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Sustainability Action Tracker

Gladys Hilerio

Isabelle Termaat

Patricia Ornelas Jauregui

SANTA CLARA UNIVERSITY

DEPARTMENT OF COMPUTER ENGINEERING

Date: June 16, 2020

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Gladys Hilerio
Isabelle Termaat
Patricia Ornelas Jauregui

ENTITLED

Sustainability Action Tracker

BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF SCIENCE IN COMPUTER SCIENCE AND ENGINEERING

Thesis Advisor

DocuSigned by:
Nam Ling
96CE94A1A83A48A...

Department Chair

Sustainability Action Tracker

by

Gladys Hilerio
Isabelle Termaat
Patricia Ornelas Jauregui

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Gladys Hilerio
Isabelle Termaat
Patricia Ornelas Jauregui

Department of Computer Engineering
Santa Clara University
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ABSTRACT

The Center for Sustainability at Santa Clara University is actively looking for ways to involve students in sustainable actions and accountability. With our help, they would like to create a site where students and faculty may track their sustainable behavior. This site will provide users with all the information they need to live a sustainable life, and include milestones in the form of progress bars and badges. The Center for Sustainability will be able to collect the data from this site to evaluate the progress of our university as well as the success of the site. Our motivation for this project is the urgency around raising awareness about the critical state of the environment. This project is necessary for the University to track their progress with their mission of creating a 'more just and sustainable world'.

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Chapter 1

Introduction

1.1 Motivation

Climate change is ruining our world, killing it slowly every single day. The Center for Sustainability at Santa Clara University is committed to helping the community at SCU make a change and reduce their carbon footprint through a new strategic action plan developed by different experts around campus. The goal is to create a mentality of sustainability on campus and provide the knowledge and education to faculty, staff and students across SCU to live a more sustainable life. However, the center does not have an easily accessible way of getting this information to the community on campus. If a student or faculty or staff member on campus would like to figure out how they could take action and reduce their carbon footprint specifically at Santa Clara University they would not be able to currently. There is no way of tracking a community member's progress except through what is reported in person at the Center for Sustainability. Because of this, students and members of the community may find it difficult to participate in this new strategic action plan.

1.2 Solution

Our solution was to create a mobile and web application where students can track their progress towards sustainability. Working closely with the Center for Sustainability, we made an incentive-based program that allows students to discover ways they can live a more environmentally friendly life. This software includes badges for completion of sustainability milestones and a smart action tracker quiz. It serves to inform the student body by including the strategic plan devised by the Center for Sustainability as well as an interface for students to ask questions and interact with employees at the Center. This software will also collect and display data on the overall contribution and impact of the participants.

We are building this project for the Center for Sustainability and will be used by the students and faculty at Santa Clara University. As the user base of this project grows, the Center for Sustainability will have a stronger presence at SCU. This can help the center grow and gain more support from students, faculty, and staff across campus. We

evaluated our solution based on its fulfillment of the Center for Sustainability's needs by working closely to ensure that our project aligns with their vision.

The intended users are SCU community members. A user of this application can to login using their Santa Clara University login information. Once logged into the system, the user is able to take a quiz on the action tracker to see what specific areas they need to work on. Users can also see what badges they have completed and which they have left to complete.

The goal of this project is to incentivize and reward actions that promote sustainability. Our motivation is the urgency around raising awareness about the critical state of the environment. Changes in daily habits can slow down climate change, so we provided students at SCU with the knowledge of how they can reduce their carbon footprint.

Chapter 2

Requirements

2.1 Functional

- Critical
  - Provide users with sustainable actions quiz
  - Award badges for sustainable tasks
  - Display completed and incomplete badges
  - Allow administrators to edit quiz
- Recommended
  - Provide space for users to ask questions to the staff of the Center for Sustainability
  - Provide option for users to join as a team or department
- Suggested
  - Embed social media feed for people to use hashtags and make posts about Sustainable Behavior Action Tracker

2.2 Non-Functional

- Create an interactive and friendly interface to encourage students and faculty to use the action tracker
- Incentivize sustainable actions
- Inform students on their environmental impact and the strategic plan devised by the Center for Sustainability
- Allow students to discover new ways to be sustainable
- Provide the staff of the Center for Sustainability with a useful platform to evaluate the overall success of the sustainability tracker

2.3 Design Constraints

- Complete project within before the senior design conference in May
- Use Google Single Sign on for logging in
- Only include information provided and approved by the Center for Sustainability
- Mobile and web friendly

Chapter 3

Use Cases

3.1 The User

The user for this software is a student or faculty member of Santa Clara University who is interested in sustainability. The user can take a quiz about their habits that will provide a personalized sustainable action plan. They will then be able to enter and check their progress on their personalized action plan. Upon completion of sustainable milestones, users will receive badges. The badges will include information about the impact of the actions involved.

