

Progress Report

CS640 – Computer Science Project

PACE: A Website for tracking and contributing to sustainable development goals.

Student Name: Vamsi Krishna Kancharapu

Student Number: 24252051

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Department of Computer Science
Maynooth University, Maynooth
Co. Kildare, Ireland

Head of Department: Dr. Aiden Mooney

Supervisors: Dr. Kevin Casey, Dr. Peter Jean Paul

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Chapter 1: Project Overview

1.1 Objective:

The Personal Accounting Climate Economics (P.A.C.E.) System is a web-based platform designed to promote sustainability through user engagement, donations, volunteering, and analytics tracking. The project aims to provide individuals and corporations with tools to monitor their sustainability impact, contribute to environmental initiatives, and track their progress through data-driven insights.

The importance of this project lies in addressing the lack of accessible platforms for sustainability contributions. Many individuals and organizations want to contribute to sustainability efforts but lack a structured way to track and visualize their impact. The P.A.C.E. System solves this problem by offering a transparent and interactive platform where users can:

- Donate to sustainability projects securely.
- Participate in volunteering initiatives.
- Track and adapt their individual contributions to the Sustainable Development Goals (SDGs) through interactive dashboards and leaderboards.
- Encourage corporate accountability in sustainability efforts.
-

By combining sustainability metrics, the platform aims to increase user participation while ensuring data transparency and security.

1.2 Scope

The P.A.C.E. System is designed for both individuals and corporate entities looking to engage in sustainability practices. The core functionalities include:

1. User-side Features
 - Secure sign-up and login system.
 - Donation portal with Stripe integration.
 - Volunteering event registrations.
 - An interactive user dashboard where users can enter and track their sustainability contributions, including donations made, volunteering hours logged, and progress in selected sustainability initiatives. The dashboard will provide feedback through visual analytics, leaderboards, and goal completion tracking.
 - Leaderboards comparing user participation and achievements.
2. Corporate-side Features (Upcoming)
 - Sustainability KPI tracking for organizations, including waste management efficiency and corporate sustainability contributions such as donations and employee volunteer participation.
 - A corporate dashboard will visualize data through charts, trend analysis, and comparative performance tracking to help organizations measure their sustainability impact.
 - Performance comparison tools for organizations.

The system ensures that all sustainability-related interactions are stored in a database and retrieved dynamically for User and Organization analytics. The outcome is a fully functional, scalable, and sustainability platform.

1.3 Key Literature Considered

The key research areas considered for this project include:

- **Sustainable Development Goals (SDGs):** Guidelines from the United Nations on sustainability practices [1].
- **Service Design & User Experience (UX):** Ensuring an intuitive and engaging user journey to encourage active participation.
- **Red Routes Analysis:** Identifying critical user actions that define the core functionality of the platform.
- **SCRUM Process:** Adopting an iterative and agile approach for efficient project management and feature implementation [2].

Additionally, a number of similar platforms were reviewed, including GoFundMe and sustainability-focused websites such as Earth Easy and Eco Matcher, to understand:

- Best practices in donation management [3].
- How to increase engagement through leaderboards and Dashboards.
- Data security and transparency mechanisms in donation-based platforms.

A total of 20 research papers were reviewed from journals such as the Journal of Sustainable Development, ACM Digital Library, and IEEE Access, focusing on sustainable web design and donation-based models. The key themes identified and integrated into the project approach include efficient web development practices, secure and transparent donation processing, user engagement through gamification, and real-time analytics for tracking sustainability impact.

1.4 Technologies Used

The P.A.C.E. System utilizes a modern web technology stack for performance, scalability, and low-energy consumption [4]. The selected technologies are:

- Frontend:
 - **React.js:** Chosen for its fast rendering, reusability, and component-based architecture [5].
 - **JavaScript & CSS:** For interactive and responsive UI development [6].
- Backend:
 - **Express.js:** Lightweight and efficient Node.js framework for handling API requests [7].
 - **Supabase:** Backend-as-a-Service (BaaS) using PostgreSQL for storing user activities,

donations, and sustainability metrics [8].

- **Payment Integration:**
 - **Stripe API:** Enables secure donation processing with real-time transaction tracking [9].
- **Hosting & Deployment:**
 - **Cloud-based low-energy hosting** (to be determined) to ensure minimal carbon footprint.

This technology stack was chosen because it provides:

- The Superior performance, scalability, and energy efficiency compared to traditional web development stacks.
- Compared to monolithic architectures using PHP and MySQL, the combination of React.js, Express.js, and PostgreSQL offers faster rendering times, improved load balancing, and reduced server requests.
- Additionally, cloud-based low-energy hosting reduces carbon footprint compared to conventional server-based hosting solutions.
- The stack also ensures secure payment processing through Stripe API, which has been benchmarked for low-latency transactions and enhanced fraud prevention mechanisms.

The next step is to complete the corporate-side functionalities, further optimize performance, and conduct real-world testing before final deployment.

