount of greenhouse gases would help slow climate change. So although the primary source of data for this project includes residents of Santa Clara County, it can be noted that these issues affect not just Santa Clara but communities worldwide.

Our project has several critical considerations to ensure compliance with regulatory standards and best practices. Firstly, in adherence to the California Consumer Privacy Act (CCPA), we are committed to protecting user data privacy. We will transparently disclose our data collection practices, detailing the types of data collected, their usage purposes, and users' rights regarding their data. Secondly, legal compliance concerning the use of APIs is paramount. We will secure the necessary licenses and adhere to the terms of service for utilizing UCCE's API, ensuring our

use aligns with legal requirements and data usage policies. Accuracy and substantiation of our environmental claims are essential to avoid misleading information, in line with the FTC's Green Guides. We are committed to using reliable data from UCCE and employing EPA-recommended algorithms for our calculations, ensuring our information remains accurate and substantiated. Lastly, web accessibility is a priority. We aim to comply with WCAG 2.1 standards to the greatest extent possible, incorporating animated representations of data and other accessibility features to make our tool inclusive and accessible to all users.

3. Results and Analysis

3.1 Final Product Specifications

The Composting Calculator's final product features a dynamic and interactive user interface. The enhancement of the calculator page and the addition of the "How to Track Accurately" page significantly improved the user experience and educational value of the tool.

Meaningful Representation

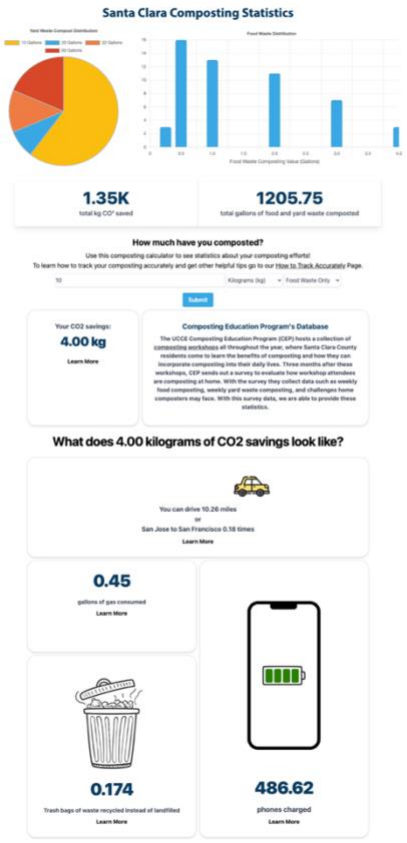

Figure 2: Composting Calculator Interface

In our effort to make our Composting Calculator, we used a more meaningful representation to describe each composting conversion clearly. This includes a special setup named the "Three Stat Container." Instead of sticking to the usual 2x1 layout, we arranged two smaller boxes on top of each other next to a longer box resulting in a much more interesting site layout which can be seen in Figure 2. We also added a CO2 Description Container. Here, we split the space so that one-third is for the container and two-thirds for the description. This way, we give more room to explain the data, making sure it's straightforward for everyone to get the information. Our aim with these approaches is simple: present our project data in a direct, clear,

and user-friendly way. By doing this, our project not only shares important information but does so in a way that everyone can understand and appreciate.