3.2 The Administrator

The administrator is the staff of the Center for Sustainability. From their platform, they can edit the personalized quiz for the action tracker. They can add and remove existing questions as well. They can input the impact and time associated with each new badge. All badges are saved for later use, and the administrator chooses which ones to enable.

These use cases are summarized in Figure 3.1.

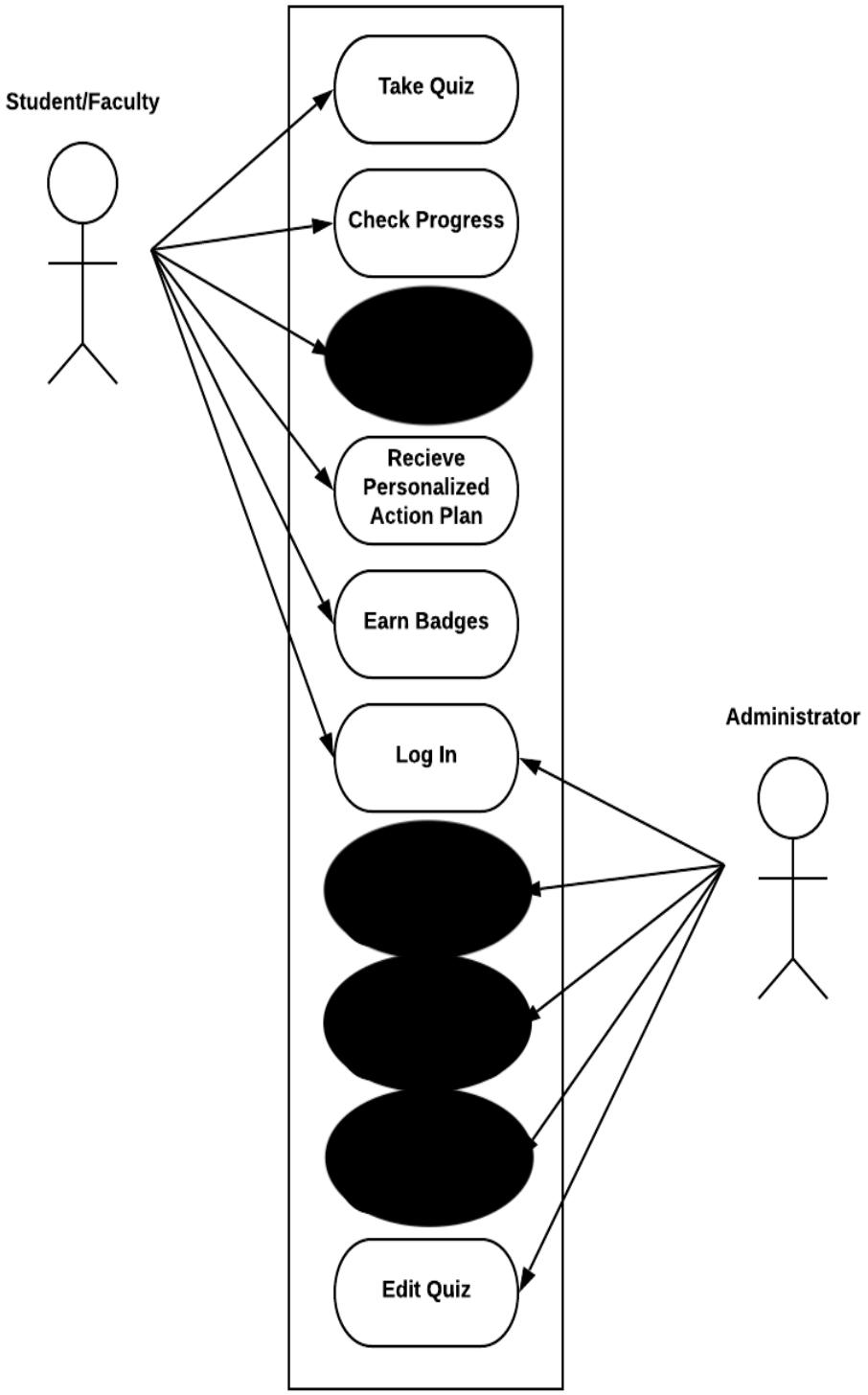

Figure 3.1: A Use Case diagram which shows the roles and abilities of the Administrator and the User. Some scenarios have been blocked out from requirement changes.

