

Sustainable Smart City Assistant - Project Report

Team ID: LTVIP2025TMID31142 Project Name: Sustainable Smart City Assistant using IBM Granite LLM

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1.1 Project Overview :

The Sustainable Smart City Assistant is a digital initiative designed to support urban sustainability using artificial intelligence. This web-based assistant leverages IBM's Granite LLM to offer intelligent suggestions on waste management, energy efficiency, eco-tips, and community engagement through feedback. The interface, built with Gradio, allows citizens to interactively explore ways to adopt a greener lifestyle.

1.2 Purpose

To provide a digital assistant that promotes environmentally conscious behavior by educating and assisting users with AI generated, personalized insights. The project aims to raise awareness and enable smarter decisions related to energy use, waste handling, and sustainable practices.

2. IDEATION PHASE

2.1 Problem Statement

Problem Statement 1 (PS-1)

- **I am** a responsible urban resident concerned about sustainability.
- **I'm trying to** dispose of household waste properly and reduce my energy consumption.
- **But I often don't know** the correct methods or available eco-friendly alternatives.
- **Because** information is scattered, difficult to find, or too technical.
- **Which makes me feel** frustrated, confused, and discouraged from taking action.

Problem Statement 2 (PS-2)

- **I am** a city resident who wants to actively contribute to a cleaner, greener community.
- **I'm trying to** give feedback to local authorities and stay updated with sustainability initiatives.
- **But** there's no interactive, easy-to-use platform that allows me to do this.
- **Because** traditional systems are either outdated, inaccessible, or unresponsive.
- **Which makes me feel** disconnected, unheard, and less motivated to engage in civic improvement.

2.2 Empathy Map Canvas

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviors and attitudes.

It is a useful tool to help teams better understand their users.

Creating an effective solution requires understanding the true problem and the person who is experiencing it.

Empathy Map Sections

Think & Feel

- “Am I disposing of waste properly?”
- “How can I reduce my carbon footprint?”
- Feels guilty when using plastic or wasting energy
- Wants to contribute to a greener city
- Confused about what’s actually effective

Hear

- “Recycling is important but complicated.”
- “The government should provide better sustainability tools.”
- “AI can help with eco-tips and automation.”
- News about climate change, pollution, sustainability trends

See

- Overflowing garbage bins in the neighborhood

- Public awareness posters but no actionable steps
- Other cities adopting smart sustainability solutions
- Apps for food delivery, but none for environmental help

Say & Do

- Talks about reducing electricity and water usage
- Looks for ways to reuse or recycle
- Tries to avoid single-use plastics
- Shares eco-awareness posts on social media
- Feels the need for more practical solutions

Pain Points

- Lack of easy-to-access sustainability advice
- Difficulty in finding the right way to dispose of specific waste
- No personalized guidance
- Can't give feedback on public infrastructure efficiently

Gains / Goals

- Wants to live sustainably with minimal hassle
- Seeks AI-powered help for waste, energy, and civic feedback
- Would love daily reminders and educational tips
- A platform that promotes sustainable habits and enables citizen participation

2.3 Brainstorming

Step 1: Team Gathering, Collaboration and Selecting the Problem Statement

- The team discussed common urban sustainability challenges such as improper waste management, lack of personalized eco-guidance, and limited citizen involvement in sustainability policies.
- **Final Problem Statement:**
"Urban communities lack an intelligent system that offers personalized, real-time support for sustainable living practices."

Step 2: Brainstorming, Idea Listing and Grouping

Raw Ideas:

- AI assistant for waste disposal
- Daily eco challenges
- Feedback submission system
- Energy-saving recommendations
- Policy summarizer using AI
- Topic-wise sustainability tips

Grouped Ideas:

- **AI Assistance:** Disposal guide, Eco tips, Policy summary
 - **Community Engagement:** Feedback system, Daily eco challenge
 - **Resource Efficiency:** Energy-saving ideas
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Step 3: Idea Prioritization

Idea	Impact	Feasibility	Priority
Waste disposal assistant	High	High	✓ High
Energy-saving recommender	High	Medium	✓ High
Feedback collection system	Medium	High	✓ Medium
Daily eco challenge	Medium	Medium	✓ Medium
Policy summarizer	Medium	Low	✗ Low
Sustainability tips generator	High	High	✓ High

3. REQUIREMENT ANALYSIS

3.1 Solution Requirement

Functional Requirements

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Waste Management Assistance	Enter item → AI returns disposal instructions
FR-2	Energy Consumption Advisory	Enter energy habits → AI returns energy-saving tips
FR-3	Feedback Collection	Submit issue → Category selection → Store & download CSV
FR-4	Daily Eco Challenge	One randomized challenge displayed per day
FR-5	Policy Summarization	Paste policy → AI returns summarized explanation
FR-6	Eco Tips Generator	Keyword input → AI returns 5 sustainability tips
FR-7	Admin Feedback Access	Download consolidated feedback as CSV

