



# GigaCharge

## *The Future of EV Charging*

### **PREPARED FOR**

ICS 466: Design for Mobile Devices

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# EXECUTIVE SUMMARY

Have you ever been stuck waiting for an electric car charging port?

Many people take a ‘set and forget’ approach to charging their E-car. Leaving a phone number on your dash leads to a variety of privacy issues and potential for private information leaks. Say goodbye to the past with GigaCharge, Our app will introduce a private messaging system where you can contact other drivers on the app. Simply put your personalized QR code on the dash before you leave the charging station. Users will gain points for swapping as an incentive to come down and move their car. With these points, users can redeem their points for gift cards, charging time, or simply swap their way up to the top of the leaderboard. Provide a real-time map showing available charging spots, so users know where to park next and have the ability to join a queue and save your spot in the swapping chain.

At GigaCharge, we are driven by a passion for creating innovative solutions and meaningful user experiences for electric vehicle users. Our approach begins with asking the right questions, engaging with users, and understanding their needs, challenges, and expectations.

By gathering actionable feedback from real-world testers, we identify areas for refinement and opportunities to enhance the GigaCharge experience. This feedback loop allows us to stay responsive, improve functionality, and introduce features that truly add value. Core components like the UI framework, leaderboard system, messaging system, firebase authentication, and dynamic maps have been implemented. The Electric Car Charging API integration is mocked up and is something we will attempt in the future.

Every feature, from private messaging to real-time charging station maps, is informed by this iterative process. Our goal is to deliver a secure, user-friendly platform for the UH community, facilitating seamless spot-swapping and setting a new standard for charging station coordination and community engagement.

**At GigaCharge, we’re not just building an app; we’re building a better experience—one informed by collaboration, feedback, and a deep understanding of our users.**



# Project Overview

The GigaCharge app aims to revolutionize the electric vehicle charging experience by introducing a community driven system where drivers can earn rewards for cooperating at charging stations. The main objectives of this project are to enhance efficiency at charging stations, promote a community driven ecosystem, reward participation, and build trust and accountability. By optimizing the usage of charging spots by allowing users to swap spots with each other in an organized and incentivized manner, it reduces waiting time and congestion around electric car charging spots primarily at the University of Hawaii at Manoa.

This app will also help facilitate communication between drivers through a private messaging system that protects personal information which will help to promote a community driven ecosystem. Additionally, by creating a gamified experience where users earn points for swapping spots and helping fellow drivers, it allows drivers to be able to redeem these points for rewards. Since the experience will be gamified, the introduction of a feedback system will be in place to ensure a fair and transparent swapping process, encouraging trust and collaboration among users of the GigaCharge app.

Focused initially on public charging stations at the University of Hawaii at Manoa, GigaCharge has the potential to expand to larger geographical areas and broader EV networks. Key features include QR code and license plate-based messaging, real-time GPS-enabled charging spot availability, a queue management system, and a point-based rewards system. To maintain fairness, the app integrates anti-abuse mechanisms such as randomized one time passcodes and location verification. GigaCharge provides an innovative, user-friendly platform that enhances the EV charging experience and supports the growing community of electric vehicle drivers.

The app will include a wide range of features such as QR code/License plate messaging, real time charging availability, charging spot queue management, point based rewards system, anti abuse mechanisms, and a feedback system.

## QR Code Messaging

With QR code messaging, it allows users to communicate privately by scanning personalized QR codes displayed on other drivers' dashboards which will ensure privacy as it will not be sharing any personal information such as phone numbers. Additionally, users will not be able to send custom messages as the integration of preset messages will be used in order to maintain clear and safe communication between users. This solves the problem of the current solution which is to leave a phone number on the dash. Through testing we will find a middle ground between preselected and freeform messaging. If a QR code is unavailable, users will also be able to input a license plate which will not violate privacy of users as a license plate number is visible to everyone.

## **Real time charging availability/Queue system**

There is also the implementation of a live map which will display available charging spots which will help users plan whether to park or wait. The markers will be color coded to let people know the availability of the charging station. Green will mean that currently no one is using the station. Yellow will mean there is one person currently charging so you can potentially message them. Red means multiple users are waiting for this charging station.

In addition to this, a virtual queue that drivers part of the GigaCharge system can join has been implemented. Drivers of the GigaCharge system will be able to save their spot in the charging chain which will optimize the flow of cars at stations and create a more coordinated electric car charging experience. There are two main ways to join the queue for a parking spot, the first being requesting a parking spot swap but getting rejected. Once a user gets rejected from a parking spot swap, they are added to the queue where they will wait for a parking spot to be available. The second way to join the queue would be if there is more than one person already in queue for a parking spot, the user will automatically be sent to the queue without having to send a request to swap. There may be concerns regarding misuse, however, the app incorporates features such as location verification, randomized QR codes, and cooldowns between point gains which will help ensure a fair system.

## **Point Based Incentives**

Users of the app will be able to earn points called GigaVolts by coming down to the charging station and allowing other drivers to charge. These points will be used for a virtual leaderboard so users can compete to see who can be the best swapper. Charging company funds can be used to fund the reward system where users can redeem their points for something of monetary value such as charging time or gift cards. At this point each GigaVolt is intended to be worth 1 cent, but future testing might lead us to a better conversion rate.

## **Scenario**

Intended operations for GigaCharge include user setup, charging spot swapping, gamification, real time charging management, and privacy. For user setup, upon registration, users will receive a personalized QR code that they can display on their dashboard while at a charging station. This allows other users to scan it and initiate communication without revealing personal contact details. When it comes to charging spot swapping, when a user is ready to leave their charging spot they can notify the app, allowing others in the queue to swap places. If a user physically moves their car to accommodate another driver, they can earn extra points which incentivizes cooperation. Since the app tracks users' swapping activity, points are awarded based on effort (e.g., more points for physically moving a vehicle), and users can track their ranking on leaderboards. Those who frequently swap earn more points which can be redeemed for rewards, such as gift cards or other perks.

This project is particularly valuable for high-demand charging locations like university campuses. At the University of Hawaii parking structure, for instance, where EV charging demand is high, GigaCharge will reduce congestion, allow better utilization of limited resources, and reward users for

contributing to an efficient and cooperative charging environment. The system could potentially expand to other public charging networks, creating a broad user base of EV drivers who benefit from a community-first approach to charging.

## 2. Obstacles

The GigaCharge app does have potential risks, primarily related to user experience, security, and system integrity, which must be addressed. A key risk involves misuse or cheating within the rewards system. Users may attempt to exploit the point-based swapping mechanism by claiming to move their cars without actually doing so or sharing QR codes inappropriately. To mitigate this, the app will require location tracking to verify vehicle movement, and QR codes will be randomized frequently, similar to how some apps such as Whole Foods prevent static QR code sharing. This will help to ensure that users must be physically present at the charging station to earn points, reducing the risk of fraudulent activity.

Privacy concerns are also a significant risk, particularly around the use of personal data and location tracking. Users may be apprehensive about sharing their location or communicating with strangers. To address this, the app will utilize a private messaging system based on QR codes, or alternatively license plate numbers, rather than phone numbers. This will ensure that no personal contact details are shared. Additionally, all location data will be used solely for verifying point gains and will not be stored or shared with third parties.

Additionally, feedback mechanisms will be implemented which will allow users to report issues or rate their swapping experience, helping to improve the app performance and maintain community trust.

## 3. Technical specifications

The GigaCharge app faces several technical obstacles, particularly around integrating systems for real-time data, user authentication, and location tracking. Real-time charging spot availability requires reliable API connections with charging networks, which may provide inconsistent data. Mitigation involves using robust APIs, caching, and redundancy to ensure accuracy.