Chapter 4

Activity Diagrams

Our activity diagrams show the various tasks users will complete throughout their experience using the website.

4.1 Admin Activity Diagram

Figure 4.1 shows how admins can use the website. The three main uses for admin is that they can add a new badge, view the current website, and edit the quiz so that users can have different questions. If they would like to delete or add a badge to the quiz they can.

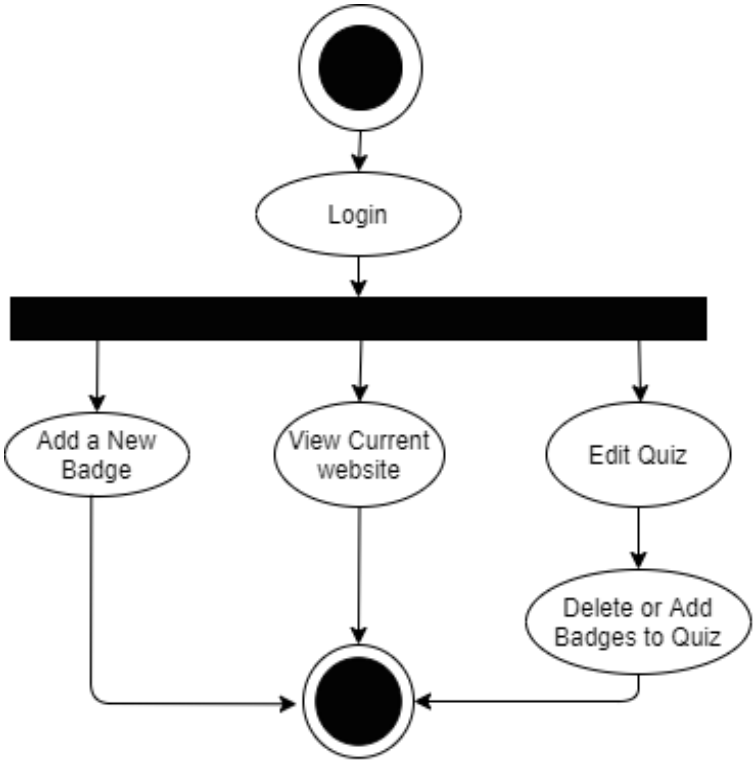

Figure 4.1: Admin Activity Diagram

4.2 Participant Activity Diagram

Figure 4.2 shows how participants can use the website. After logging in, they can view the quiz, view their badges, or check out the strategic plan. From there they can see the work they need to do to complete more badges.