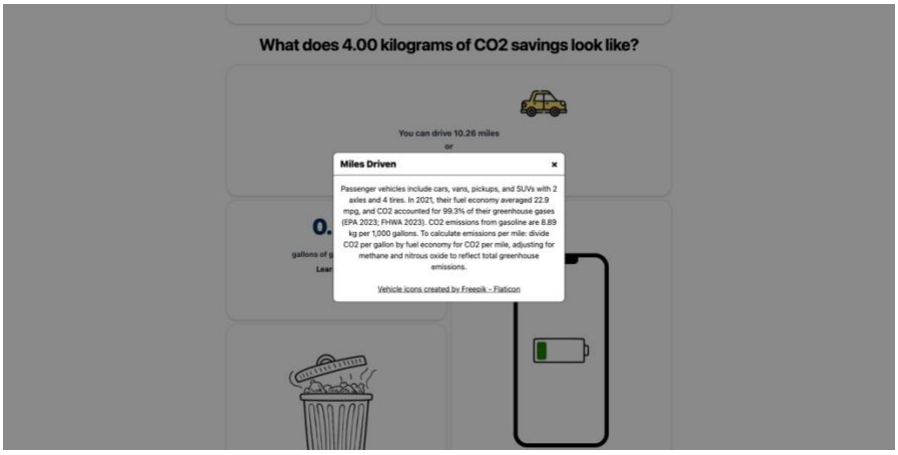

Figure 3: Pop Up Description Modal

Pop-up descriptions

This feature was developed using code examples available on platforms like YouTube and GitHub, specifically drawing inspiration from a Vanilla JavaScript Modal example found at https://github.com/WebDevSimplified/Vanilla-JavaScript-Modal/blob/master/index.html which resulted in the pop up window seen in Figure 3. Following each conversion, users are presented with a pop-up window that provides a detailed explanation of the conversion's significance. To ensure the accuracy and relevance of these descriptions, we've sourced all the information from the United States Environmental Protection Agency (EPA) website. This approach not only enriches the user experience by offering valuable insights but also grounds our project in reliable and authoritative data, highlighting our commitment to delivering meaningful and educational content.

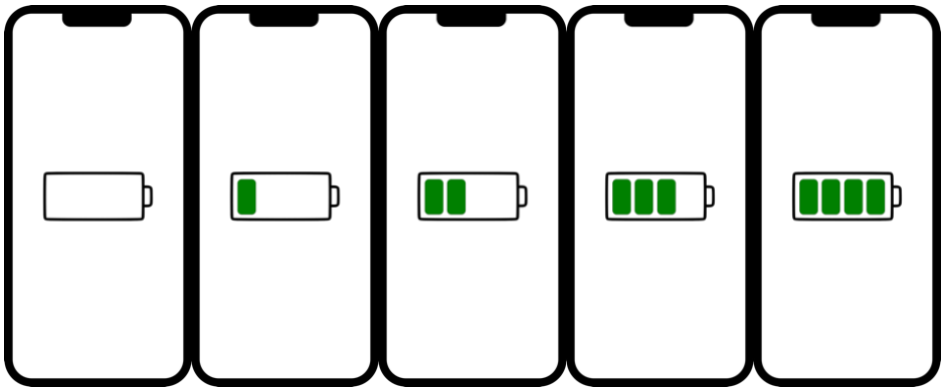

Figure 4: Figma Phone Charging Visuals

Dynamic Animations

The dynamic animations were created with guidance from resources such Stack Overflow discussion on creating animations without keyframes but with transitions from https://stackoverflow.com/questions/49140448/how-do-animation-without-keyframes-but-with-transition. Our animation work primarily utilizes HTML, CSS, and JavaScript. However, to maintain consistency with the project's existing codebase, which differed from our initial approach, we adapted by converting HTML elements entirely into JavaScript. For the animations, we featured a moving car and a loading battery to visually represent different concepts within our project. The car image was sourced from https://www.flaticon.com/free-icon/car_3721600, and we created the battery visuals utilizing Figma, employing a slideshow technique to seamlessly transition between images. We decided on iterating through five charging progressions: Empty Battery, ¼ Charged Battery, ½ Charged battery, ¾ charged battery, and a fully charged battery. This method not only made our animations more dynamic but also ensured that they were integrated smoothly into the project's overall design, enhancing the visual appeal and engagement of our digital platform.

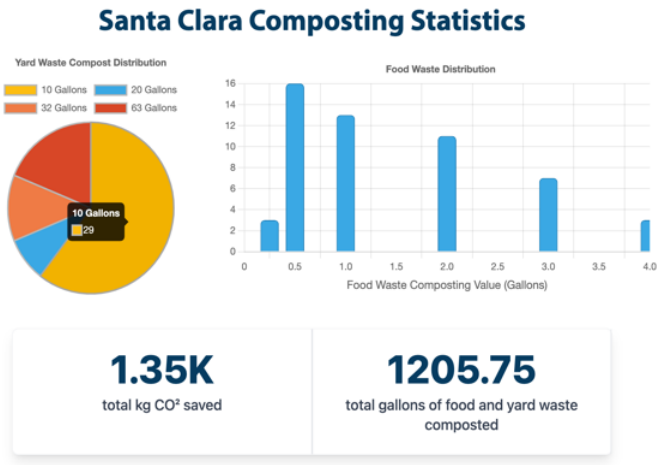

Figure 5: Live Data Display

Live Data Feature

We introduced a live data feature by leveraging the API key provided by the previous team, enabling Victoria to input values that align with the Qualtrics survey results. The process involves Victoria using Excel commands to enter these values into a Google Form seen in Figure 6, which then populates a Google Sheet. Our script automatically fetches the latest entry from this sheet, displaying the updated data on our website. This live data integration, initiated around February 26th, posed the project's most significant challenge, necessitating several design iterations. Initially, we aimed to utilize the prior team's data visualization methods, which included a histogram to represent the total composting activity (yard and food waste combined) of individual. However, compatibility issues with the Qualtrics Database emerged, notably the inability to match specific entries of food and yard waste to individual respondents. Consequently, we opted to develop two separate charts as seen in Figure 5, each dedicated to showcasing either food waste or yard waste data exclusively, ensuring clarity and accuracy in our live data presentation.