QR code-based user authentication must prevent misuse, like sharing static codes. This can be addressed by using time-based QR codes that expire quickly, ensuring secure user interactions. Location tracking is essential for verifying vehicle movement but must balance accuracy with battery efficiency. A combination of GPS and geofencing, along with background services, can ensure precise tracking without excessive battery drain.

## 4. Market and Demographics

GigaCharge targets the growing market of electric vehicle owners, particularly those who rely on public charging stations. Its primary demographic includes individuals ages 18-54 who are tech savvy, environmentally conscious, and park at the Zone 20 parking structure. Students and staff will ideally use GigaCharge due to the frequent competition for limited charging spots on campus. These users often face long waits for charging which makes GigaCharge's spot swapping feature and real time availability updates very appealing.

## 5. Hardware

The GigaCharge app, designed for Dart, Flutter, and the AndroidSDK, has specific hardware needs to ensure smooth operation. The app will target Android smartphones running Android 6.0 (Marshmallow) or higher. For location tracking, the devices must include a GPS module and support geofencing to accurately track position for spot-swapping verification. The app relies on 4G/5G or Wi-Fi connectivity to function optimally, especially when real-time charging spot availability updates are required. Additionally, the app should be optimized for battery efficiency since location services will often be running in the background to verify vehicle movement, which could otherwise drain the battery.

## 6. Software

GigaCharge will utilize Flutter for cross-platform UI development, ensuring compatibility across various Android devices and screen sizes. Dart is used to write the core logic of the app, offering efficiency in handling asynchronous processes like QR code generation and real-time data updates. The AndroidSDK will give the app access to Android-specific features, such as location services, background processes, and QR code scanning.

The app requires integration with external APIs for real-time charging spot availability, as well as cloud storage solutions to manage user data, handle rewards, and track transactions. Real-time data accuracy is crucial, so the app must maintain stable connectivity and use caching mechanisms to ensure quick access to charging spot information even if network conditions are weak.

The backend will require a scalable cloud infrastructure like Firebase or AWS, ensuring the app can support a growing user base. Encryption will also be necessary to protect sensitive data, such as user information and location details, particularly during QR code exchanges.

## 7. Design Decisions

At GigaCharge, our design decisions are focused on creating a user-friendly app that encourages high engagement with its features, aiming for users to utilize at least 80% of available functions. Each feature is designed to address key user needs, from streamlined communication to easy verification of other users, all while enhancing the electric vehicle charging and parking experience.

By focusing on essential and meaningful functionality, such as a state-based messaging system, QR code verification, and a real-time map interface, we prioritize simplicity and relevance. This approach not only makes the app intuitive but also ensures that each interaction is valuable, enhancing user satisfaction and promoting frequent, effective use.

### State-Based Messaging System

The state-based messaging system is designed to provide secure, purposeful communication between users. The main reasoning here is to prevent unsolicited or inappropriate messaging,

ensuring users only receive messages relevant to spot swapping. This system will offer a limited number of interaction types (e.g., request to swap, confirm spot release, notify of arrival), helping to streamline communication. For security, messages will be logged to prevent misuse and limit each contact session to spot-swapping needs. Since one of our solutions was to stop people from leaking their phone number to receive unsolicited messages, we should also prevent that from occurring when using our app. There is a case to be made for some freeform messaging for complicated scenarios, we will work with consumers to find an optimal balance.

*Why this matters:* Electric car owners need to be coordinated in order to optimize charging station usage, so controlled messaging keeps communication relevant. This also adds accountability and improves user experience by keeping communications purposeful. Since one of the problems our app aims to solve is to stop people from leaking their phone number and receiving unsolicited messages, we should also prevent that from occurring when using our app.

### **QR Code Scanner**

GigaCharge's QR code scanner is a quick verification tool that allows users to scan each other's QR codes displayed on dashboards. This feature ensures that users are actively in the system, simplifying interactions and ensuring mutual understanding between swappers. Additionally, users will have the option to enter license plate numbers manually which will add to the flexibility for users without QR codes visible. Entering license plate numbers will allow the system to search for the owner so that potential spot swapping can occur. The license plate will be encoded into each user ID which will be stored in the Firebase.

*Why this matters:* By making sure that both users are in the app's system, it makes contacting and communications easier. QR codes also reinforce user engagement, while the license plate option adds a layer of flexibility for different use cases or if QR codes are temporarily unavailable.

### **One-Time Passcodes**

The utilization of one-time passcodes helps provide an extra layer of security to the swap. The purpose of a one-time passcode is to confirm that a user did agree to move their electric vehicle and actually showed up to the swap. Another intended purpose behind the one-time passcode is to ensure that no other driver takes the parking spot besides the approved driver. Charging stations will be locked by charging companies and will not be unlocked until the incoming driver takes the spot. The charging station will allow incoming drivers a grace period of 5 minutes before being unlocked and open to anyone to claim.

*Why this matters:* Having this extra layer of security allows users to have one less thing to worry about. The use of a one-time passcode allows users to ensure that no other driver accidentally takes someone's parking spot since charging stations will be locked for 5 minutes. The importance of the 5 minute lock session is so that it allows incoming drivers to actually park in the spot and prevents potential abuse of the system.

### **Map Interface**

The map interface shows a quick view of parking locations and charging spots at UH, along with available swap spots. It will display locations where spots are open (green marker), potential spots that could be requested to swap with (yellow marker), and which locations are busy (red marker). At a glance users will be able to tell where they can charge their vehicles.

*Why this matters:* Access to current availability reduces the time spent searching for spots, especially during peak hours. This dynamic map integration is essential for time-sensitive swapping and offers users the most updated view of potential spots.

## **Leaderboard**

In addition to being able to redeem GigaVolt points for charging time or gift cards, users will also be able to see a ranking of users with the most points. Integration with the electric car charger will prevent abuse of the system since points will only be gained when actually charging.

*Why this matters:* This introduces a gamification aspect to our system. People are usually naturally competitive and would like to get a higher spot on the leaderboard. This creates extra incentives to make the journey to move your car.

## **8. Use Cases**

The GigaCharge App is designed to support a wide range of use cases tailored to the needs of electric vehicle users. Each use case addresses different scenarios, from finding available charging spots to setting up spot swaps with other users in real-time.

### **Use Case: Swapping Parking Spots through QR Scanning and Messaging**

Scenario: It's a busy Monday at the University of Hawaii, and the parking lots are almost full. Bob, who drives an electric car, is in need of a charging spot but sees only one option—a spot currently occupied by Joe's car. Bob notices a GigaCharge App QR code displayed on Joe's dashboard and immediately opens his GigaCharge App to initiate a swap request.

#### **Step 1: Identifying a Potential Swap Partner**

Bob pulls up the app and uses the built-in QR code scanner to scan Joe's QR code. This scan confirms that Joe is registered in the GigaCharge App system, which allows Bob to contact him. If Joe's QR code weren't visible, Bob could have entered Joe's license plate number into the app to check his membership and initiate contact. Bob thinks this process is pretty convenient—no more awkwardly waiting around, hoping to catch the driver as they're heading back to their car. GigaCharge App takes care of it.

#### **Step 2: Initiating the Swap Request**

With Joe's membership confirmed, Bob clicks the "Request Swap" button in the app, which opens a preset messaging interface. He sends Joe a message asking if he'd be willing to swap his spot. Joe receives a notification on his phone and opens the app. He's about ready to leave,

so he replies with an “OK” and gives Bob an estimated time for his departure. Bob waits, checking out the status in the app to know when Joe’s ready.

#### **Alternative Scenario: Joe says “No”**

In the case where Joe says “No” to the swap, Bob then gets added to a queue for the next open parking spot. The open parking spot will come from when an incoming driver does not claim their designated parking spot after a 5 minute timeout period.

#### **Alternative Scenario: Multiple People in Queue**

In the case where there are multiple people in queue for the parking spot, instead of having Bob message Joe, Bob will simply be added to a queue for the next open parking spot.