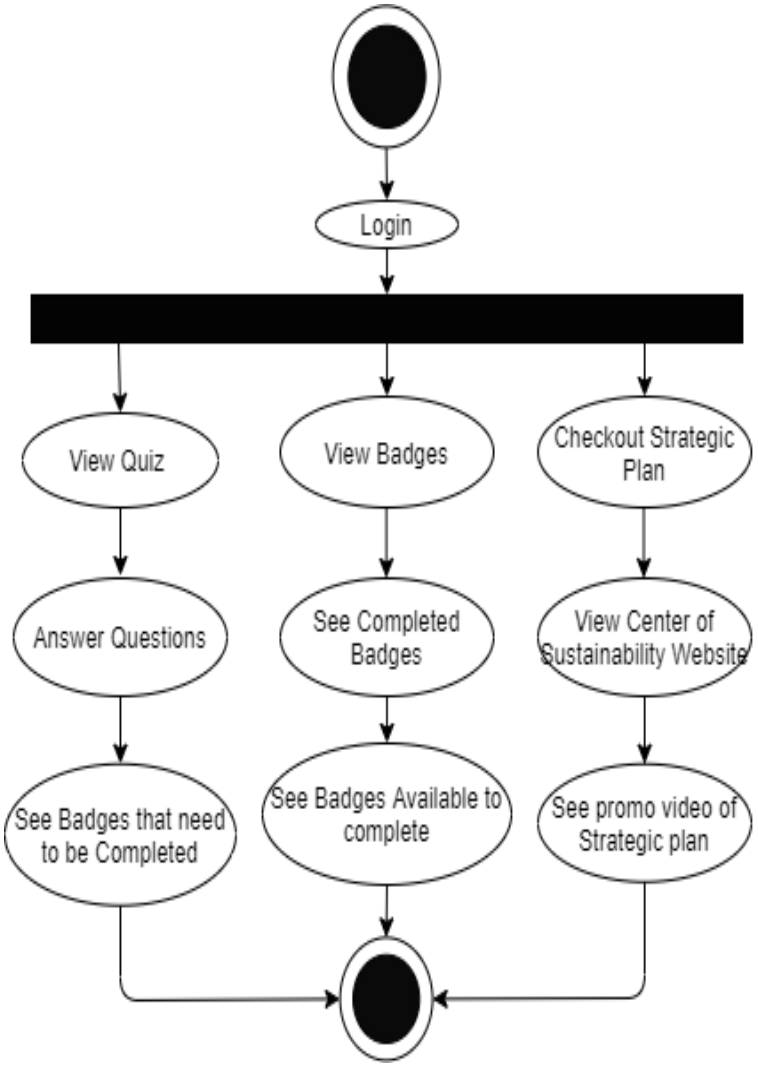

Figure 4.2: Participant Activity Diagram

Chapter 5

Conceptual Model

5.1 Home Page

Figure 5.1 is the homepage of our website. It is a carousel that shows the different options of what to do on the website.

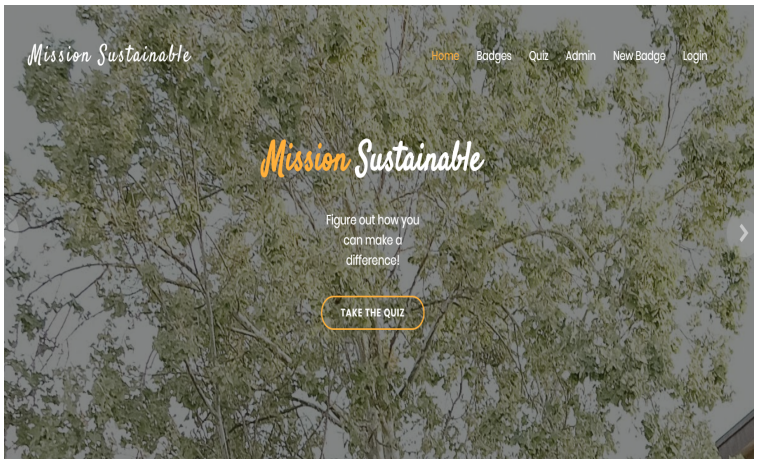

Figure 5.1: Conceptual Model

5.2 Dashboard Page

Figure 5.2 is the bottom half of our home page. It is the dashboard where a participant can click to see their badges, all the available badges and can also check out the Sustainability Action Plan.

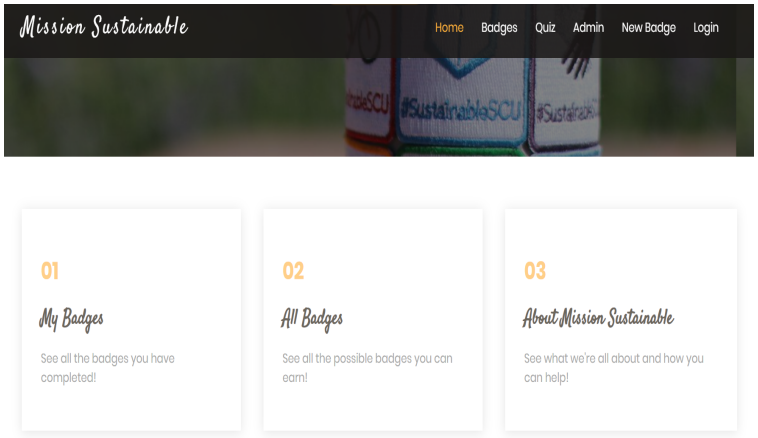

Figure 5.2: Conceptual Model

5.3 Quiz

Figure 5.3 is an example of what the quiz page looks like. Participants will be able to take a quiz that determines where they are doing well in terms of sustainability on campus and what areas they need to work on. From there it will tell them what badges they need to work on.