Chapter 2: Methodology

2.1 Primary Methodology: SCRUM Framework

The development of the P.A.C.E. System follows the SCRUM methodology [10], an iterative and agile approach to software development. This method was chosen to ensure continuous feedback, adaptability to changes, and faster delivery of functional components, which are critical for an evolving sustainability platform. Given the dynamic nature of user engagement and donation behaviors, the SCRUM methodology allows for iterative improvements based on real-time feedback. This ensures that usability issues, performance bottlenecks, and new feature requests can be addressed efficiently. The process involved several key stages, detailed below:

Creation of User Personas:

- **How They Were Created:** The user personas were developed using a combination of insights gained from a literature review, primary data collection, and an interview with Dr. Dorena Bishop, the Waste Management Working Group leader and part of the Green Campus initiatives. The interview provided valuable insights into the sustainability efforts and helped clarify the flow and processes involved in sustainability actions. These insights were used to better understand how individuals and organizations engage with sustainability initiatives.
- **Method of Creation:** Following the interview, a literature review was conducted to further understand the needs of individuals and organizations regarding sustainability engagement. Additionally, a survey was conducted with potential users to refine the personas. Two distinct personas were developed: one for individual users (students) and another for corporate entities (organizations). These personas were refined through discussions with my supervisors, ensuring they aligned with real-world sustainability goals.

Creation of Corporate Persona:

- **How It Was Created:** The need for a corporate persona emerged from the recognition that organizations, such as businesses and educational institutions, would require tools to track their sustainability efforts, including employee volunteer hours and sustainability KPIs. This requirement was further validated through the interview with Dr. Bishop, who highlighted the necessity of a platform that could help organizations track their environmental impact and employee engagement in sustainability projects.

Red Routes Analysis:

- **How the Analysis Was Done:** A Red Routes Analysis was conducted to identify the critical actions that users need to complete on the platform. Insights from the interview with Dr. Bishop

were crucial in identifying the most important tasks, such as making donations, registering for volunteering, and checking sustainability progress. These actions were mapped out and prioritized as part of the red routes.

- **Application:** For instance, the student persona's preference for simplicity and ease of use led to prioritizing features like a simple donation portal and dashboard analytics. Similarly, the corporate persona's need for sustainability KPI tracking influenced the development of corporate dashboards and sustainability reporting features. These insights guided the development process, ensuring high-impact features were implemented first.

Sprint Planning:

- **How It Was Implemented:** The user personas and red routes directly informed the prioritization of features for each sprint. For example, the dashboard for tracking sustainability progress was prioritized early because of the student persona's need for real-time updates on donations and volunteer hours. The tasks were broken down into smaller, manageable user stories, and each sprint was planned with clear deliverables.
- **Collaboration:** Throughout the process, I worked closely with my supervisors to define the scope of each sprint, ensuring the tasks were achievable, aligned with the personas, and contributed to the overall project objectives.

Development Process:

- **What Was Done:** During the development phase, tasks were implemented in alignment with the user stories and sprint goals. The initial focus was on the development of the donation system and volunteer registration system, ensuring core functionalities were in place early. Later, more complex features such as the corporate sustainability tracking dashboard were introduced.
- **Collaboration and Tools:** The front-end was built using React.js, while the back end used Express.js with PostgreSQL. Continuous integration ensured smooth code updates, and unit testing was conducted for each feature to ensure functional requirements were met.

Testing and Iteration:

- **How Testing Was Done:** After each sprint, usability testing was conducted with sample users from the target audience. A group of students were selected to test key features like the donation portal, dashboard, and volunteering registration system. Feedback was collected through surveys, interviews, and observation, focusing on ease of use, visual appeal, and clarity of instructions.
- **Improvements Made:** Based on the feedback, iterative improvements were implemented. For example, users requested a more intuitive layout for the dashboard, leading to changes in the visual hierarchy and the addition of clearer call-to-action buttons.

Retrospectives and Continuous Improvement:

- **What Happened in Retrospectives:** At the end of each sprint, a retrospective was held to review the successes and challenges of the sprint. Insights from user interactions, analytics, and performance metrics were reviewed.
- **Impact on Next Sprint:** Insights from each sprint informed the direction of the following sprint. For example, after noticing that real-time data retrieval was slow, the focus shifted to optimizing database queries and improving front-end responsiveness in subsequent sprints.

2.2 Defining User Personas:

User personas were created based on a survey conducted with potential users. With the help of the project supervisors, a focus group study was organized to gather insights on user expectations and behaviors.

Key Findings:

- Users prefer an easy-to-use sustainability platform that requires minimal effort.
- Gamification elements (leaderboards, Dashboards) increase engagement.
- Many users are hesitant about donations, so transparency in transactions is crucial.
- Volunteering opportunities need to be well-advertised to increase participation.

User Personas Developed:

- **Student User Persona (Primary Audience)**
 - Wants to track sustainability impact easily.
 - Prefers a simple and engaging interface.
 - More likely to participate if incentives (badges, recognition) are available.
- **Corporate User Persona (Secondary Audience)**
 - Needs detailed sustainability tracking and analytics.
 - Prefers goal-setting features to track performance.
 - Interested in how sustainability efforts align with business values.

The feedback from this study shaped the website design and features, ensuring alignment with real-world user needs.

2.3 Red Routes Analysis:

A Red Route Analysis [11] was conducted to identify critical user actions that define the platform's core functionality. This analysis helped prioritize features that directly impact user engagement and sustainability efforts.