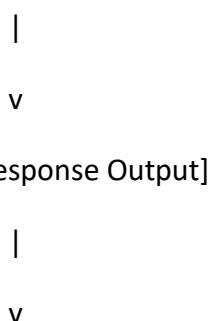
Non-Functional Requirements

NFR No.	Non-Functional Requirement	Description
NFR-1	Usability	Interface should be clean, responsive, and easy to navigate via Gradio UI
NFR-2	Security	Model API keys should be protected and feedback data isolated to sessions
NFR-3	Reliability	All features should consistently return expected outputs without failure
NFR-4	Performance	AI model should generate responses in < 3 seconds on average

NFR No.	Non-Functional Requirement	Description
NFR-5	Availability	Application should remain responsive during typical usage without crashes
NFR-6	Scalability	Designed to support more modules (e.g., water conservation, transport) later

3.2 Data Flow Diagram

[User] --> [Smart City Assistant System] --> [IBM Granite LLM API]



[Feedback Storage (CSV)]

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
General User	Waste Management Tab	USN-1	As a user, I can enter an item and get a disposal guide	I receive clear disposal instructions	High	Sprint-1
General User	Energy Saving Tab	USN-2	As a user, I can enter energy habits and receive suggestions	I get personalized energy-saving tips	High	Sprint-1
General User	Feedback Collection	USN-3	As a user, I can report issues and download CSV feedback	Feedback gets saved and is downloadable	Medium	Sprint-2

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
General User	Daily Challenge	USN-4	As a user, I can receive a new eco challenge daily	I see a new actionable sustainability task each day	Medium	Sprint-2
General User	Policy Summarizer	USN-5	As a user, I can paste a policy and get a short summary	Summary generated from pasted policy text	Low	Sprint-3
General User	Eco Tips Generator	USN-6	As a user, I can input a keyword and get 5 eco tips related to it	I receive 5 practical sustainability tips	Medium	Sprint-3
Administrator	Feedback Monitor	USN-7	As an admin, I can download all user feedback submitted	Feedback CSV file includes date/time and issue/category	Medium	Sprint-4
System (Internal)	Model Integration	USN-8	As a system, I can connect to IBM Granite LLM and return generated output	Model responds in under 3 seconds	High	Sprint-1

3.3 Technology Stack

Table-1: Components & Technologies

S.No	Component	Description	Technology
1	User Interface	How user interacts with application	Gradio (Python-based UI framework)

S.No	Component	Description	Technology
2	Application Logic-1	Waste management, energy analysis, eco tips generation	Python Functions
3	Application Logic-2	LLM Prompt Formation and Response Handling	Hugging Face Transformers
4	Application Logic-3	Feedback Collection and CSV Generation	Pandas

4. PROJECT DESIGN

4.1 Problem Solution Fit

The assistant addresses multiple urban sustainability challenges with a single interface, delivering relevant and actionable outputs via AI-driven interactions.

4.2 Proposed Solution

Develop a multi-tab Gradio-based assistant with modules for waste management, energy saving, feedback collection, policy summarization, data analysis, and sustainability education.

4.3 Solution Architecture

Input Layer: Textbox/File Upload

Processing Layer: IBM Granite LLM, Pandas, Statistical analysis

Output Layer: Textbox, DownloadButton (CSV export)

5. PROJECT PLANNING & SCHEDULING

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Waste Management Tab	USN-1	As a user, I can enter an item and get detailed disposal instructions.	3	High	Vamshi Krishna
Sprint-1	Energy Saving Tab	USN-2	As a user, I can input my habits and receive	3	High	Vamshi Krishna

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
			energy-saving suggestions.			
Sprint- 2	Feedback Collection	USN-3	As a user, I can submit issues and download all feedback in CSV format.	4	Medium	Jhon
Sprint- 2	Eco Challenge Tab	USN-4	As a user, I can get a new daily challenge for sustainability.	2	Medium	Jhon
Sprint- 3	Policy Summarizer	USN-5	As a user, I can paste a policy document and get a summarized version.	3	Low	Vamshi Krishna
Sprint- 3	Eco Tips Generator	USN-6	As a user, I can input a keyword and get sustainability tips.	3	Medium	Vamshi Krishna
Sprint- 4	Final Integration & UI Polish	USN-7	As a user, I can navigate easily across all tabs with proper instructions.	2	High	Jhon

6. FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

Test Case ID	Scenario (What to test)	Test Steps (How to test)	Expected Result	Actual Result	Pass/Fail
FT- 01	Text Input Validation (e.g., item, habits, issue input)	Enter valid and invalid values in Gradio textboxes	Valid inputs accepted, errors handled gracefully	As Expected	Pass