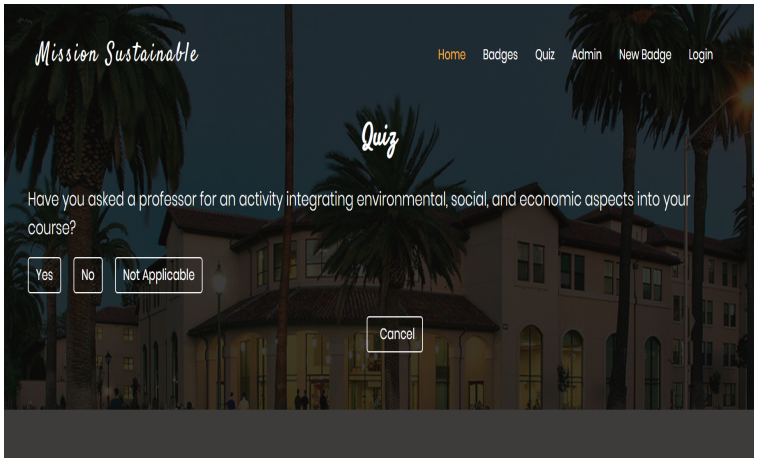

Figure 5.3: Conceptual Model

5.4 Login

Figure 5.4 is an example of what the login page looks like. If students do not have an account, they can register with their SCU emails.

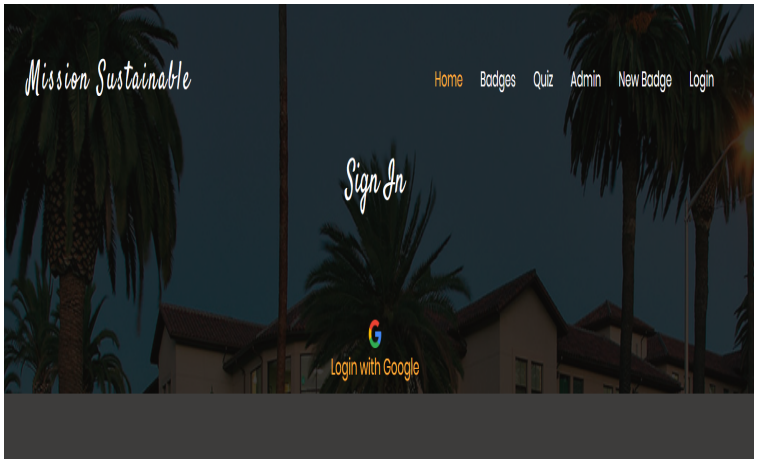

Figure 5.4: Conceptual Model

5.5 Badges Page

Figure 5.5 is what the badges page looks like for participants. They can see how many badges they have completed and how many they have left to complete.

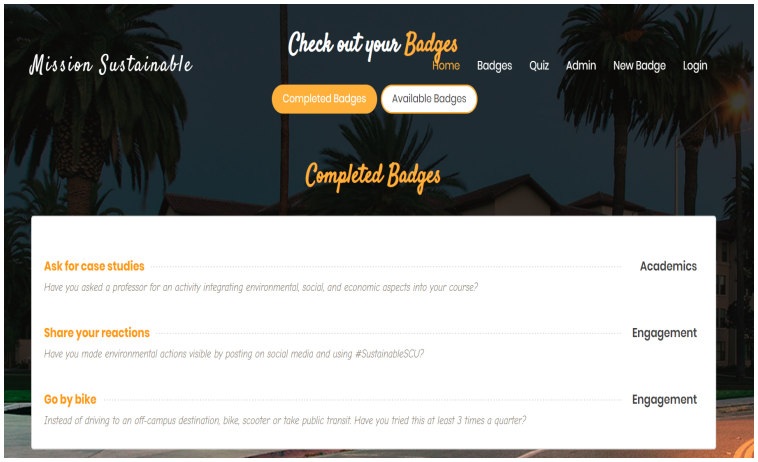

Figure 5.5: Conceptual Model

5.6 New Badges Page

Figure 5.6 is where the admin can go and create a new badge if they would like to add it to the website as an available badge for students to complete.