Key Red Routes Identified:

The red route analysis identified the most critical user interactions that define the platform's core functionality. For individual users, actions such as signing up, checking analytics, and participating in donations or volunteering were the most frequent interactions. For organizations, performance tracking, leaderboard comparison, and sustainability goal setting were top priorities. These insights guided the development process, ensuring that high-impact features were implemented first. The following figures illustrate the red routes identified for customer and corporate personas.

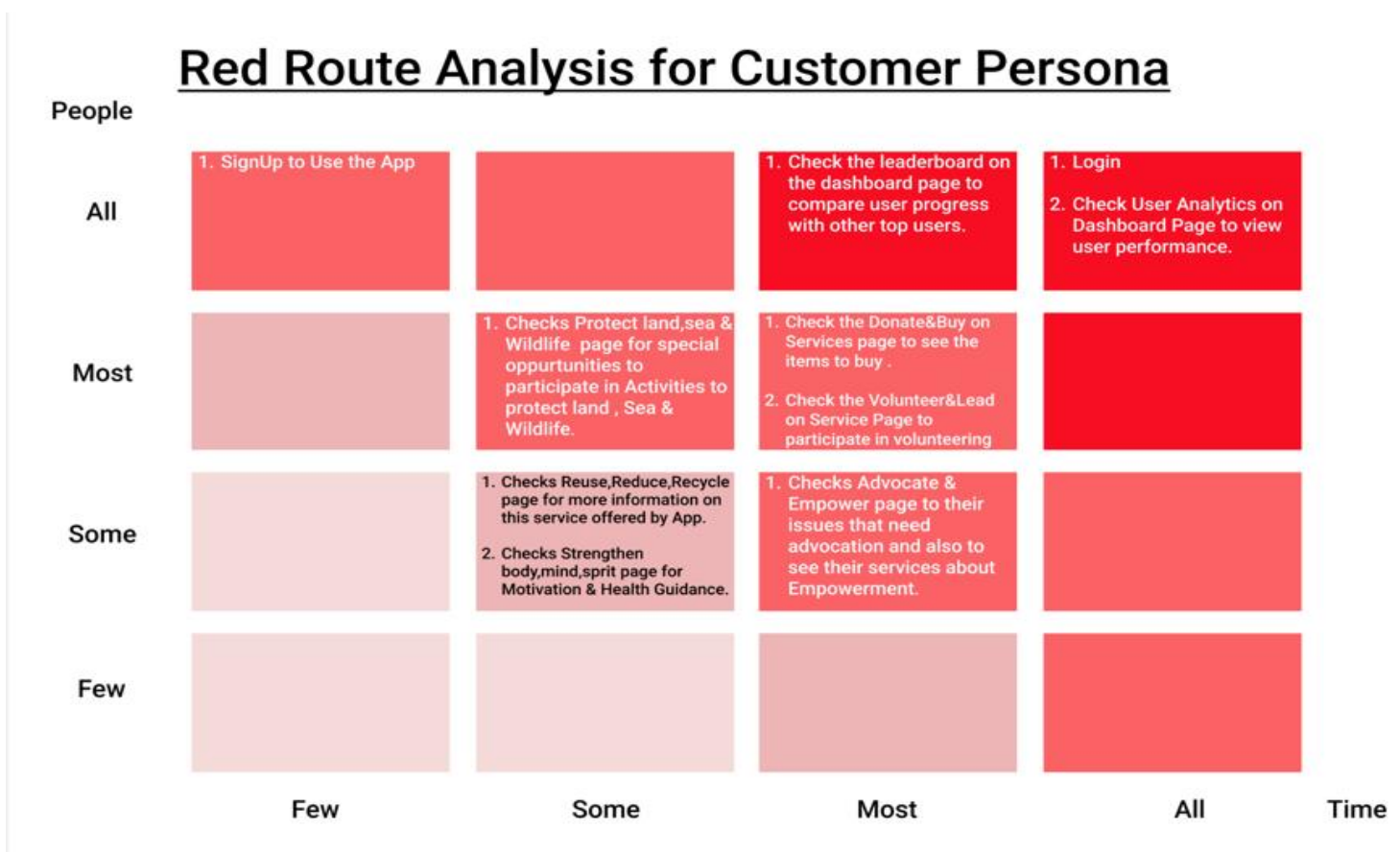


Figure 1 - Customer Red Routes

Red Route Analysis for Corporate Persona

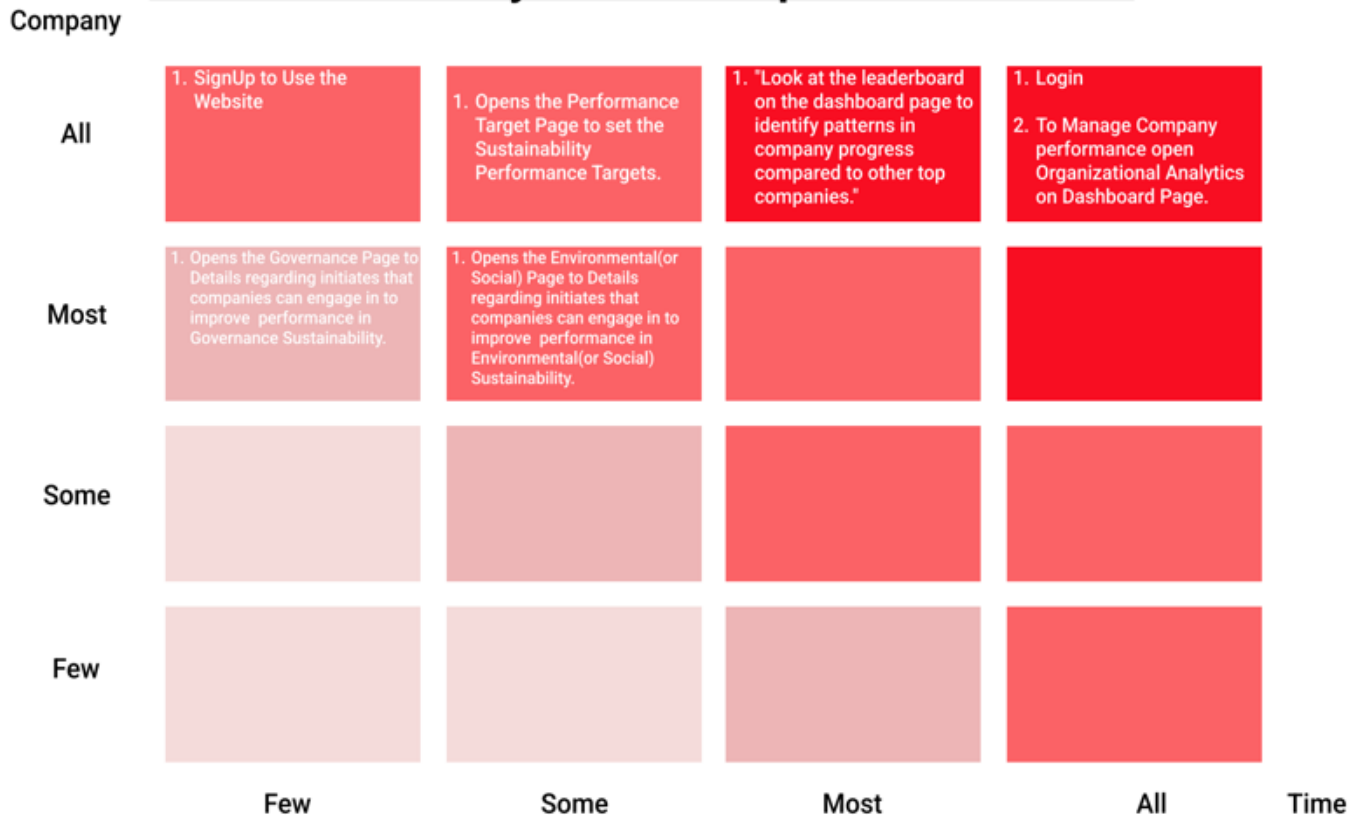


Figure 2 - Corporate Red Routes

2.4 Layout Diagrams & Prototyping:

To ensure a clear development workflow, low-fidelity and high-fidelity wireframes were created before coding.

Low-Fidelity Wireframes [12] (Sketches and Mockups)

[Master Thesis/My Docs/08_website Low fidelity Design V2.pdf](#)

- Designed basic layouts for all web pages before implementation.
- Helped in visualizing user flow and interactions.
- Early feedback from wireframing helped improve navigation, dashboard layout, and call-to-action buttons. These changes were added to high-fidelity wireframes before development.

High-Fidelity Wireframes [13](Refined UI/UX Designs)

- Created using Figma and Adobe XD for a polished look, as these tools allow for precise UI/UX design, real-time collaboration, and easy prototyping for user testing before development.
- Incorporated color schemes, branding, and UI elements.
- Ensured responsive design for mobile and desktop users.

These wireframes played a crucial role in development, allowing me to code efficiently while maintaining consistency across pages.

2.5 Building the Solution:

With all planning stages completed, the development process began using:

- React.js for front-end development.
- Express.js with PostgreSQL for back-end API and database.
- Stripe integration for secure transactions.
- Dashboard implementation for real-time analytics.

The SCRUM methodology was implemented through iterative development cycles, involving collaboration with test users and supervisors. Feedback was gathered through usability tests, surveys, and observation sessions, where users were asked to navigate key features such as sign-up, donations, and dashboards. Data was collected from session recordings, user interactions, and performance benchmarks, which highlighted areas for improvement. Insights from each sprint, such as the need for clearer navigation and faster data retrieval, informed adjustments in the next cycle, ensuring continuous refinement and an intuitive user experience.

Next Steps:

- Complete corporate-side development.
- Optimize UI/UX for a seamless experience.
- Conduct final testing and performance improvements.