#### **Step 3: Verifying with One-Time Passcodes (OTPs)**

When Joe confirms, the GigaCharge App generates a unique One-Time Passcode (OTP) for Bob, adding an extra layer of security to the swap. The charging station then enters a timeout for 5 minutes as it waits for Bob to claim the charging spot. The timeout stage of this process is where the charging station becomes unavailable to anyone except for Bob. Only the approved user can take the spot, and no one else will accidentally grab it before Bob arrives.

#### **Alternative Scenario: Accidental Spot Stealing**

In the case where another driver named Jerome parks in the charging spot designated for Bob, Jerome will be notified. When Jerome attempts to charge his car, the charging station/app will notify him that the parking spot is reserved for another driver. In addition to this notification, the charging station will not start charging Jerome’s electric vehicle.

#### **Alternative Scenario: Bob is late/disappears**

In the case where Bob does not show up within the 5 minute grace period. If there are other users waiting in the queue, the next user will get notified and if they accept the spot, they will receive a new OTP that will enable the charger. If there are no other users, then the charging spot will simply open up again for anyone to use.

#### **Step 4: Completing the Swap**

Within 5 minutes of Joe leaving, Bob gets to the parking spot, Bob will then enter the OTP into the charging station/app and the charging station will unlock. If Bob was already near the parking station, it would be fine since Bob will just have to enter the code and start charging. If Bob had to drive around for a few minutes, then the 5 minute timeout will give him time so that his spot is not taken.

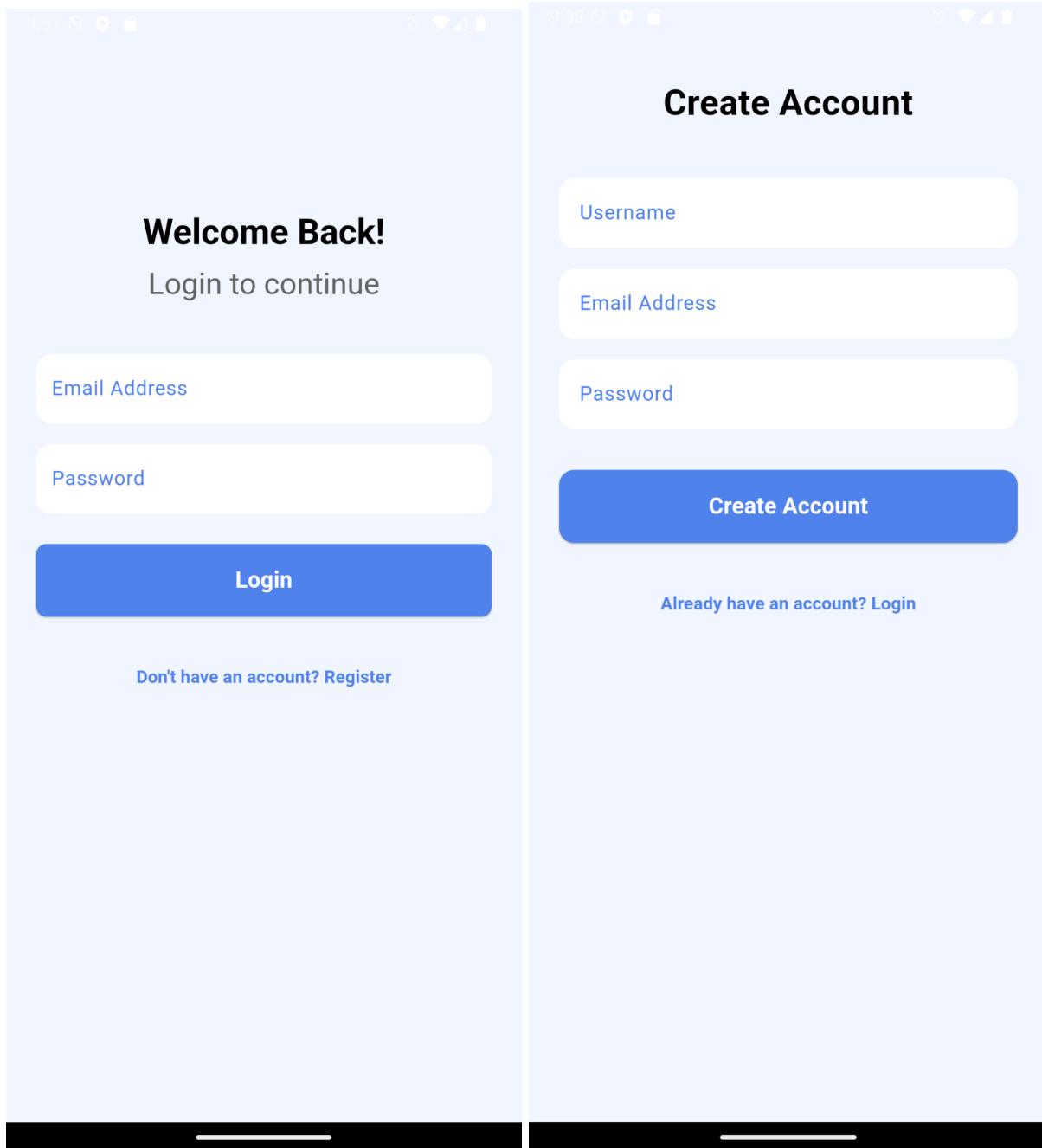
This process verifies both parties’ actions, ensuring a seamless handoff. The GigaCharge App prevents confusion by coordinating these exchanges.

## **Step 5: Rewards and Confirmation**

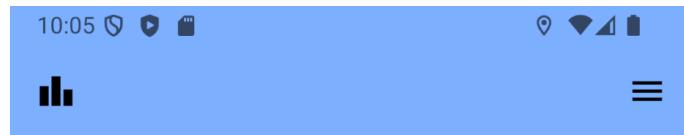
As soon as both OTPs are confirmed, GigaCharge App updates the app to reflect that Bob now occupies the spot and notifies both users that the swap was successful.

Joe earns points for successfully completing a swap. These points contribute to his standing on the GigaCharge App leaderboard, giving him a little extra motivation to keep helping others find parking spots. He's already started to climb the ranks!

## Screenshots



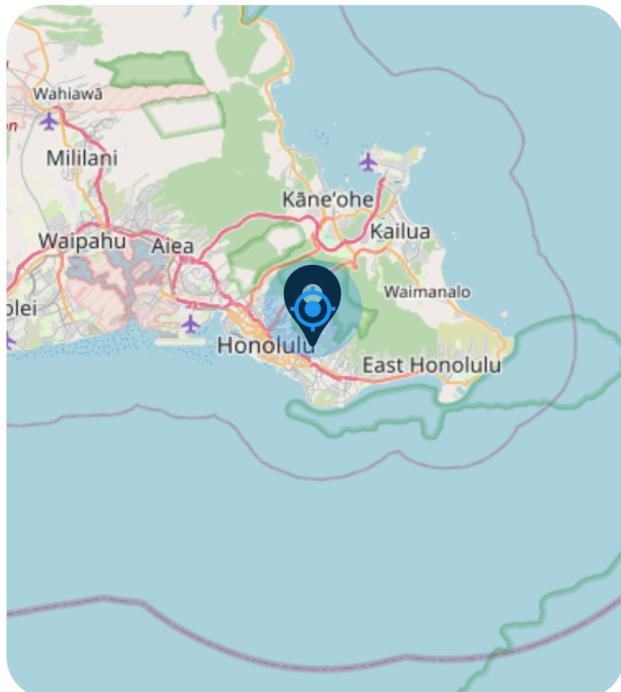
Login and Register Screens.