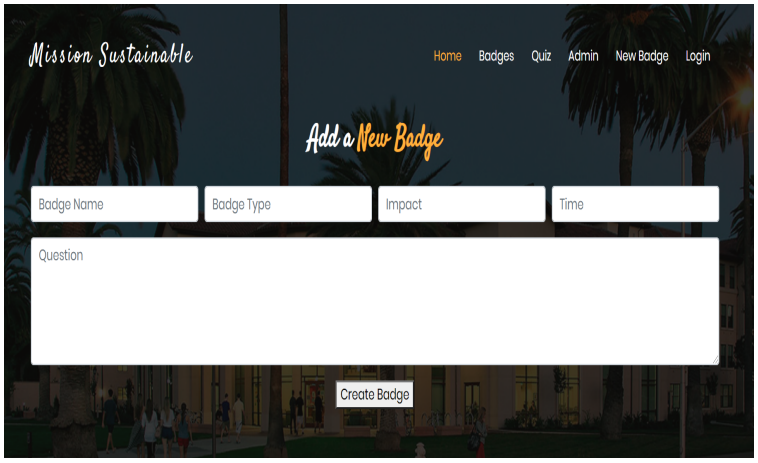

Figure 5.6: Conceptual Model

5.7 Badges Page

Figure 5.5 is where the administrator can go if they would like to change the quiz in anyway. They can add a new badge to the quiz or remove badges from the quiz.

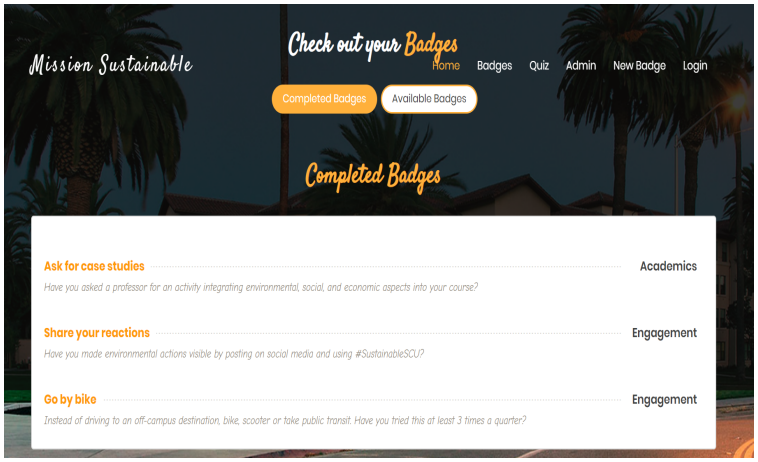

Figure 5.7: Conceptual Model

Chapter 6

Technologies Used

- GitHub
- MySQLWorkbench
- Angular JavaScript
- Bootstrap
- .NET Core 3.1

We used the above technologies based on the amount and quality of documentation they had and their compatibility with other technologies. For version control, we used GitHub. For our database, we used Amazon RDS DB and MySQLWorkbench. For our frontend, we used Angular JavaScript and Bootstrap. Angular JS allowed us to interact with the backend smoothly. Bootstrap made it easy to make our website responsive to different screen sizes. It also made our frontend have one sleek and smooth user interface design. For our backend, we used .NET Core 3.1. This framework makes it easy to write clean and easy-to-understand code. When we had troubles with our database, we were able to overcome those challenges because of the strong documentation for .NET Core 3.1 that helped us create a mock database. These technologies were also helpful for making each of our individual components modular. Once we had to work remotely, modularity became very useful so that we would be less interdependent. These were not the technologies we had originally intended to use, but we adapted as we met challenges connecting our individual parts.

Chapter 7

Design Rationale

7.0.1 Frontend

We aimed for a familiar look to that of the Center of Sustainability's current website. Our goals for the design of the web app are for it to be:

- Intuitive
- Easy to follow
- Visually pleasing

To accomplish these goals, we used colors to show what is clickable and to emphasize or draw attention to something. To encourage more users to use our web application, we focused on making the interface user-friendly and mobile responsive. We used colors and pictures that the Center for Sustainability uses so that it was clear that this web application is theirs. To be able to integrate well with the backend, we used Angular CLI. This organized our frontend as well into modules that were easy to compile and debug.