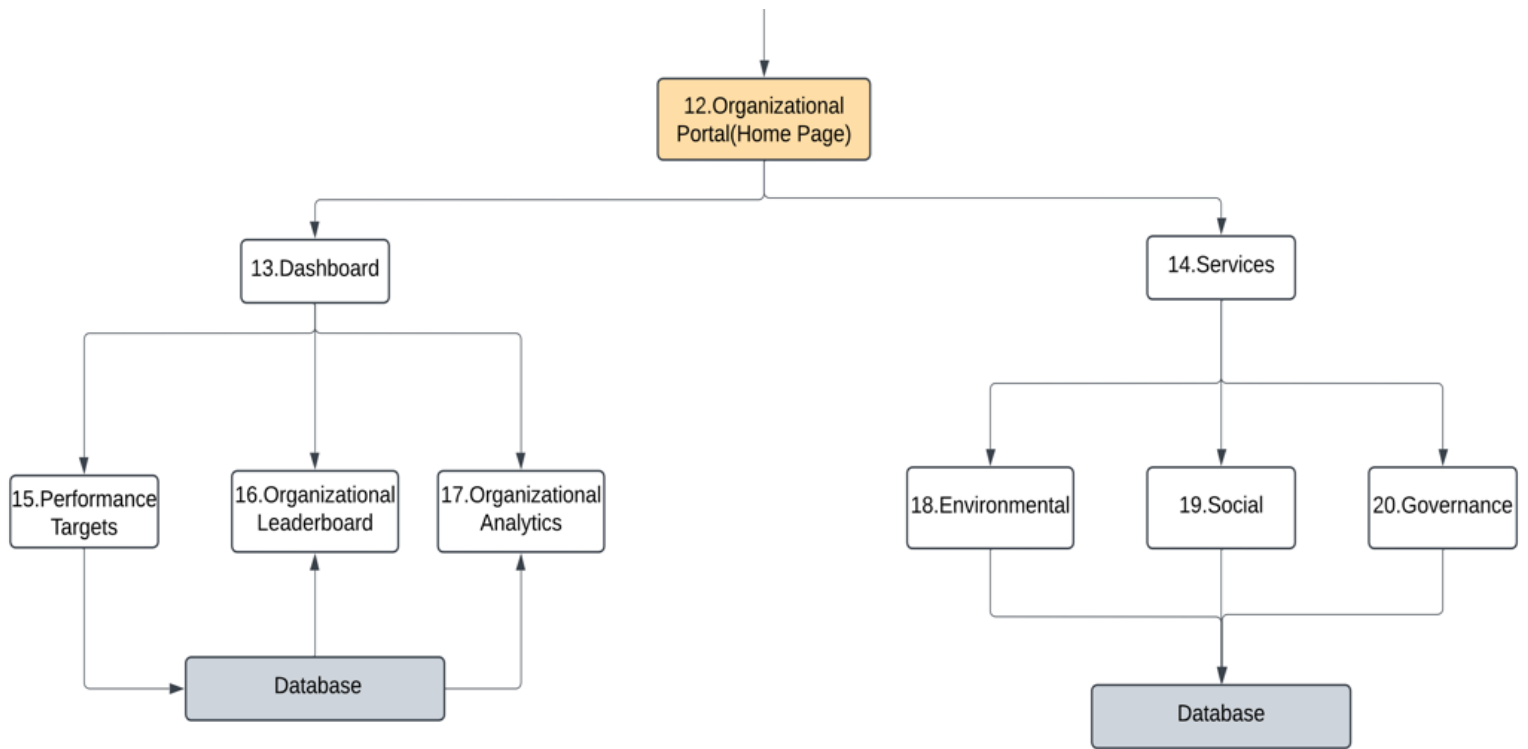


Figure 3- Organizational Page Flow

Chapter 3: Detailed Progress and Challenges

3.1 Completed Milestones (To Date):

The P.A.C.E. System has undergone several key development phases, with various milestones successfully achieved. Below are the completed milestones, along with a brief description of what was accomplished:

Milestone 1: Defining Users and Website Design

Features Implemented:

- Defined user personas based on insights gathered from surveys and interviews, including the student and corporate personas.
- Designed wireframes for the website layout and user flow, ensuring a user-friendly interface that aligns with the needs of both individual users and corporate organizations.
- Created low-fidelity wireframes, followed by high-fidelity designs, for a structured development workflow.

Milestone 2: User Authentication & Database Setup

Features Implemented:

- Developed sign-up and login system using React.js and Express.js.
- Integrated PostgreSQL database for storing user credentials [14].
- Ensured secure authentication using encryption techniques.

---Testing & Debugging:

- Validated database queries for efficiency.
- Conducted unit testing to verify authentication flow.