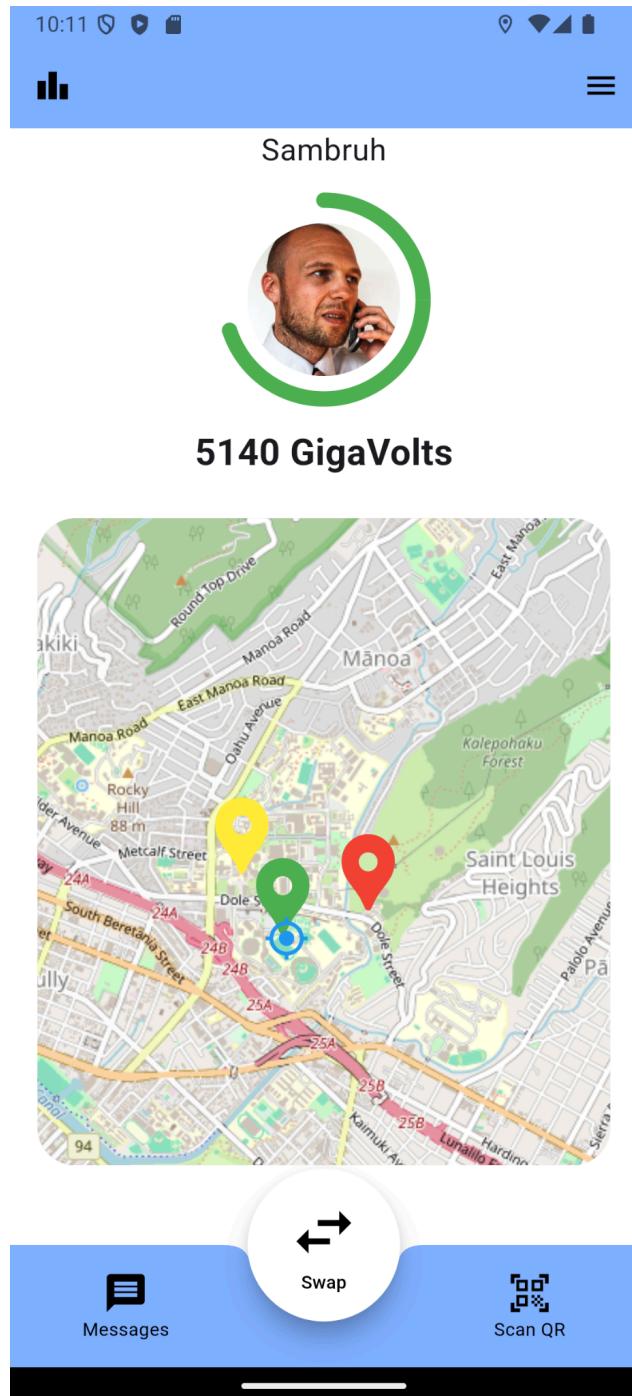
Sambruuh



**5140 GigaVolts**



**Home Page**



**Zoom in on the map**

Green - No one

Yellow - One person

Red - Multiple people

10:12 9 5 6

9 5 6

## ← Queue Details

Queue at 21.3001, -157.8194

Number of people in queue: 5

Your position in the queue: 3

1 Person 1

2 Person 2

3 Person 3

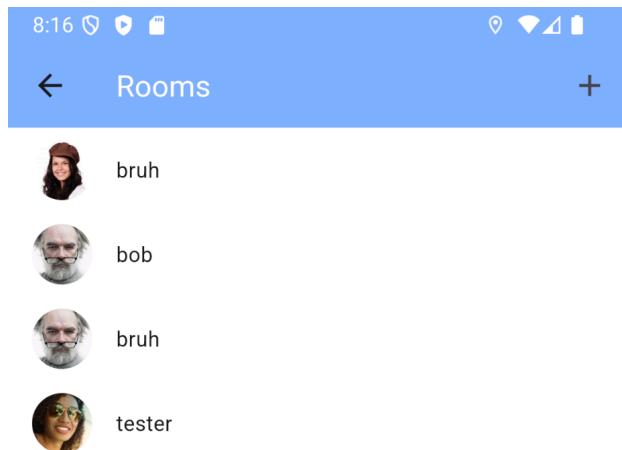
4 Person 4

5 Person 5

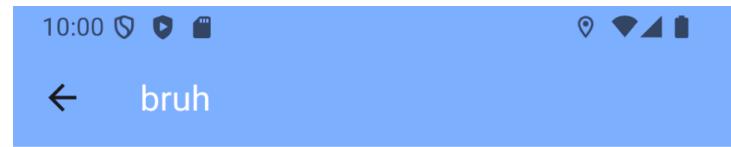
Queue



After opening up the QR code scanner. This is an emulated camera but it will be able to scan QR codes to find GigaCharge Users. Users can type in a license number here too. When hitting the check mark, they will start a chat with the person.

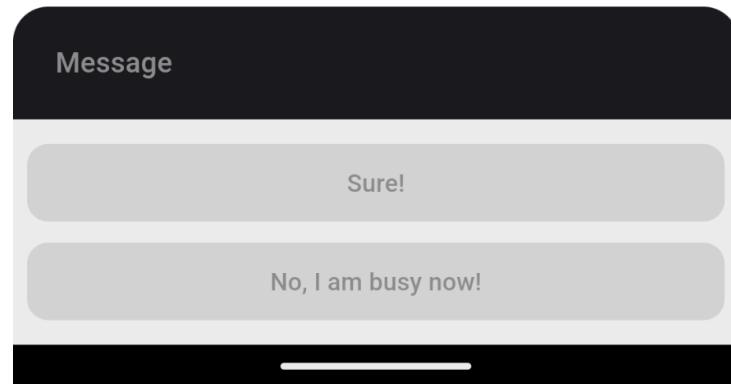


Press the chat button to see your message history and choose someone to chat with



22:00

Hello! Can we swap?



Real-time messaging with preset messages.