7.0.2 Backend

In terms of design of the backend, we designed it in a way that separated objects and endpoints depending on how the frontend would need the information. For example, we created a "Badge" object containing all of the information of a badge (i.e. name, type, impact, question) as attributes. Similarly, we had a "User" object that was associated with a user's email address, a boolean to determine if they were an admin or not, and the list of their badges. Our endpoints were also grouped depending on their functions: quiz, administrative operations, user, and badges. Not only was this helpful to structure our database and frontend, but it also served to make our code readable and modular.

7.0.3 Database

For our design of the database, we initially planned on creating and storing the actual database through Azure and then using MySQL to code the tables. After we ran into budgetary issues with Azure, we began to use the Relational

Database platform on Amazon Web Services along with MySQL Workbench. We organized our data tables based on the objects that we had created in our code - the badges and the users. We had storing tables for each object and their attributes, that would be filled in as users come and interact with our platform. We also had Master tables that contained data that would feed into the site to populate the page. Ultimately, any database has a cost associated with it and due to Covid-19 our budget was completely cut, so we ended up using local data and hosting our website locally. This will be something left to complete for the next group who picks up this project once funding is restored.

Chapter 8

Architectural Diagram

8.1 Reasons For Chosen Architecture

We chose a client-server architecture because it provides centralized communication. Our project will require transferring data securely from users to a database through an API hosted on Azure. The REST server will have API calls that clients can access through HTTP requests. We believe this model fits our project given our expected use cases. Lastly, this model is the most appropriate for our team based on our strengths. Gladys excels in frontend development; Patricia has significant experience with backend development; and Isabelle is the most familiar with databases. This client-server architecture conveniently separates concerns according to our specialized skills.

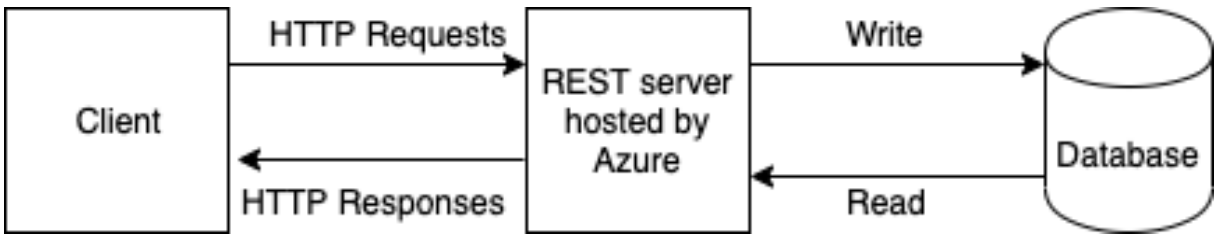

Figure 8.1: Client-Server Architecture Diagram

Chapter 9

Test Plan

9.1 Developer Testing

To test our software, we implemented a variety of methods. From the developer side, these methods can generally be broken down into initial testing and final testing. Initially we checked for blatant errors and basic functionality. For our final testing we involve more edge cases to thoroughly test every possible outcome.

9.1.1 Initial Testing

We constantly unit tested, so that we could incrementally guarantee that our software was becoming more stable. We looked through each others code to spot errors that the programmer may not have seen. We were able to do this by sharing a common repository on GitHub where we shared all of our code. After basic errors were fixed, we applied validation and verification testing to ensure that the code was functioning according to our requirements and outcomes.

9.1.2 Final Testing

During the final phases of testing, we tested more edge cases so that we could account for potential but unlikely breaks in our code. We tested using boundary values, exercising each line of code, and inputting special/unexpected values. We had split our project into three main components - the front end, the back end and the database. In our final testing, we consolidated and connected all three pieces and tested that they functioned appropriately once linked together.

9.2 Client Testing

Every week, the staff of the Center for Sustainability has a team meeting. We occasionally used this as an opportunity for the staff members to test our software and provide feedback. This allowed us to make sure that our code aligned with their desires before we made too much progress in the wrong direction. We had zoom meetings with the Center for Sustainability once the stay at home order began. We were able to share our screens to do a walk through demo with our client. It is important to have the client test the software because they are the ones that ultimately have to

accept the project.