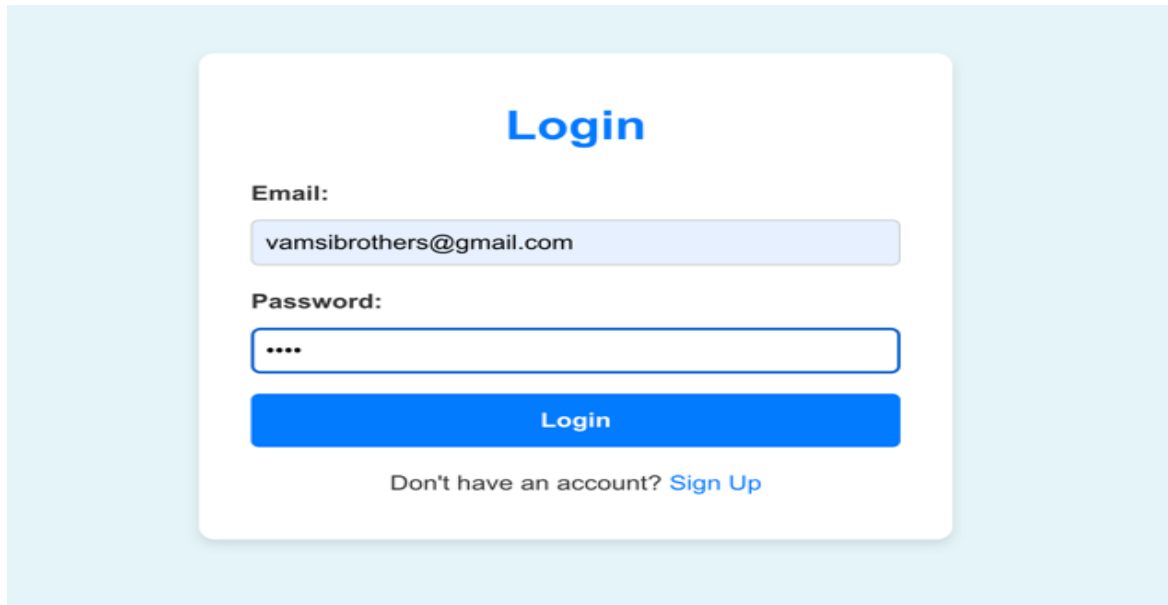


Figure 4- Login Page

Milestone 3: User Dashboard & Analytics

---Features Implemented:

- Built a dynamic user dashboard that tracks sustainability activities, including donations made, volunteering hours logged, advocacy participation, and recycling efforts. Data is collected through user inputs, automated transaction records (via Stripe API for donations), event registrations for volunteering, and interactive feedback forms for advocacy participation. The dashboard dynamically retrieves and visualizes this data, allowing users to monitor their contributions over time.
- Designed a leaderboard system to compare user performance with other users by tracking individual contributions such as donations, volunteering hours, and advocacy participation. For users, it ranks their engagement based on sustainability actions, encouraging competition and motivation.
- Implemented real-time data retrieval from PostgreSQL [15].

---Testing & Debugging:

- Optimized database queries for faster retrieval of user contributions, including donation records, volunteering participation, and sustainability impact metrics. Users access this data through their dashboards to track progress, while organizers retrieve aggregated insights for monitoring overall engagement and reporting sustainability impact.
- Conducted performance testing, including load testing, response time analysis, and UI responsiveness checks. Tests revealed that high-resolution images were slowing down page load times, and database queries for leaderboard rankings needed optimization. As a result, images were compressed for faster rendering, and database indexing was implemented to improve query efficiency, reducing leaderboard load time.