1st

**Sambruh**  
5140 points

2nd

**Superman**  
400 points

3rd

**batman**  
220 points

4

tester  
40 points

5

Supertester  
20 points

6

bob  
0 points

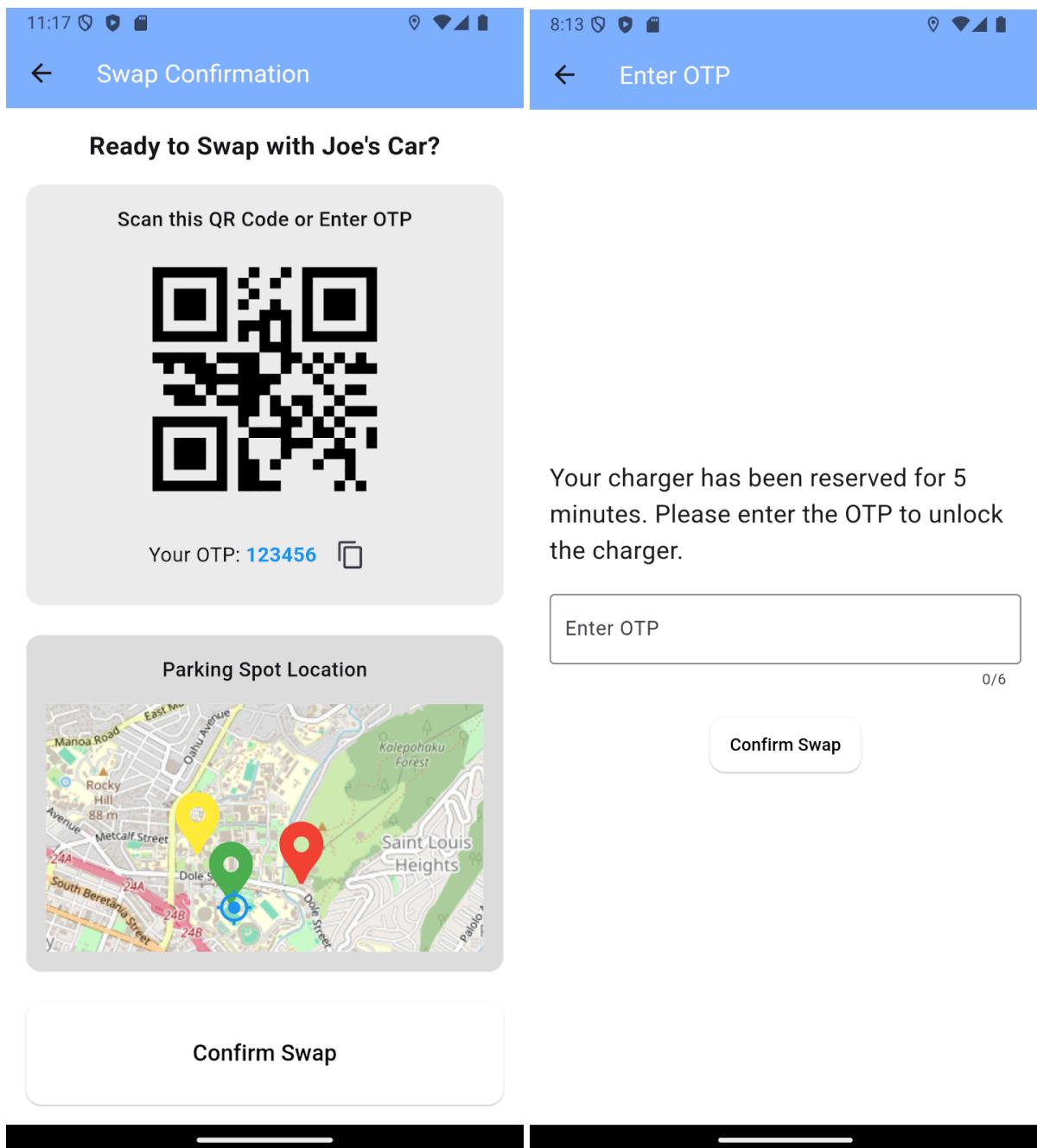
7

bruh  
0 points

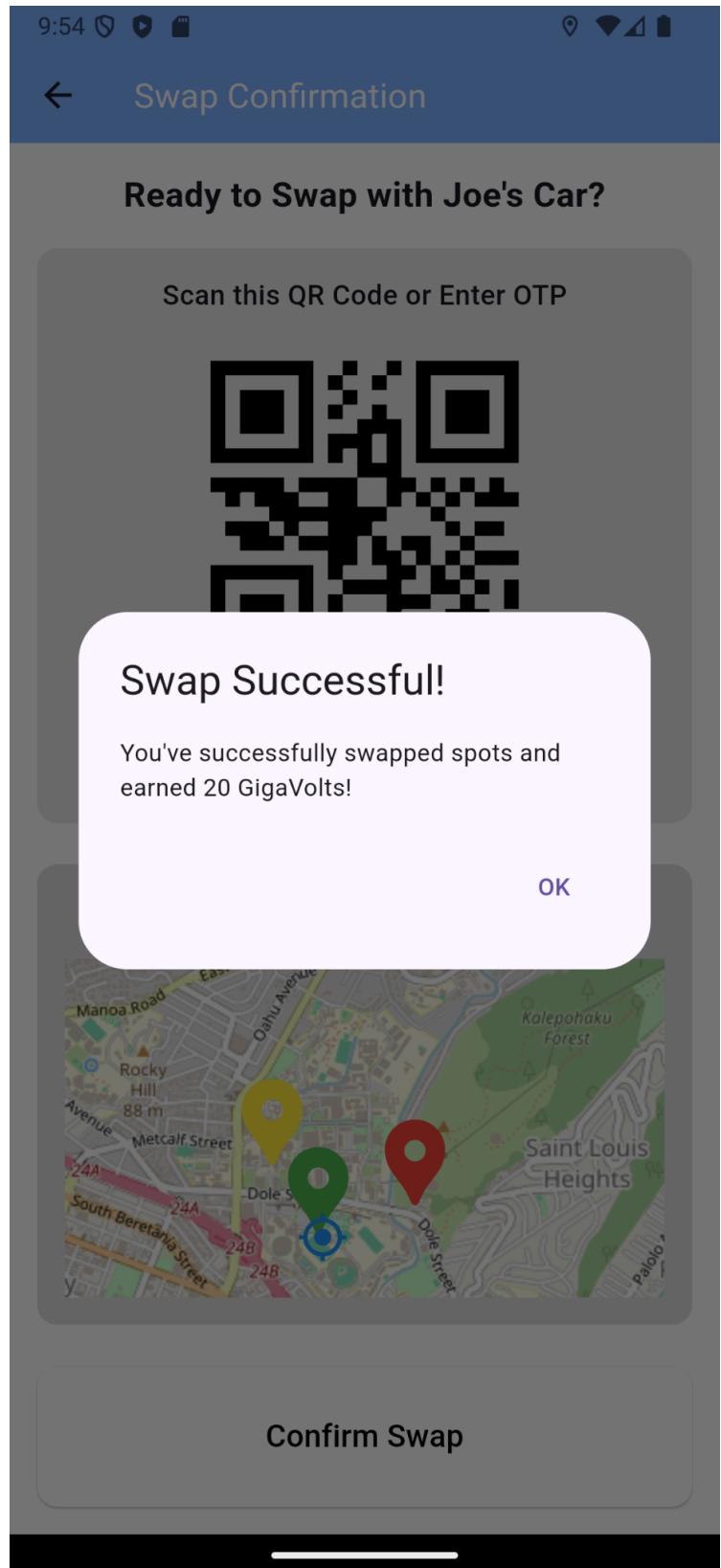
8

bruddah  
0 points

Leaderboard with sample users



**Swap Confirmation Page UI.** You receive the OTP and when you arrive at the charging station, you can enter it in and unlock the charger.



Sample GigaCharge Swap Prompt

## 9. Implementation vs Mockup

The implementation of several core features have been successfully updated to better enhance user experience. These key features include the UI framework, messaging interface, and static map of parking locations. Previously, the user authentication was mocked up; however, that has been successfully implemented. The integration of the Electric Car Charging API is still in the mockup stage and will remain in the mockup stage. This section will go more into depth about the recent implementations and rationale behind mock ups.

### Completed Implementations

Several completed implementations provide the GigaCharge app with essential functionality. The UI framework is operational, allowing users to navigate between screens such as the scanner, chat, and map. The chat interface features a basic messaging framework, incorporating preset options and simplified controls to enhance user interaction. Additionally, the UH map integration displays a static version of the campus map, showcasing parking lot locations. These foundational components establish a solid base for further development and user engagement.

The leaderboard system is also completed and it is designed to display user rankings and rewards based on the frequency of spot swaps. These features are crucial for enhancing user engagement and ensuring a comprehensive app experience.

Another key feature that has been implemented would be the implementation of user authentication. The implementation of user authentication has been developed using Firebase so user data can now be securely stored and allow for real time chat functionality. This is crucial for the app since it will support personalized app experiences and enable authenticated access to restricted features. Firebase will also be supporting the real time chat functionality.

### Mocked-up Components

The majority of the key features have been implemented but the one and only feature that is currently in the mock-up stage would be the Electric Car Charging API.

The Electric Car Charging API is still a work in progress but it will enable direct interaction with car charging status for users. The main difficulties associated with integrating the Electric Car Charging API is lack of documentation, specific chargers may have different interfaces and course scope/time constraints. The integration of the Electric Car Charging API is anticipated to significantly enhance the app's value, yet it requires further documentation analysis to ensure compatibility with existing features. This strategic focus allows us to address the most critical components first, ensuring a robust and secure user experience.

## 10. Planned Implementation and Timeline

As of October 30th, 2024, the planned implementation and timeline section outlined the upcoming features for the GigaCharge app, along with estimated completion dates to guide development. The tasks have been completed by their respective dates. We now outline the future tasks for the app.

