



# INSTITUTE OF AERONAUTICAL ENGINEERING (AUTONOMOUS)

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## Complex Problem-Solving Self-Assessment Form

1	Name of the Student	AMAL BIJOY	
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3	Branch and Section	CSE-(AI&ML) - A	
4	Program	B. Tech	
5	Course Name	Front-End Web Development	
6	Course Code	ACSE04	
7	Please tick (✓) relevant Engineering Competency (ECs) Profiles		
	<b>EC</b>	<b>Profiles</b>	<b>(✓)</b>
	EC 1	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
	EC 2	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
	EC 3	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
	EC 4	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	✓
	EC 5	Conceptualises alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	✓
	EC 6	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	✓

EC 7	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	✓
EC 8	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	✓
EC 9	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	✓

	EC 10	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	✓
	EC 11	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	✓
	EC 12	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	✓
8	Please tick (✓) relevant Course Outcomes (COs) Covered		
	CO	Course Outcomes	(✓)
	CO 1	Build responsive web applications using HTML5, CSS3, and JavaScript ES6+ with geolocation and map visualization capabilities.	✓
	CO 2	Implement advanced filtering algorithms and search functionality with client-side data processing and optimization.	✓
	CO 3	Develop accessible interfaces following WCAG 2.1 standards with proper semantic HTML and keyboard navigation support..	✓
	CO4	Utilize browser APIs including Geolocation, LocalStorage, and JSON for real-time location detection and data persistence..	
	CO 5	Design progressive disclosure patterns and information architecture to manage complex datasets with optimal information density.	✓
	CO 6	Apply three-tier architecture (Data/Business Logic/Presentation layers) to create maintainable, scalable front-end solutions.	✓
9	Course ELRV Video Lectures Viewed	Number of Videos	Viewing time in Hours
		-	-
10	Justify your understanding of WK1	-	

11	Justify your understanding of WK2 – WK9	-
12	How many WKs from WK2 to WK9 were implanted?	-
	Mention them	-

Date: 13-12-2025

Amal Bijoy

Signature of the Student

**COMPLEX ENGINEERING PROBLEM**

**A COURSE SIDE PROJECT**

**ON**

**Front-End Web Development**

***Amal Bijoy***

***25951A6635***

# **RecycleRadar**

*A Project Report submitted  
in partial fulfillment of the  
requirements for the award of the degree of*

**Bachelor of Technology  
in**

**CSE (Artificial Intelligence & Machine Learning)**

*By*

**Amal Bijoy**

**25951A6635**



**Department of CSE (Artificial Intelligence & Machine Learning)**

**INSTITUTE OF AERONAUTICAL ENGINEERING**

**(Autonomous)**

**Dundigal, Hyderabad – 500 043, Telangana**

**December, 2025**

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## **DECLARATION**

I certify that,

- a. The work contained in this report is original and has been done by me under the guidance of my supervisor (s).
- b. The work has not been submitted to any other Institute for any degree or diploma.
- c. I have followed the guidelines provided by the Institute for preparing the report.
- d. I have conformed to the norms and guidelines given in the Code of Conduct of the Institute.
- e. Whenever I have used materials (data, theoretical analysis, figures, and text) from other sources, I have given due credit to them by citing them in the text of the report and giving their details in the references. Further, I have taken permission from the copyright owners of the sources, whenever necessary.

Amal Bijoy

**Place: Hyderabad**

**Signature of the Student**

**Date: 13-12-2025**

## **CERTIFICATE**

This is to certify that the project report entitled **RecycleRadar** submitted by **Amal Bijoy** to the Institute of Aeronautical Engineering, Hyderabad in partial fulfillment of the requirements for the award of the Degree Bachelor of Technology in **CSE - (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)** is a Bonafide record of work carried out by his guidance and supervision.

The Contents of this report, in full or in parts, have not been submitted to any other Institute for the award of any Degree.

**Supervisor**

**Head of the Department**

**Date: 13-12-2025**

**Principal**

## **APPROVAL SHEET**

This project report entitled **RecycleRadar** submitted by **Amal Bijoy** is approved for the award of the Degree Bachelor of Technology in Branch **CSE (Artificial Intelligence & Machine Learning)**.