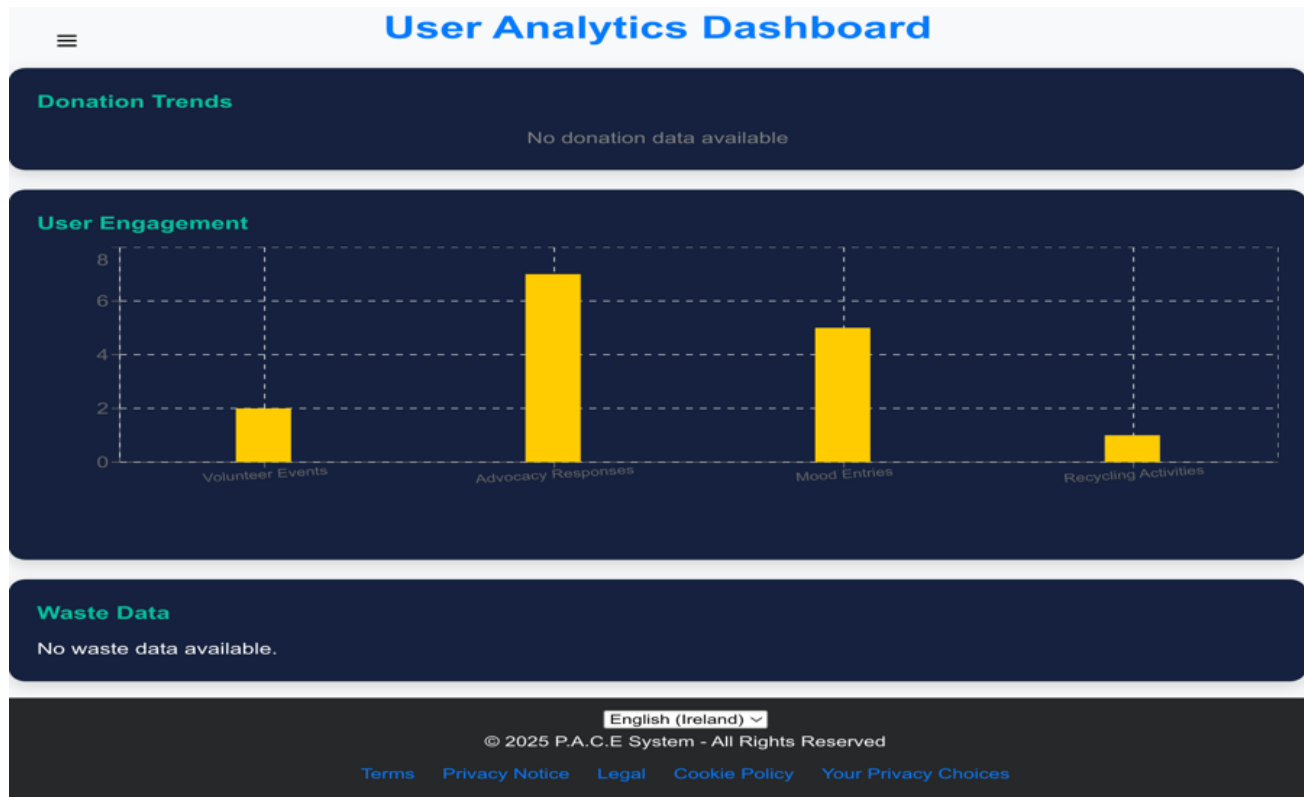


Figure 5- Analytics Page

Milestone 4: Stripe Payment Integration for Donations

---Features Implemented:

- Integrated Stripe API for secure online donations.
- Enabled real-time transaction tracking to store payment details.

---Testing & Debugging:

- Conducted sandbox transactions to verify the payment flow, testing for transaction success, failure handling, and security compliance. Initial tests revealed issues with incorrect error messages for failed payments and occasional delays in transaction confirmation. These were addressed by refining error-handling logic, improving API response times, and ensuring accurate status updates in the user dashboard. The final implementation successfully processed payments with real-time tracking and secure transaction handling. [16].

- Implemented error handling for failed transactions

Figure 6- Donation Page

Milestone 5: Volunteering & Community Engagement Features

---Features Implemented:

- Developed volunteer registration system for sustainability events.
- Stored user participation records in the database, including volunteer event registrations, hours contributed, and event feedback. Users enter their details during sign-up for events, while organizers can log attendance and completion status. This data is used to track engagement levels and recognize active contributors.

---Testing & Debugging:

- Ensured registration process runs smoothly across devices.

- Verified data consistency in user profiles.

Volunteer & Lead



Join upcoming sustainability events and make a difference in your community.

Tree Plantation Drive

Join

Community Cleanup

Join

Wildlife Conservation Program

Join

Eco-Friendly Awareness Campaign

Join

Figure 7- Volunteer Page

Milestone 6: Website Optimization & UI Improvements

---Features Implemented:

- Optimized React components for faster rendering.
- Improved CSS by enhancing color contrast, button visibility, and spacing for better readability. Users found navigation easier, with faster task completion and a cleaner interface.
- Ensured mobile responsiveness across different screen sizes.

---Testing & Debugging:

- Conducted cross-browser testing on Chrome, Firefox, and Edge to ensure compatibility and responsiveness. Tests revealed layout inconsistencies in Firefox and Edge. Adjustments were made to CSS flexbox settings and script optimizations and improved consistency [17].
- Resolved UI bugs affecting responsiveness.

Next Steps: Begin corporate-side development and implement sustainability KPIs.

3.2 Timeline Status:

---Current Status:

The project is on track with the original timeline for the user-side functionalities, with a fully functional platform available for users. However, the corporate-side features have not yet been developed.

---Expected Adjustments:

- User-side optimizations will be completed within 2 weeks.
- Corporate portal development will start immediately after and is expected to take 4 weeks.
- Final testing, KPI integration, and bug fixes will be conducted before the final project deadline.

Goal: Deliver a fully functional, scalable, and optimized web platform within the planned timeline.

3.3 Challenges Encountered:

Problem 1: Lack of Backend Development Experience

Issue:

- Developing secure API endpoints, managing database queries, and handling server-side logic were new challenges.

Solution & Action Taken:

- Referred to documentation for Express.js and PostgreSQL best practices [18].
- Implemented incremental testing to ensure backend logic worked correctly.

Outcome: Successfully developed backend services, allowing seamless user authentication, data storage, and API integration.

Problem 2: Implementing Dynamic Data Visualization in Dashboard

Issue:

- Creating real-time, interactive dashboards to track user progress and donations was difficult.
- Needed to fetch and update sustainability KPIs dynamically.

Solution & Action Taken:

- Researched React.js charting libraries (e.g., Chart.js, Recharts) [19].
- Optimized data fetching using asynchronous API requests.
- Used state management techniques (React Context API) for real-time updates [20].

Outcome: Successfully implemented a user-friendly dashboard that displays real-time progress, leaderboards, and contributions.

Problem 3: Stripe Payment Integration for Secure Donations

Issue:

- Ensuring secure online transactions using Stripe API.
- Handling transaction errors and failed payments.

Solution & Action Taken:

- Followed Stripe API documentation for best integration practices [21].
- Implemented error-handling mechanisms for payment failures

Outcome: Users can now donate securely through the platform, and payments are processed in real-time.

Problem 4: Balancing Project Development with Master's Studies

Issue:

- Managing coursework, assignments, and project development simultaneously was challenging.
- Required effective time management to meet deadlines.

Solution & Action Taken:

- Created a weekly work plan to allocate dedicated time slots for development.
- Prioritized high-impact tasks first (e.g., database setup, API integration).
- Took breaks to avoid burnout and maintain consistent progress.

Outcome: The project remains on track, and progress is being made without compromising academic responsibilities.