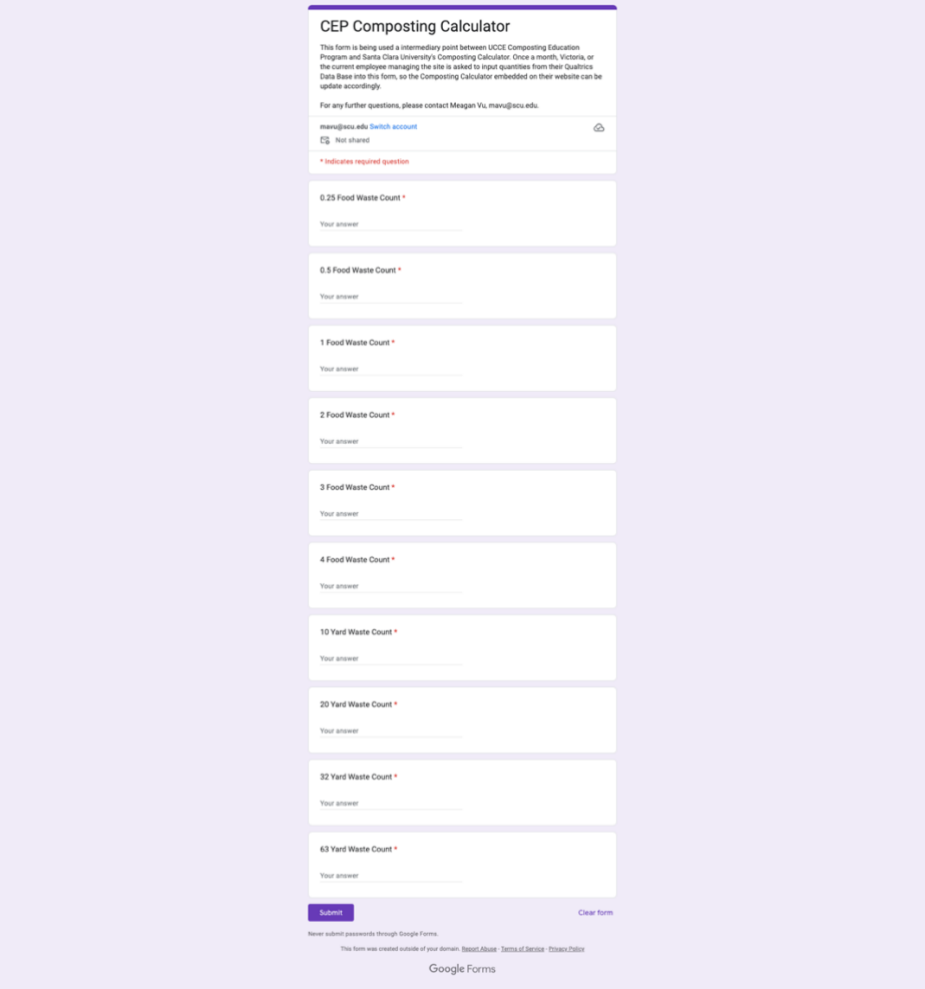

Figure 6: Google Form for Live Data Feature

"How to Track Accurately' Page

This page, designed with an infographic layout, breaks down the composting process into digestible segments, each accompanied by visual aids. The format is responsive, ensuring accessibility across various devices, and emphasizes visual learning to improve user comprehension of composting quantities and environmental impact. Moreover, all images utilized on the site are sourced from public domain sites, ensuring compliance with copyright regulations.

Our solution of creating a more visual page with engaging information went well. We were able to achieve all the goals we had for the site, which included adding visual aids for context.

Our aid ended up relating the average amount of compost that a Santa Clara resident should be producing to the common organic trash can of Santa Clara. This was so that residents could now visualize and have a set goal to compost. Overall, we also were able to design our website in an infographic-like style which makes all the information easier to read and more engaging.

Figure 7: Visual aids for How to Track Accurately

For the implementation of the site all the code was done in HTML and CSS. The formatting was one of the hardest parts of the site because making the site responsive for mobile took some reworking of the code. The site was primarily made up of articles and sections, formatting tags in HTML, that represent the different boxes of the infographic however, when making the site responsive, the code had to be reworked and now is written primarily as two main divs that can be better manipulated to fit differing screen sizes.

