# Chapter 6 Technical Implementation

## 6.1 Front-End Development

Front end is that portion of the web site that the user interacts with directly in the browser. It encompasses everything on the visual side such as buttons, navigation menu, text field, images and animation. The frontend of the P.A.C.E. is developed with React, a JavaScript library that is used to develop the fast and interactive user interfaces. React is made efficient and is fast because it relies on a concept known as Virtual DOM (Document Object Model) that only updates the modified sections of the webpage rather than loading the entire webpage.

### 6.1.1 User Front-End

The user interface (UI) is made as simple and as explicit as possible, and a central portion of the interface is a Start Here button, rather than a menu bar. The pages include:

* Home Page: Shows welcome message, user points and progress.
* Action Page: provides sustainable activities based on SDGs and ESGs.
* Leaderboard Page: Displays level of tiers and user rankings.
* Reward Page: Shows the number of points that are needed to redeem rewards.
* Notification Page: Displays action updates and user feedback.

Using APIs (Application Programming Interfaces) which are tools that enable the forward-end to call the backend to send or receive data are used to fetch dynamically a piece of data. The UI has a recommendation bracket that is AI powered. This animated bracket draws attention to the activity that has the largest Q-learning value to indicate what is expected of the users next.

### 6.1.2 Corporate Front-End

The Corporate Front-End is a dedicated web interface that specifically allows administrators, organizations, and sustainability managers to administer, control and assess the sustainability engagement of all the participants on the platform.

This is in contrast with the user interface, which offers data-oriented graphic representations and control capabilities to trace impact, adjust rewards, delegate duties, and produce automated reports.

**Dashboard Overview Page**

The dashboard is the hub of the entire platform providing admins with a bird-eye view of the platform activity. When the admin logs in, he/she can observe:

* No. of Participants- Number of people registered to the organization.
* No. of Completed Activities- Total Count of activities completed by all users
* Total Points Awarded - Sum of the points gained on all users.

**Category Overview (Donut Charts)**

* User by Category - Displays the distribution of user activities across the 6 categories:
  + - * 1. Donate & Buy
        2. Volunteer & Lead
        3. Advocate
        4. Body & Mind
        5. Reuse/Recycle
        6. Protect Wildlife
* Points by Category – Shows which category the total points were contributed.

**Mini Trends & Popular Activities**

* Mini Trends Graphs Line charts that indicate growth of activity in the previous two events that were tracked (e.g., Note Sharing, Reusable Mug). Two mini trends are displayed, one for categories and another for the activities.
* By Activity (Top 6)- A bar chart (a graphical presentation of data with rectangular bars) of the most done sustainability actions.

**Leaderboard**

* Shows the high achievers in the organization.
* Ranked in terms of overall points to promote competition.

**SDG Report Generator (powered by Ollama)**

The button of downloading SDG Report on the admin dashboard is one of the most innovative features. This button automatically transfers the data on the dashboard (activity completion, trends, points, etc.) to a local AI engine named Ollama, when it is clicked.

Ollama: Open-source AI language model engine, the same as ChatGPT, installed and executed on a local machine (offline). It works on the data without using cloud service or internet connection and is high-speed and entirely private. Ollama also processes received data to create a personalized SDG progress report in the Microsoft Word (.docx) format. Immediately the admin can download the report and present it or make use of it.

**Security**

* Role-based access control (RBAC) limits access to this dashboard. RBAC is a method that gives only the user with the role of administrator the ability to access or manipulate organizational data.
* Administration login will need a unique organization ID that is issued to only verified partners.

## 6.2 Backend Development and Data Flow (Database Setup)

The other side of the system that a user does not see is the backend. It contains the server, database and all the logic (such as computations, authentication and storing user actions).

The back-end is developed with the help of Node.js and Express. Node.js is a JavaScript runtime enabling the execution of JavaScript code in the server. Express.js is a flexible web application and API framework in Node.js. The entire information is saved safely in Supabase, which is an open-source application of authentication, database, and file storage. Supabase is a structured relational database (PostgreSQL).

The backend includes:

* Authentication: It is done by email and password. Rule-based validation is applied in Supabase which includes the use of the at sign(@) in an email address and at least 6 characters on a password.
* Role-based access: The users and organizations have different rules of logging in. Unique org ID is supplied in the form of organization login.
* Security: Supabase has JWT (JSON Web Tokens) to provide secure access and hashed passwords to secure user information.

### 6.2.1 Dataflow Between Front-End & Back-End

The sequence of data flow is the following:

1. User Action: This is when a user makes an action or sends in a donation.
2. API Call: API is used by the front end to send the data to the back end.
3. Database Update: The backend updates Supabase database.
4. Response: The backend reacts to the front end by transmitting updated data, to refresh UI elements.

A diagram of a software application

AI-generated content may be incorrect.Any user data is updated in real time to assist dashboards and leaderboards.

## 6.3 Key Features and Functionalities

The basic features used in the system are:

1. Authentication

* The users create accounts and log in by using email and password.
* Organizations require a distinct org ID to be able to enter the corporate portal.
* The passwords are hashed (encrypted).
* JWT tokens have secure sessions.

2. Data Storage

Supabase contains all user information such as:

* Personal details
* Points
* Activities completed
* Donation history

The data in these records are read by organization dashboards to display engagement statistics.

3. Donation System

* Stripe is a secure payment gateway that handles real-time transactions and is used to process donations.
* Donation gives the user additional points.
* Donation history (without card information) is stored in Supabase and are displayed in user profiles and organization dashboards.

4. AI-Based Q-Learning Recommendation

* Q-learning is a form of Reinforcement Learning algorithm. It does this by learning what the user does to suggest the next activity that is the most rewarding activity.
* The Q-table holds the state-action pair along with a value known as Q-value that grows with repetitive you are using that activity.
* Example: Q-value will increase with the use of reusable mug when the rewards are common.
* The bracket UI points out the action that is recommended based on the largest Q-value.
* Python Backend code computes the Q-values and then updates the database on-the-fly.

5. Audio Greeting

* Users are welcomed by a mini smiley emoji icon that plays an audio file when they are accessing the site.
* This enhances user experience with a sense of personalization and friendliness.

6. Real-Time Leaderboard & Analytics

* Leaderboard lists the users in order of points earned.
* The rewards are divided into levels according to the points.
* Admin dashboard includes live charts of user action, donation impact and SDG progress.

7. Shared Backend for Web & App

* The website shares the same Supabase database as the mobile app.
* Both platforms reflect user actions in both interfaces.