**Examiner**

**Supervisor(s)**

**Principal**

**Date: 13-12-2025**

**Place: Hyderabad**

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I take this opportunity to express my deepest gratitude to one and all who directly or indirectly helped me in bringing this effort to present form.

# RecycleRadar

## A Location-Based Recycling Center Discovery Platform

Front-End Web Development Laboratory (ACSE04) Project Report

Department of Computer Science and Engineering  
(Artificial Intelligence & Machine Learning)

Institute of Aeronautical Engineering, Hyderabad

Autonomous Institution

December 13, 2025

### **Abstract**

RecycleRadar represents a comprehensive solution designed to address environmental sustainability challenges through accessible technology. This web-based application facilitates the discovery of recycling facilities by leveraging geolocation services and interactive mapping interfaces. The platform enables users to locate nearby recycling centers, understand accepted materials, and access environmental education resources. Developed entirely using front-end technologies including HTML5, CSS3, and JavaScript, the application demonstrates how modern web development can contribute to environmental stewardship. The project incorporates responsive design principles, intuitive user interfaces, and sophisticated filtering mechanisms. This report documents the complete project lifecycle, from problem statement through implementation, discussing technical architecture, feature development, challenges encountered, and solutions deployed. The findings indicate that accessible web applications play a crucial role in promoting sustainable waste management practices and environmental awareness.

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# 1 Introduction

## 1.1 Project Overview

RecycleRadar addresses a fundamental environmental challenge: the accessibility of recycling infrastructure. While environmental consciousness continues to grow globally, many individuals struggle to locate convenient recycling facilities and understand material acceptance criteria. Traditional methods of finding recycling information—including online searches, directory browsing, and manual inquiries—prove time-consuming and often yield incomplete information. This application gap creates a significant barrier to participation in waste reduction and recycling initiatives.

RecycleRadar bridges this gap by providing an integrated, user-friendly digital platform that consolidates recycling facility information within an accessible web interface. The application prioritizes usability, ensuring that users from diverse technical backgrounds can successfully locate appropriate recycling options for their needs.

## 1.2 Problem Statement

Contemporary society faces increasingly severe environmental challenges related to waste management and resource consumption. Inadequate waste recycling contributes significantly to landfill overflow, environmental pollution, and resource depletion. Despite growing environmental awareness and the proliferation of recycling initiatives, systematic barriers prevent meaningful participation:

1. **Information Fragmentation:** Recycling facility information is distributed across multiple platforms, government agencies, and local organizations, requiring significant research effort.
2. **Accessibility Barriers:** Non-technical users encounter difficulty navigating complex databases or directory systems designed primarily for administrative rather than public use.
3. **Incomplete Material Information:** Many users remain uncertain about which materials each facility accepts, leading to improper disposal choices.
4. **Location Discovery Challenges:** Identifying the nearest recycling center requiring specific material handling capabilities involves multiple steps.

5. **Educational Gaps:** Limited integration of environmental education within discovery platforms reduces opportunities for behavioral change.

RecycleRadar directly addresses each identified barrier through thoughtful application design and comprehensive feature integration.

### 1.3 Application Goals

The project pursues the following strategic objectives:

- Simplify recycling facility discovery through geolocation-based services and interactive visualization
- Provide comprehensive, accurate information about material acceptance policies and facility operations
- Integrate educational resources promoting informed recycling practices
- Create an intuitive, accessible interface accommodating users with varying technical proficiency
- Demonstrate front-end technology applications in environmental sustainability contexts

## 2 Technical Architecture and Design

### 2.1 Technology Stack

RecycleRadar employs the following core technologies:

Technology	Purpose
HTML5	Semantic document structure and accessibility features
CSS3	Responsive design, visual styling, and animations
JavaScript (ES6+)	Interactive functionality, geolocation handling, and state management
Geolocation API	Browser-based user location detection
LocalStorage	Client-side data persistence
JSON	Data structuring for recycling center information

## **2.2 System Architecture**

The application implements a client-side architecture following the Model-View-Controller (MVC) pattern:

**Data Layer** Maintains recycling center records including location coordinates, accepted materials, operating hours, and contact information.

**Logic Layer** Implements filtering algorithms, distance calculations, and search functionality.

**Presentation Layer** Manages user interface rendering, event handling, and visual feedback.

## **2.3 Key Components**

### **2.3.1 Geolocation Module**

Retrieves user coordinates using the browser Geolocation API. Implements fallback mechanisms for scenarios where location access is denied. Provides clear user communication regarding location usage.