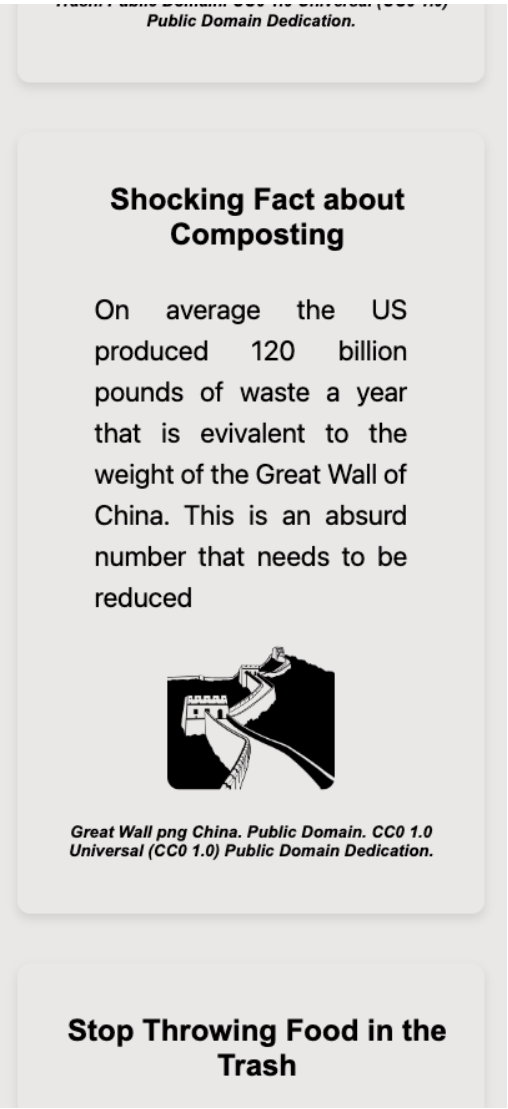

Figure 8: Display of page on an iPhone

3.2 Implementation and Testing

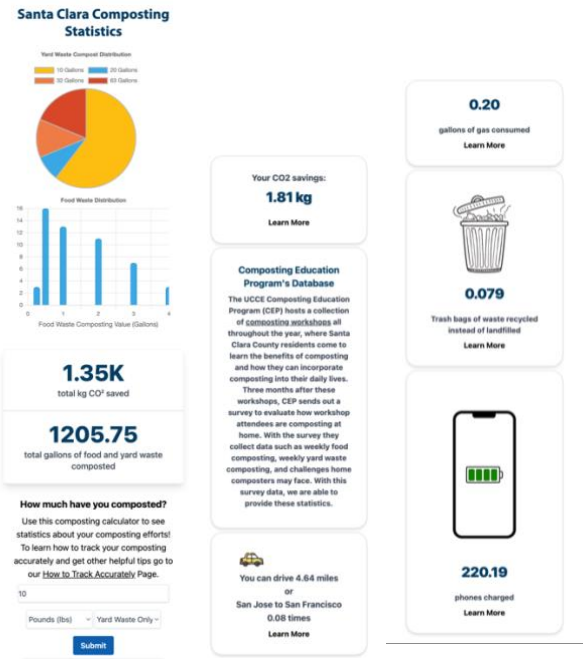

Figure 9: Mobile Layout

To ensure the smoothest integration of the website between different devices we had to do testing for each display size. For screen sizes equivalent to or larger than an iPad, we stuck to the same format as shown previously. This meant having boxes stack on top of and next to each other as the spaced allowed for it. For smaller devices such as an iPhone or Android, we had to switch the positioning of the boxes, stacking all the containers on top of one another inside of having some side by side as seen in Figure 9.

Additionally, we had to test that the Google Sheets API dynamically updates charts with each new entry or removal, ensuring it always pulls data from the latest entry. There's no fixed section it looks at; rather, it adapts to changes, pulling from the most recent data. Deletion of the newest row prompts the sheet to revert to the previous entry for accurate updates. With all this in mind, we've successfully implemented and manually tested all features from the initial website mockup, except for automating the live data feature. Currently, Victoria, our UCCE

representative, manually inputs data counts into a Google Form due to privacy concerns preventing direct access to UCCE's database via API. To bridge this gap, we've integrated a Google Sheet as a middleman between the Qualtrics database and our script.

We believe that the interactive elements and dynamic visuals significantly increased user engagement. The detailed pop-up descriptions and real-time data representation provided a deeper educational experience, helping users understand the tangible effects of their composting activities and the "How to Track Accurately" page effectively guides users in accurate compost reporting, contributing to the tool's overall educational goal.