Feature	Estimated Completion	Notes
Firebase Authentication & Register/Login Page	1–2 Weeks COMPLETED	Current priority due to the importance of secure user data handling. Design the register/login page for users.
Create Queueing Feature	3–4 Weeks COMPLETED	Create the queueing feature so that users can queue up to swap with other users.
Real-Time Map Integration	4–5 Weeks COMPLETED	Upgrading to include live GPS tracking of parking spots.
Electric Car Charging API	Future	Dependent on completion of documentation review and integration compatibility testing.
Fine tune point value and chat	Future	GigaVolt point value and balance between freeform and preselected messaging.

## 11. Research

This phase focused on creating a framework to evaluate the GigaCharge app's usability, functionality, and overall user experience. Qualitative and quantitative methods were employed, such as a talk-aloud protocol, scenario-based assignments, and an exit survey, to simulate real-world usage and gather meaningful insights. Key design elements included interactive mockups representing essential app features like availability tracking, notifications, and the QR code system. Surveys and tasks were tailored to assess user interaction with the app's interface and functionality.

### Goals and Questions

The primary goal of GigaCharge is to create a user-friendly app that encourages high engagement with its features, aiming for users to utilize at least 80% of available functions. Each feature is designed to address key user needs, from streamlined communication to easy verification of other users, all while enhancing the electric vehicle charging and parking experience. To achieve this goal, we aim to evaluate the usability, functionality, and overall user experience of the GigaCharge app and identify areas for improvement.

### Research Questions:

1. How intuitive is the current user interface?
2. How long does it take users to figure out where each tab is?
3. Are users able to figure out how the flow of using the app works, from downloading and registering to being able to contact someone to set up a swap without instructions?
4. What is a good point to dollar value for our GigaVolt points?
5. Would users be opposed to seeing advertisements as a way to fund part of our expenses/rewards?
6. Do users have any more feedback?

### **Methods**

To gather meaningful insights, we used a combination of qualitative and quantitative methods. We used the talk-aloud protocol in combination with a scenario based assignment to simulate real-world usage of the app. One scenario is:

“You are tired of trying to find a charging station at school and trying to contact people to use that spot. Your friend has recommended you to download this new app called GigaCharge. You download it and are presented with the login screen”

We then allowed users to figure out how to create an account and explore the various options on the home screen while verbalizing their thoughts. Additionally, we timed users to benchmark the average time it took for participants to become acclimated to the app. This provided insight into how users might perceive the app during their first interaction and helped us identify and address any non-intuitive buttons or navigation issues.

Another scenario we have created is:

“As you are getting ready for school, as soon as you get in your EV car you realize that you forgot to charge last night. You only have enough battery to make it to school but not back. You must find a charging station otherwise you will be stranded. Not wanting to be late you drive to school and after a couple circles you see a car with the GigaCharge QR code on their dash. Your goal is to contact the driver to see if you can take their spot”

Scenario-based assignments simulated real-world usage by giving participants specific tasks. Participants were also given the opportunity to experience the app from the perspective of the person being contacted by someone wanting to swap. Since this experience was slightly different, it ensured that we gathered valuable feedback about every aspect of the app.

We then had participants complete an exit survey with both multiple-choice and open-ended questions, such as "What feature did you find most useful?" These tools were designed to prompt meaningful feedback on usability and engagement while ensuring participants understood the context of their tasks.

Here are a few of the questions that we had people answer at the end:

1. How intuitive was the app to learn? Did it take you longer than expected to understand how to use it?
2. Were there any steps or processes that felt unnecessarily complicated or repetitive?
3. Which features were most useful to you? For instance, was it notifications, structure maps, or availability tracking?
4. Was the scenario provided (e.g., earning points, swap charging) enough to put you in the shoes of a regular user?
5. Do you feel that earning points to redeem prizes provide a strong incentive to participate in the app's features?
6. How do you feel about in-app advertisements, and where would you prefer ads to appear, if at all?
7. How much should a gigavolt point be worth?
8. Rate the app's usability, discoverability, and learnability on a scale from strongly disagree to strongly agree?
9. What additional features would you suggest adding to the app?

## Analysis

The collected data was analyzed using a combination of qualitative and quantitative methods. Feedback from talk-aloud protocols and open-ended survey responses was reviewed to identify common patterns and areas of concern. Quantitative data, such as survey results, was summarized statistically to reveal trends in user preferences and feature usage. Usability metrics, including task completion rates, time to complete tasks, and observed errors, provided additional insights into the app's performance, user-friendliness, and areas for improvement.

## Participants

The evaluation involved nine participants, primarily students from ICS-466, along with a couple of students from outside the class. However, this was slightly less than ideal. Ideally, participants would include individuals outside of ICS to gather feedback from less tech-savvy people and those who own electric cars.

While not all participants owned electric cars, they engaged with scenarios tailored to help them understand the app's use cases. Each session took only 5–10 minutes and was conducted on a provided device to ensure consistency. This device was an Android emulator rather than a physical Android device, as a physical device was unavailable. Additionally, another group member used a second emulator to simulate a second person for the car-swapping scenario. Participants then swapped roles to experience the other perspective.

Although compensation was not required for this portion of the project, no compensation was provided. In a real-world scenario, small incentives, such as Starbucks gift cards or GigaCharge points (if the app were fully deployed), could be offered as compensation. All participant data was anonymized to protect privacy, and no unnecessary personal information was collected.

## **12. Evaluation**

The evaluation phase is designed to assess the GigaCharge app based on feedback and performance metrics collected during testing. Participants engage with scenarios that mimic real-life use cases, such as finding available charging spots or swapping spaces to earn points. The evaluation incorporates usability testing, user feedback, and surveys to identify strengths and areas for improvement. Results are analyzed using thematic coding for qualitative data and statistical methods for quantitative feedback. This approach provides actionable insights to refine app features, optimize user experience, and address user concerns, guiding future iterations of the app.

### **Results**

Through qualitative and quantitative evaluations, the study addressed key research questions about the app's usability, performance, and overall user experience. The results suggested that many users found the app intuitive, with most describing it as easy to navigate with clear directions. However, there were some minor concerns regarding the repetitive back button pressing for the messages tab.

Features like availability tracking, the swap system, and chat were identified as the most useful, while the UI was praised for its cleanliness with some minor critiques on design choices. Additionally, features such as notifications and structure maps received significant praise, particularly for aiding users in locating potential parking or charging spots. While some participants, such as those who regularly take the bus, felt the app's direct utility was limited, others highlighted its role in reducing stress when navigating campus parking on tricycles or other vehicles.

The app's gamified features, like earning points to redeem prizes, were seen as strong incentives for engagement, with one participant humorously noting they would "probably do just about anything" for a prize. However, in-app advertisements were met with resistance, with users expressing a strong preference for an ad-free experience, as banner or pop-up ads were deemed intrusive.

Suggestions for improvements included making specific elements, such as checkmarks, more visually distinct and accessible. Usability, discoverability, and learnability were rated highly overall, with users noting the app was effective for its intended purpose.

### Possible Changes

#### **Enhancing Feature Labels**

User feedback indicated confusion with certain visual cues, such as the green checkmark, which some users reported they might have missed if it weren't explicitly pointed out. To address this, we plan to redesign and highlight important elements like the checkmark using more

prominent colors and tooltips. This will ensure users can easily identify and utilize core features without requiring guidance.

## **Streamlining Navigation**

To improve the experience of navigating through different sections of the app, changes will be made to reduce unnecessary steps. For instance, backing out of the message tab will no longer require multiple taps of the back button. Instead, the back button will be universal and reduce the number of pages that you would need to go back through to get to the home page. Specifically, when accessing the chat from the QR code, the back button would take users to the home page instead of back to the QR code scanner.