### **2.3.2 Map Interface**

Visualizes recycling centers using an interactive map representation. Supports marker placement, information windows, and user interaction through click handlers.

### **2.3.3 Search and Filtering Engine**

Enables users to filter facilities by material type, location radius, and operating hours. Implements efficient searching algorithms that update results in real-time.

### **2.3.4 Information Management**

Maintains comprehensive facility database with dynamic updates reflecting current operational status and material acceptance policies.

## **3 Features and Functionalities**

### **3.1 Core Features**

#### **3.1.1 Geolocation-Based Discovery**

The application automatically detects user location upon initialization, establishing geographic context for facility discovery. Users receive clear communication regarding location usage and retain the option to manually specify their location.

#### **3.1.2 Interactive Facility Search**

Comprehensive search functionality enables users to:

- Search by facility name or location area
- Filter by accepted material types (plastic, metal, paper, glass, electronics, organic)
- Specify search radius in kilometers
- Filter by operational hours and amenities

#### **3.1.3 Detailed Facility Information**

Each facility entry displays:

- Complete address and contact information
- Operating hours with holiday considerations
- Comprehensive material acceptance lists
- Amenity indicators (24/7 service, free service, accessible facilities)
- User ratings and review counts
- Distance calculations from user location

#### **3.1.4 Educational Integration**

The application includes integrated recycling guidelines addressing:

- Material preparation (cleaning, separation)
- Proper sorting methodologies

- Material-specific handling requirements
- Environmental impact information

## **3.2 Advanced Features**

### **3.2.1 Responsive Design**

The interface adapts seamlessly across device categories:

- Desktop displays: Full-featured interface with comprehensive information
- Tablet displays: Optimized layout with adjusted spacing and touch targets
- Mobile displays: Touch-friendly interface with stackable content layout

### **3.2.2 User Preference Persistence**

LocalStorage functionality enables the application to retain:

- User search history
- Frequently accessed facilities
- Material preferences
- Interface customization choices

### **3.2.3 Real-Time Availability**

Simulated availability updates provide realistic facility status information. In production environments, integration with IoT sensors would enable actual real-time updates.

## **4 Implementation Details**

### **4.1 HTML Structure**

The application employs semantic HTML5 elements promoting accessibility and SEO optimization:

- `<header>`: Application title and navigation
- `<nav>`: Filter and search controls

- `<main>`: Primary content container
- `<section>`: Logical content grouping
- `<article>`: Individual facility information

## **4.2 CSS Implementation**

Responsive styling utilizes:

- CSS Grid for layout management
- Flexbox for flexible component arrangement
- Media queries for device-specific styling
- CSS custom properties for maintainable color schemes
- CSS animations for enhanced user feedback

## **4.3 JavaScript Functionality**

### **4.3.1 Event-Driven Architecture**

User interactions trigger event listeners that:

- Validate user input
- Execute filtering algorithms
- Update DOM elements
- Persist data to LocalStorage

### **4.3.2 Data Processing**

JavaScript algorithms handle:

- Distance calculations using geographic coordinates
- Material type matching
- Operating hours validation
- Result sorting and prioritization

## 5 Challenges Encountered and Solutions

### 5.1 Technical Challenges

#### 5.1.1 Geolocation Accuracy

**Challenge:** Obtaining accurate location information while respecting user privacy and managing scenarios where geolocation access is denied.

**Solution:** Implemented a dual-approach strategy providing high-accuracy geolocation when available while offering manual location input as fallback. Clear user communication explains location necessity and usage. Fallback mechanisms provide graceful degradation.

#### 5.1.2 Complex Data Filtering

**Challenge:** Implementing efficient filtering across multiple dimensions (location, materials, amenities, hours) without compromising performance.

**Solution:** Employed client-side filtering using JavaScript array methods (filter, map, reduce). Optimized search algorithms minimize unnecessary iterations. Pagination reduces rendering load for large result sets.

#### 5.1.3 Responsive Map Display

**Challenge:** Maintaining map responsiveness across diverse devices while preserving functionality and visual clarity.

**Solution:** Implemented container queries and resize listeners enabling dynamic map recalibration. CSS media queries adjust map container dimensions appropriately for each device category.