Budget

The project was allocated a budget of $100. However, the utilization of Google API's and public domain images resulted in no expenditures, demonstrating efficient resource management.

4. Conclusion and Recommendations

4.1 Conclusion

In conclusion, our collaborating project with UCCE is a Composting Education Program that aims to encourage Santa Clara County residents to compost their waste more actively by providing a calculation tool to convert their composting waste to other uses. The project itself has two different pages, which are the “How to Track Accurately” page and the calculator tool. Although we were facing multiple challenges, including limited access to the previous back-end data, a constrained timeframe, and limited human resources, the project still accomplished its major objectives. We have successfully updated to include meaningful visual representations of our tool’s output by adding dynamic animations and contextual pop-up descriptions window. Such meaningful visual representation will make the website more appealing to engage users and provide them with a clear understanding of the impact of their composting efforts on reducing

greenhouse gas emissions. Furthermore, the “How to Track Accurately” page was designed to teach users how to accurately report their composting activities, meanwhile enhancing the accuracy and reliability of our data collection.

4.2 Recommendations

If another group were to continue our project, they could focus on several key areas to enhance its impact and reach. Firstly, they could prioritize enhancing data integration by exploring avenues to access and integrate more extensive and varied composting data, potentially through partnerships with local waste management services or community-based composting initiatives. Secondly, implementing additional user engagement strategies such as introducing gamification elements, regular updates on composting impact stories, and interactive community challenges could help increase user engagement and retention. Additionally, expanding educational content by further developing the "How to Track Accurately" page with comprehensive materials like video tutorials, case studies, and expert tips on best composting practices could provide users with valuable resources. Lastly, ensuring accessibility and inclusivity by making sure the tool and its data remain accessible to all users, including those with disabilities, could involve adding features on the website to accommodate a larger diversity of users. These efforts would contribute to the continued success and effectiveness of the project in promoting sustainable composting practices.

Bibliography

Google Cloud (2023) Compute Engine. Google, https://cloud.google.com/compute/#pricing Accessed 6 December 2023

Google Cloud (2023, October 30). Service accounts overview. Google, https://cloud.google.com/iam/docs/service-account-overview Accessed 2 Nov.2023

PyPI (2023, November 7). google-api-python-client 2.107.0. https://pypi.org/project/google-api-python-client/ Accessed 14 Nov.2023

Regents of the University of California. (2023). Composting Education Program. UCCE Santa Clara County; UCANR. https://cesantaclara.ucanr.edu/Home_Composting_Education/. Accessed 24 Sep. 2023.

Shydlovski, M. (2023, September 19). UC Cooperative Extension Composting Education Program. September 19, 2023. https://drive.google.com/file/d/1q8VEODud2NH02JbyXphfWiVui2oSjKdY/view. Accessed 24 Sep. 2023.

University of California Division of Agriculture and Natural Resources. (2023). Martial Cottle Park Demonstration Garden and Community Education Center. UC Master Gardeners, Santa Clara County, CA; UCANR. https://mgsantaclara.ucanr.edu/demonstration-gardens/martial-cottle-park/. Accessed 24 Sep. 2023.

https://drive.google.com/file/d/1wKkLs8ECmOUw7WXP6GrLhDBunm-MfN_2/view

https://drive.google.com/file/d/1iu18Kdst8toZInmCbJT17aROHxnldwUF/view

WebDevSimplified. (n.d.). index.html. Vanilla-JavaScript-Modal. https://github.com/WebDevSimplified/Vanilla-JavaScript-Modal/blob/master/index.html

Stack Overflow. (2018, January 15). How do animation without keyframes but with transition? Stack Overflow. https://stackoverflow.com/questions/49140448/how-do-animation-without-keyframes-but-with-transition

Footprint Calculator. (n.d.). Retrieved from https://www.footprintcalculator.org/home/en

Flaticon. Car Icon [Icon]. Retrieved from https://www.flaticon.com/free-icon/car_3721600

Vecteezy. Trash Can Vector Illustration in Doodle Drawing Style [Vector illustration]. Retrieved from https://www.vecteezy.com/vector-art/20906752-trash-can-vector-illustration-in-doodle-drawing-style

UCRRA. (2021, March 30). *Waste Reduction - UCRRA*. UCRRA - Grow Ulster Green. https://ucrra.org/waste-recycling/waste-reduction/#:~:text=The%20average%20American%20generates%204.4,waste)%20per%20person%20per%20day.

How many planets does it take to sustain your lifestyle? (n.d.). https://www.footprintcalculator.org/home/en