Summary of Progress & Challenges

- User-side functionalities are fully operational (Dashboard, Donations, Volunteering, Analytics).

Next Focus: Develop the corporate portal, integrate sustainability KPIs, and perform final optimizations.

With continuous progress and structured development, the P.A.C.E. System remains on track for successful completion.

Chapter 4: Future Work / Next Steps

This section outlines the remaining tasks, upcoming integrations, and estimated completion dates for the P.A.C.E. System. The focus will now shift towards optimizing existing features, developing the corporate-side functionalities, and ensuring final testing before deployment.

4.1 Next Steps for the Coming Weeks

The development plan follows an agile backlog structure, prioritizing tasks based on importance and feasibility.

---Feature Development & Enhancements

Task 1: Complete the Organizational Portal (High Priority – 4 Weeks)

- Implement corporate sign-up and authentication system.
- Develop corporate dashboards with sustainability KPIs [22].
- Allow companies to set sustainability goals and track progress.

Task 2: KPI Integration & Sustainability Metrics (High Priority – 3 Weeks)

- Define corporate sustainability KPIs based on real-world business standards.
- Integrate KPI tracking into corporate dashboards [23].
- Store and visualize data on company contributions.

Task 3: Optimize User-Side Code & UI Improvements (Medium Priority – 2 Weeks)

- Refactor existing React.js components for improved performance.
- Optimize database queries to reduce response times [24].
- Apply final UI/UX adjustments, including CSS touch-ups for a polished look.

Task 4: Implement Notification System (Medium Priority – 2 Weeks)

- Develop email notifications for donation confirmations and volunteer sign-ups.
- Enable dashboard alerts for user milestones [25].

Task 5: Develop Sustainability Scoring System (Low Priority – 3 Weeks)

- Create a scoring model for users based on donations, volunteering, and engagement.
- Display scores on leaderboards and user profiles. [26]

Task 6: Deploy Website to a Live Server (Final Stage – 2 Weeks)

- Select an energy-efficient hosting provider [27].
- Perform server-side optimizations for sustainability.
- Ensure secure deployment with SSL encryption and database backups.

4.2 Upcoming Testing & Integrations

Phase 1: Corporate Dashboard Testing (In 3 Weeks)

- Test corporate account creation & [28].
- Validate corporate data storage and retrieval.

Phase 2: KPI & Analytics Testing (In 4 Weeks)

- Conduct data validation checks to ensure accurate sustainability reporting.
- Compare expected vs. [29].

Phase 3: Security & Performance Testing (Final Month)

- Conduct penetration testing to identify security vulnerabilities [30].
- Perform load testing to ensure website scalability.
- Optimize API calls and database queries for maximum efficiency.

Phase 4: Beta Testing & User Feedback (Before Final Submission)

- Release a test version of the website for a select group of users.
- Gather feedback on usability, performance, and engagement.
- Apply necessary improvements based on user input.

4.3 Estimated Completion Dates

Table 1- Target Estimation Date

Milestone	Task Description	Expected Completion
User-Side Final Optimizations	Improve UI, fix minor bugs, and refine dashboard.	March 25,2025
Organizational Portal Development	Build corporate accounts, dashboards, and KPI tracking.	April 8, 2025
KPI Integration	Implement sustainability performance metrics.	April 1, 2025
Notification System	Add email & dashboard alerts.	March 25, 2025
Sustainability Scoring System	Develop user sustainability ranking.	April 1, 2025
Deployment & Hosting	Deploy final version on live server.	By May 1, 2025
Security & Performance Testing	Load testing, security checks, and optimizations.	By May End
Beta Testing & Feedback Implementation	Collect user feedback and make final adjustments.	Before Project Deadline

Summary of Next Steps

The next major development focus is on corporate-side functionalities and KPI integration. Final testing and optimizations will ensure a polished, scalable, and sustainable platform. Deployment will be completed in the final phase, followed by user testing and feedback collection.

Final Goal: Deliver a fully functional, scalable, and user-friendly sustainability platform that enables individuals and organizations to track their sustainability contributions, participate in initiatives, and drive engagement through donations, volunteering, and impact analytics. This aligns with the project's objective of providing a transparent and interactive system for promoting sustainability efforts.

Chapter 5: Conclusion

The P.A.C.E. System has made significant progress, with core user-side functionalities fully developed and operational. The platform currently supports secure authentication, donation processing, user dashboards, volunteering event registrations, and real-time analytics tracking. The Stripe payment gateway integration ensures secure financial transactions, while the dashboard feature allows users to track their contributions toward sustainability goals.

Challenges such as learning backend development from scratch, implementing a real-time data visualization system, and managing project development alongside master's coursework, were successfully overcome through self-learning, structured problem-solving, and iterative improvements.

At this stage, the platform is fully functional for individual users, but work remains on developing the corporate portal. The next phase will focus on:

- Building corporate dashboards with KPI tracking.
- Refining the UI/UX for better engagement.
- Enhancing database performance and sustainability scoring metrics.
- Final security and performance testing before deployment.

With the SCRUM development approach, the project remains on track for completion within the planned timeline. The final goal is to deliver a fully functional, scalable, and user-friendly sustainability platform that not only engages users but also contributes meaningfully to global sustainability efforts.

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