### 5.2 Design Challenges

#### 5.2.1 Information Architecture

**Challenge:** Presenting comprehensive facility information without overwhelming users through excessive content density.

**Solution:** Employed progressive disclosure pattern where initial map view displays essential markers. Detailed information surfaces through targeted interactions (marker clicks, information panels). Hierarchical content organization prioritizes critical information.

### **5.2.2 Accessibility Compliance**

**Challenge:** Ensuring the application meets WCAG 2.1 accessibility standards accommodating users with visual, motor, and cognitive disabilities.

**Solution:** Implemented color contrast ratios exceeding minimum standards. Added ARIA labels to interactive elements. Ensured keyboard navigation functionality. Provided alternative text for all visual elements.

## **6 Modules and Concepts Applied**

The project demonstrates mastery of the following course concepts:

### **6.1 HTML5 Semantic Elements**

Comprehensive use of semantic tags (`<header>`, `<nav>`, `<main>`, `<section>`, `<article>`) improves document structure, accessibility, and SEO optimization.

### **6.2 CSS3 Responsive Design**

Mobile-first design approach utilizing media queries enables seamless adaptation across device sizes. Flexbox and Grid layouts provide flexible, maintainable responsive structures.

### **6.3 JavaScript Event Handling**

Event-driven architecture manages user interactions through listeners capturing click, input, and form submission events.

### **6.4 DOM Manipulation**

Efficient DOM operations update interface elements dynamically in response to user interactions and data changes.

### **6.5 Asynchronous Programming**

Geolocation API calls demonstrate understanding of asynchronous operations and promise handling.

## **7 Testing and Validation**

### **7.1 Functionality Testing**

Comprehensive testing validated:

- Geolocation retrieval and fallback mechanisms
- Search and filtering accuracy
- Data persistence through LocalStorage
- UI responsiveness across interactions
- Error handling and edge cases

### **7.2 Device Testing**

The application was tested across:

- Desktop devices (Windows, macOS, Linux)
- Tablet devices (iPad, Android tablets)
- Mobile devices (iOS, Android)

### **7.3 Browser Compatibility**

Confirmed functionality across:

- Google Chrome (current version)
- Mozilla Firefox (current version)
- Safari (current version)
- Microsoft Edge (current version)

## **8 Conclusions**

RecycleRadar successfully demonstrates how front-end web technologies can create practical solutions addressing environmental sustainability challenges. The application provides an accessible, intuitive platform enabling users to discover

recycling facilities, understand material acceptance policies, and access environmental education resources.

The project validates several important principles:

1. **Client-Side Sufficiency:** Complex functionality including geolocation, filtering, and data persistence can be implemented entirely using front-end technologies.
2. **Responsive Design Excellence:** Careful attention to responsive design principles enables seamless user experiences across diverse device categories.
3. **Accessibility Integration:** Accessibility compliance should not be treated as an afterthought but rather as a foundational design principle.
4. **Environmental Impact:** Technology solutions can meaningfully contribute to environmental sustainability objectives.

## 9 Future Enhancement Opportunities

Several enhancement opportunities emerge from the current implementation:

### 9.1 Backend Integration

Integration with backend services would enable:

- Real-time facility data updates through IoT sensor networks
- User account systems supporting cross-device synchronization
- Community-driven facility information updates
- Advanced analytics regarding recycling patterns

### 9.2 Advanced Features

Potential future enhancements include:

- AR visualization of facility locations
- Mobile app development using React Native or Flutter
- AI-based recycling education personalization

- Integration with municipal waste management systems
- Gamification features promoting recycling participation

### 9.3 Expansion Possibilities

Broader project expansion could include:

- Multi-language support serving diverse communities
- International facility database development
- Integration with transportation systems for facility access
- Partnership with environmental NGOs for educational content

## A Key Code Snippets

### A.1 Geolocation Implementation

```
navigator.geolocation.getCurrentPosition(  
  position => {  
    const {latitude, longitude} = position.coords;  
    initializeMap(latitude, longitude);  
  },  
  error => handleLocationError(error)  
);
```

### A.2 Search and Filter Function

```
function searchRecyclingCenters() {  
  const results = recyclingCenters.filter(center => {  
    return matchesName(center) &&  
      matchesMaterial(center) &&  
      matchesRadius(center);  
  });  
  displayResults(results);  
}
```

## B References

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