## **Streamlining Features**

Feedback revealed some redundancy and confusion between the swap system and QR code functionalities, which could overwhelm new users. To address this, these features will be reviewed and potentially consolidated into a single, cohesive flow. For instance, the swap system might integrate the QR code function to automate spot exchanges or confirmations. By simplifying these processes, the app can reduce the learning curve and enhance the overall user experience, ensuring that users can easily navigate and understand its core features.

## **Gamification and Incentives**

The positive reception of earning points to redeem prizes suggests that this feature is a strong motivator for user engagement.  $\frac{2}{3}$  of the participants rated the game/point system said they "loved it" which is the highest rating, while  $\frac{1}{3}$  said they "liked it" which is the second highest rating. We plan to refine this system by clarifying the value of "Gigavolt points" (e.g., 1 point = half a cent) and ensuring transparency in how users can redeem these points. This will make the rewards system feel more tangible and appealing.

## **Avoiding Advertisement Intrusiveness**

We initially started the app with two alternatives for business models and value. Advertisement based or Company/Commercial based.

Based on user feedback, there was a strong dislike for advertisements on the app. Given users' strong aversion to banner and pop-up ads, we will try to maintain an ad-free experience for the app. With this feedback we can confidently plan to shift our business model from ad-driven to direct funding from charging companies who should be incentivized to invest in our app because GigaCharge provides a good service for their customers. This will ensure that the core user experience remains unaffected even if we shift business models.

By addressing these areas, the app will continue to evolve into a more user-friendly, efficient, and engaging tool that meets the diverse needs of its audience.

## 13. Conclusion

The GigaCharge app aims to deliver a thoughtfully designed solution to streamline electric vehicle (EV) parking and charging coordination, particularly at the University of Hawaii at Manoa. By integrating core features such as state-based messaging, QR code scanning, and a real-time map interface, GigaCharge addresses key challenges EV drivers face, including locating available charging spots and managing spot swaps. These features foster secure, structured interactions, reducing delays and confusion while enhancing the overall parking experience on campus.

A user-centered design approach has guided GigaCharge's development, focusing on simplicity, usability, and privacy. The state-based messaging system ensures relevant communication and protects user privacy by eliminating unsolicited messages. QR code and license plate verification enhance security and trust, while real-time maps help users plan more efficiently. The gamified reward system, which encourages cooperation through points and leaderboards, has been well-received, motivating users to engage actively with the app.

User evaluations have provided valuable feedback, highlighting the app's intuitive design and effective features like availability tracking and notifications. Through the user provided feedback, careful consideration and improvements have been made to the GigaCharge app. From streamlining redundant functionalities, enhancing visual cues, and simplifying navigation - especially within the messaging interface, the app now reflects these valuable feedback to help enhance user experience. These refinements, coupled with maintaining an ad-free experience, will enhance user satisfaction and align with user preferences.

While core components like the UI ,static maps, and basic chat functionalities are in place, the app now includes fully implemented Firebase authentication, which supports real-time chat messaging, enhancing user communication and coordination. GPS tracking is also operational, allowing accurate real-time location updates for charging spot availability and swap verification. However, the Electric Car Charging API integration remains in the mockup phase, as it is considered out of scope for this course. Initially, advertisements were proposed for funding, but based on user feedback, the funding model will shift towards collaboration with charging companies. This approach will help sustain the app and fund rewards while maintaining a seamless, ad-free experience for users. Additionally, the points system has been refined, with each Gigavolt point likely being worth one cent, making the rewards more tangible and motivating for users.

For future improvements, GigaCharge plans to fine tune the messaging system in order to strike a balance between free form and preselected as it will enhance user's ability to effectively convey messages to other users. The fine-tuning of GigaVolts and in terms of its monetary value and funding method will continue to be worked upon, ideally gaining the support of charging companies.

Ultimately, GigaCharge is poised to become a dependable tool for the UH community, improving coordination among EV drivers and contributing to sustainable campus mobility and perhaps

expanding to the larger EV scene. Through continuous development and user feedback, GigaCharge not only addresses current needs but also lays the groundwork for future advancements in EV support and coordination.

## 14. Appendix

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### Qualitative Exit Survey

Bolded questions are what users were asked. Bullet points are user answers

#### **1. How intuitive was the app to learn? Did it take you longer than expected to understand how to use it?**

- It was easy to pick up and understand.
  - I found it quite straightforward to use.
  - Navigating through the app felt natural and simple.
  - The interface was well-designed, making it easy to figure out.
  - It was user-friendly and didn't take long to grasp.
  - The instructions were clear, so it was quick to learn.
  - Learning to use the app felt effortless.
  - The app's design made it very intuitive.
  - I understood how to use the app much faster than I anticipated.
- 

#### **2. Were there any steps or processes that felt unnecessarily complicated or repetitive?**

- Not that I noticed.
  - Most processes felt smooth and logical.
  - Backing out of a message tab took multiple presses, which felt a bit repetitive.
  - I didn't experience any unnecessary complexity.
  - Everything seemed straightforward and efficient.
  - The app's steps were logical and didn't feel repetitive.
  - A few steps might be simplified, but nothing major stood out.
  - There weren't any processes I'd call overly complicated.
  - Repetition wasn't an issue except for one minor navigation step.
- 

#### **3. Which features were most useful to you? For instance, was it notifications, maps, or availability tracking?**

- Notifications were particularly helpful.
- The map showing charging spots stood out as a great feature.
- Availability tracking was the most useful feature for me.
- I appreciated the alerts keeping me informed.
- The map made it easy to locate parking spaces.

- Structure maps were a great addition for navigation.
  - I found availability tracking extremely practical.
  - The ability to see nearby spots on the map was incredibly useful.
  - Alerts about availability were my favorite feature.
- 

**4. Does the app help reduce the stress and time associated with finding charging spots or parking spaces?**

- I can't say for sure since I don't drive.
  - It definitely helped me find parking faster.
  - Yes, the app reduced my stress when looking for spaces.
  - I felt more confident finding parking with the app's help.
  - The app made it much easier to find charging spots.
  - While I don't use it for parking, others would likely find it useful.
  - It was great for planning where to park ahead of time.
  - I struggle less now when trying to find a spot.
  - It simplified the process of finding available spaces.
- 

**5. How does the scenario provided (e.g., earning points, pre-class charging) influence user engagement and task completion? Does earning points to redeem prizes provide a strong incentive to participate in the app's features?**

- Yes, earning points motivates me to use the app more.
  - Redeemable prizes definitely increase my engagement.
  - Incentives like points and prizes are a strong motivator.
  - I think earning points makes the app more engaging.
  - Having a reward system makes participation more appealing.
  - Earning points gives me an extra reason to use the app regularly.
  - It's a creative way to keep users engaged.
  - I feel more encouraged to complete tasks when there's a prize involved.
  - Yes, the idea of earning prizes strongly motivates me.
- 

**6. How do users feel about in-app advertisements, and where would they prefer ads to appear, if at all?**

- I'd rather not have any ads in the app.
- Ads should only appear if they're non-intrusive.
- Pop-ups would ruin the experience; no ads, please.
- If ads are necessary, banner ads at the bottom might work.
- Ads should be minimal and not distract from the app's functionality.