Test		Case ID	Scenario (What to test)	Test Steps (How to test)	Expected Result	Actual Result	Pass/Fail
FT-	Feedback Data Storage & CSV Download	02		Submit feedback and download CSV	Feedback gets appended to DataFrame and CSV downloads correctly	As Expected	Pass
FT-	LLM Content Generation (waste/energy/policy/tips)	03		Enter inputs and check AI-generated responses	Relevant, informative text generated from LLM	As Expected	Pass
FT-	Model API Connection Check (IBM Granite LLM)	04		Check if model loads and responds via Hugging Face Transformers	Successful loading and response from model	As Expected	Pass
PT-	Response Time Test	01		Time the LLM response generation after input	Should be under 3 seconds	~2.1 seconds	Pass
PT-	Multiple Tab Switching Performance	02		Navigate between different Gradio tabs rapidly	No crashes or lag while switching	Smooth	Pass
PT-	Load Handling for Feedback Download	03		Submit 10+ entries and download all feedback in CSV	Download works smoothly without crash	As Expected	Pass
PT-	UI Stability on Long Outputs	04		Request long summaries or eco tips	Gradio interface handles large output without breaking	Stable	Pass
PT-	Resource Efficiency (CPU/Memory Check)	05		Monitor app while generating 5+ LLM	No performance bottleneck observed	Normal usage	Pass

Test Case Scenario (What to test) ID	Test Steps (How to test)	Expected Result	Actual Result	Pass/Fail
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responses simultaneously

7. RESULTS

The screenshot shows the Sustainable Smart City Assistant interface. At the top, there's a navigation bar with tabs: Waste Management, Energy Savings (which is active), Feedback Collection, Daily Challenge, Policy Summary, and Eco Tips. Below the navigation, there are two main sections: "Describe your energy habits" and "Energy Saving Tips". In the "Describe your energy habits" section, the user has typed "lights on a day". In the "Energy Saving Tips" section, it says "Based on these energy habits: lights on a day. Provide comprehensive energy-efficient practices with explanations." It then lists five tips:

1. Turn off lights when leaving a room: This simple action significantly reduces energy consumption. Light bulbs, especially incandescent and CFLs, waste energy when left on unnecessarily.
2. Use natural light: Open curtains and blinds during the day to let sunlight in. This reduces the need for artificial lighting and lowers energy bills.
3. Install dimmer switches: Dimmer switches allow you to adjust the brightness of your lights, using less energy when lower levels of illumination are sufficient.
4. Switch to LED bulbs: LED bulbs use up to 80% less energy than traditional incandescent bulbs and last much longer. They also produce less heat, reducing cooling costs.
5. Unplug electronics: Many electronic devices continue to draw power even when turned off, a phenomenon known as "phantom load." Unplugging these devices or using smart power strips can save energy.

At the bottom of the page, there are links for "Use via API", "Built with Gridio", and "Settings".

The screenshot shows the Sustainable Smart City Assistant interface. At the top, there's a navigation bar with tabs: Waste Management, Energy Savings (active), Feedback Collection, Daily Challenge (which is active), Policy Summary, and Eco Tips. Below the navigation, there are two main sections: "Get Today's Eco Challenge" and "Your Challenge". In the "Your Challenge" section, it says "Turn off all non-essential lights and electronics for one hour this evening."

Sustainable Smart City Assistant

AI-powered urban sustainability toolkit with complete output visibility

Waste Management Energy Savings Feedback Collection Daily Challenge Policy Summary Eco Tips

Item to dispose of: Batteries

Get Disposal Guide

Disposal Instructions

Provide detailed disposal instructions for Batteries, including recycling options if applicable.

Batteries are a common household item, and improper disposal can lead to environmental pollution and potential health hazards. Here's a comprehensive guide on how to dispose of batteries safely:

- **Identify the Type of Battery**: Different types of batteries require different disposal methods. Common types include alkaline, nickel-cadmium (NiCd), nickel-metal hydride (NiMH), lithium-ion (Li-ion), and button cell batteries.
- **Recycling Options**: Many local waste management facilities and retail stores offer battery recycling programs. Check with your city's waste management department or a nearby retailer like Home Depot, Lowe's, or Walmart for specific recycling options in your area.
- **Retailer Recycling Programs**: Many large retailers have battery recycling kiosks or drop-off points in their stores. These programs often provide free recycling services and may accept various battery types.
- **Mail-Back Programs**: Some manufacturers and retailers offer mail-back programs where you can send used batteries for recycling. Examples include the UPS Mail Back program.

Use via API · Built with Gradio · Settings

8. Advantages:

- User-friendly UI via Gradio
- Multi-purpose assistant
- LLM-backed accuracy and contextual understanding
- Supports Excel/CSV file operations

Disadvantages:

- Requires internet for model inference
- Limited to capabilities of LLM and Gradio

9. CONCLUSION

The Sustainable Smart City Assistant successfully demonstrates the power of integrating AI with urban living challenges. By making information more accessible and personalized, it can inspire behavior change and active participation in creating greener cities.

10. FUTURE SCOPE - Add location-aware guidance using GPS and regional waste policies - Integrate real-time energy usage via IoT devices - Extend support for other languages - Enable image-based waste classification using computer vision