Chapter 10

Risk Analysis

In any software project there are a series of risks that must be taken in order to develop a finished project. After careful deliberation we had determined what risks we anticipated and how we planned on mitigating them. We found that we did, in fact, encounter every risk we had predicted. This project became especially difficult with the changes that came from COVID-19. Through all of our hurdles we were able to complete our project and learn more than we would have under normal circumstances about working as engineers through difficult and stressful times.

These risks are summarized in Figure 10.1.

RISK NAME	CONSEQUENCES	PROBABILITY	SEVERITY	IMPACT	MITIGATION
Bugs and Security Issues	Personal information leaked System fails	0.4	8	3.2	Thoroughly test the code Use resources from the school for better security
Lack of Knowledge to Complete Tasks	Time lost learning new software Time lost scheduling help from professors	0.8	3	2.4	Use familiar technologies Plan around the knowledge and strengths of the group
Time Constraints and Deadlines	Inability to implement all desired features Lower quality product	0.8	2	1.6	Create a detailed development timeline Check progress frequently
Communication Issues Between Developers & Client	Wasted time Lack of guidance and expectations	0.2	8	1.6	Schedule frequent meetings to showcase work and progress
Burnout	Lack of motivation Decreased quality of work Stress	0.5	3	1.5	Don’t follow behind the timeline Set measurable goals

Table 10.1: A Risk Analysis chart which shows the potential risks and their possible solutions.

Chapter 11

Challenges Faced and Lessons Learned

There were many challenges throughout this whole process especially because of COVID-19 and the issues surrounding having to work remotely. Also, our client had a few budget changes as well as expectations for what they wanted in our project which caused us to have to shift our project around as well as requirements for ourselves. From this experience, we learned how to make the most out of our weekly virtual meetings in order to stay on track with our timeline. Much like in the industry, we began every meeting with a check-in, then a progress check of what we had accomplished and what we were stuck on. We ended every meeting with action items to complete by the next meeting. Working remotely taught us the importance of e-communication as well as good documentation and style for our own code.

In terms of technical challenges, we faced issues trying to connect our individual parts because we became very specialized in our own component. To connect the backend to the frontend, we ended up having to run two separate servers and connect them. We were unable to connect the backend to the database, so we created a local database instead. From these technical challenges, we learned how to scope the Internet for solutions, utilize StackOverflow and Youtube to learn from others, and find documentation that served as tutorials for what we needed. These are important skills that we will carry on to our work as software engineers in the future.

Chapter 12

Societal Issues

Our project aims to promote sustainability. It is beneficial to all people and our environment to raise awareness about individual actions that can reduce each person's contribution to climate change. We have considered how this web application may mislead people to believe that individual actions like the ones listed on the quiz can completely solve the issue of climate change. It is our hope that our project gets people thinking of their own impact on the environment, but we recognize that climate change is a global issue that must be tackled from multiple fronts.

We want students, faculty and staff at Santa Clara University to be able to assess their daily behaviors and see how making small changes in their habits can be positive for the environment. If all students worked towards trying to earn badges, then Santa Clara would be an overall much more sustainable university. One individual cannot make a large impact, but a large amount of individuals can.

Chapter 13

Conclusion

13.0.1 Summary

For our Senior Design project, we created a user-friendly sustainability action tracker web application for the Center for Sustainability. Users can gauge their sustainability efforts by taking a quiz to see how sustainable they are being. Our users are encouraged to engage with Santa Clara University's strategic action plan by completing sustainable tasks. Users are rewarded for environmentally friendly actions with virtual badges.

13.0.2 Work Review

Advantages

- User Interface
  - Intuitive
  - Easy to follow
  - Visually pleasing
- Implementation
  - Used tools that are easy to pick up for the next people who will take on this project. The software we used also has great documentation
  - Readable and modular code. Separating concerns makes the code easier to read, which we did intentionally so that future contributors smoothly transition into the project
  - Error handling in the API endpoints

Disadvantages

- User has to retake the quiz every time they complete a new badge
- There is no interface to manage admin users

13.0.3 Future Work

- Deploy website so that it is live
- Once the website is live, it will require security on the API endpoints so that they are not reachable externally
- Connect a database, instead of relying on the local mock repository
- Create a dashboard for admin users to see data about website usage and users' badge progress
- Allow admin users to update information on the website