- I prefer apps without advertisements entirely.
  - Ads could be limited to the settings or optional views.
  - I think the app is better off without ads.
  - Non-disruptive ads might be acceptable, but fewer is better.
- 

## 7. How much should a gigavolt point be worth?

- I'm not sure what the ideal value is.
  - Around half a cent sounds reasonable.
  - Maybe one gigavolt point could equal one cent.
  - It could depend on the types of rewards offered.
  - I'd suggest tying it to discounts or freebies.
  - The value should balance between fair rewards and app sustainability.
  - I don't have a preference, as long as the rewards are worth it.
  - The conversion rate doesn't matter much to me.
  - I'd say enough to make earning points feel worthwhile.
- 

## 8. Rate the app's usability, discoverability, and learnability on a scale from strongly disagree to strongly agree.

- I'd give it a 5/5 for usability.
  - Discoverability was good, though it could depend on the promotion efforts.
  - I found the app very intuitive, so I'd rate learnability highly.
  - Usability is excellent; no complaints there.
  - Overall, I'd rate it a strong agree across all areas.
  - Learnability was great, with minimal effort needed to understand it.
  - The app was easy to navigate, so it scores highly on usability.
  - I'd say usability and learnability were top-notch.
  - I strongly agree that the app performed well in all three aspects.
- 

## 9. What additional features would you suggest adding to the app? (none is okay)

- None; it's well-designed as it is.
- Maybe add a feature to customize the map view.
- It would be nice to include a live chat for support.
- A feature to save frequently used locations would be useful.
- Perhaps include a dark mode for nighttime use.
- A history of recently used features might help.
- Not quite, I can't think of anything
- It could benefit from a notification scheduler for reminders.

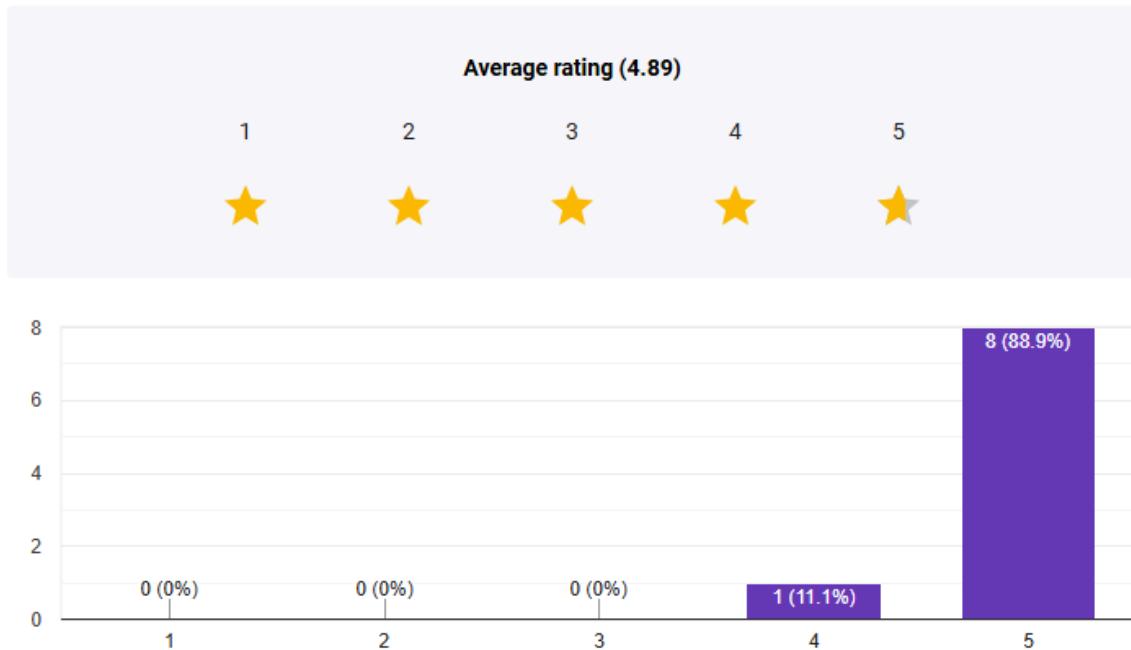
- I can't think of anything significant; the app works great as is.
- 

## Quantitative Exit Survey

What would you rate our app? 

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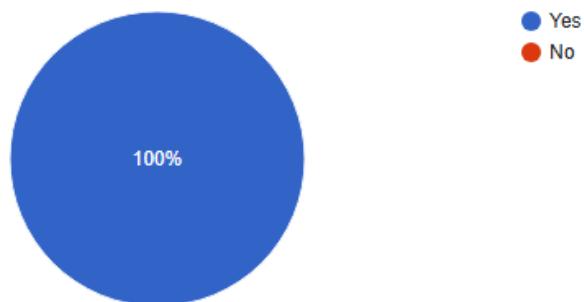
9 responses



Would you recommend this app to others?

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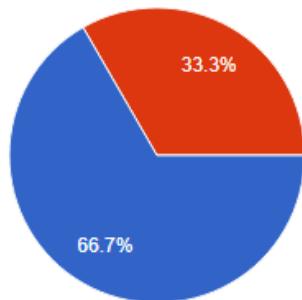
9 responses



How do you feel about the app's gamification elements (e.g., earning points, prizes)?

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9 responses

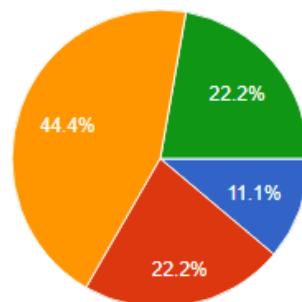


- Love It: It's engaging and keeps me motivated.
- Like It: It's a nice addition that adds value.
- Neutral: It's okay but doesn't impact my experience much.
- Dislike It: It feels unnecessary or distracting.
- Hate It: I'd prefer the app without gamification.

Which aspect of the app feels most polished?

 Copy chart

9 responses

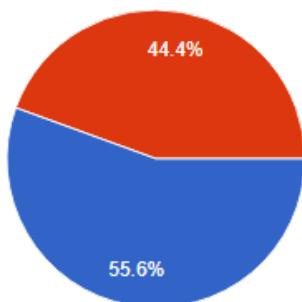


- User interface design.
- Ease of navigation.
- Feature functionality.
- Reward/gamification system.

How would you describe the app's visual design?

 Copy chart

9 responses

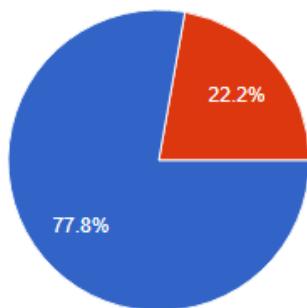


- Excellent: The app is visually appealing and well-designed.
- Good: The design is functional and looks nice.
- Average: The design is acceptable but could use improvements.
- Poor: The design feels cluttered or outdated.
- Very Poor: The design detracts from the overall experience.

How do you feel about the app's navigation (e.g., menus, tabs, buttons)?

 Copy chart

9 responses

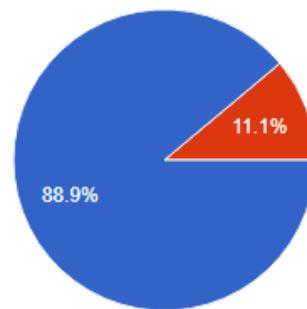


- Very Intuitive: It was easy to navigate with no issues.
- Mostly Intuitive: It was easy to navigate but had minor flaws.
- Somewhat Intuitive: It was usable but could be clearer.
- Not Intuitive: It was difficult to navigate.
- Very Difficult: It was confusing and hard to use.

Were the buttons and icons clear and easy to understand?

 Copy chart

9 responses

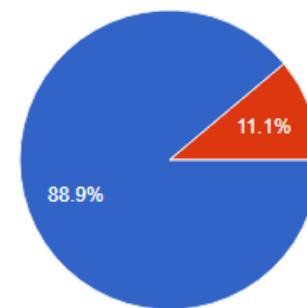


- Yes, they were intuitive and well-labeled.
- Mostly, but a few were unclear.
- Neutral, they didn't stand out.
- No, some were confusing.
- Definitely not, they were very unclear.

How would you describe the app's layout?

 Copy chart

9 responses



- Excellent: Clean, logical, and well-structured.
- Good: Easy to follow but could be improved.
- Average: Functional but not optimized.
- Poor: Messy and hard to follow.
- Very Poor: Chaotic and confusing.