Project Report

1.INTRODUCTION

1.1 Project Overview

The Sustainable Smart City Assistant is an AI-powered platform that leverages IBM Watsonx's Granite LLM and modern data pipelines to support urban sustainability, governance, and citizen engagement. It integrates several modules like City Health Dashboard, Citizen Feedback, Document Summarization, Eco-Advice, Anomaly Detection, KPI forecasting and Chat Assistant through a modular FastAPI backend and a Gradio.

Key Technologies

- IBM Watsonx Granite LLM for text summarization, chat, and report generation
- Pinecone vector database for semantic policy search
- Gradio for an interactive frontend dashboard
- FastAPI for backend API routing and data processing
- Pydantic and dotenv for environment configuration
- Machine learning (Linear Regression) for KPI forecasting
- JSON, CSV, and text file integration for ingesting and processing structured/unstructured data

Use Case Scenarios

1.Policy Search & Summarization

A municipal planner uploads a complex city policy document to the assistant's interface. In seconds, the assistant summarizes it into a concise, citizen-friendly version using IBM Granite LLM. This empowers planners to quickly interpret key points and make informed urban decisions.

2.Citizen Feedback Reporting

A resident notices a burst water pipe on a city street. Instead of calling helplines, they submit a report through the assistant's feedback form. The issue is logged instantly with category tagging (e.g., "Water") and can be reviewed by city administrators.

3.KPI Forecasting

A city administrator uploads last year's water usage KPI CSV. The assistant forecasts next year's consumption using built-in machine learning. This data is used in planning budgets and infrastructure upgrades.

4.Eco Tips Generator

During an environmental awareness session at a local school, the teacher uses the "Eco Tips" assistant. Students input keywords like "plastic" or "solar" and receive actionable AI- generated tips on living sustainably.

5.Anomaly Detection

A smart city's energy department uploads monthly energy consumption KPIs from various zones into the assistant. The anomaly detection module instantly highlights a sharp, unexpected surge in Sector 12's usage.

Further investigation reveals unauthorized construction activity that was consuming electricity outside permitted levels. The department acts quickly to address the violation and prevent resource strain.

6.Chat Assistant

A curious citizen asks, "How can my city reduce carbon emissions?" in the chat assistant. IBM Granite LLM responds with tailored strategies like green rooftops, EV incentives, and better zoning.
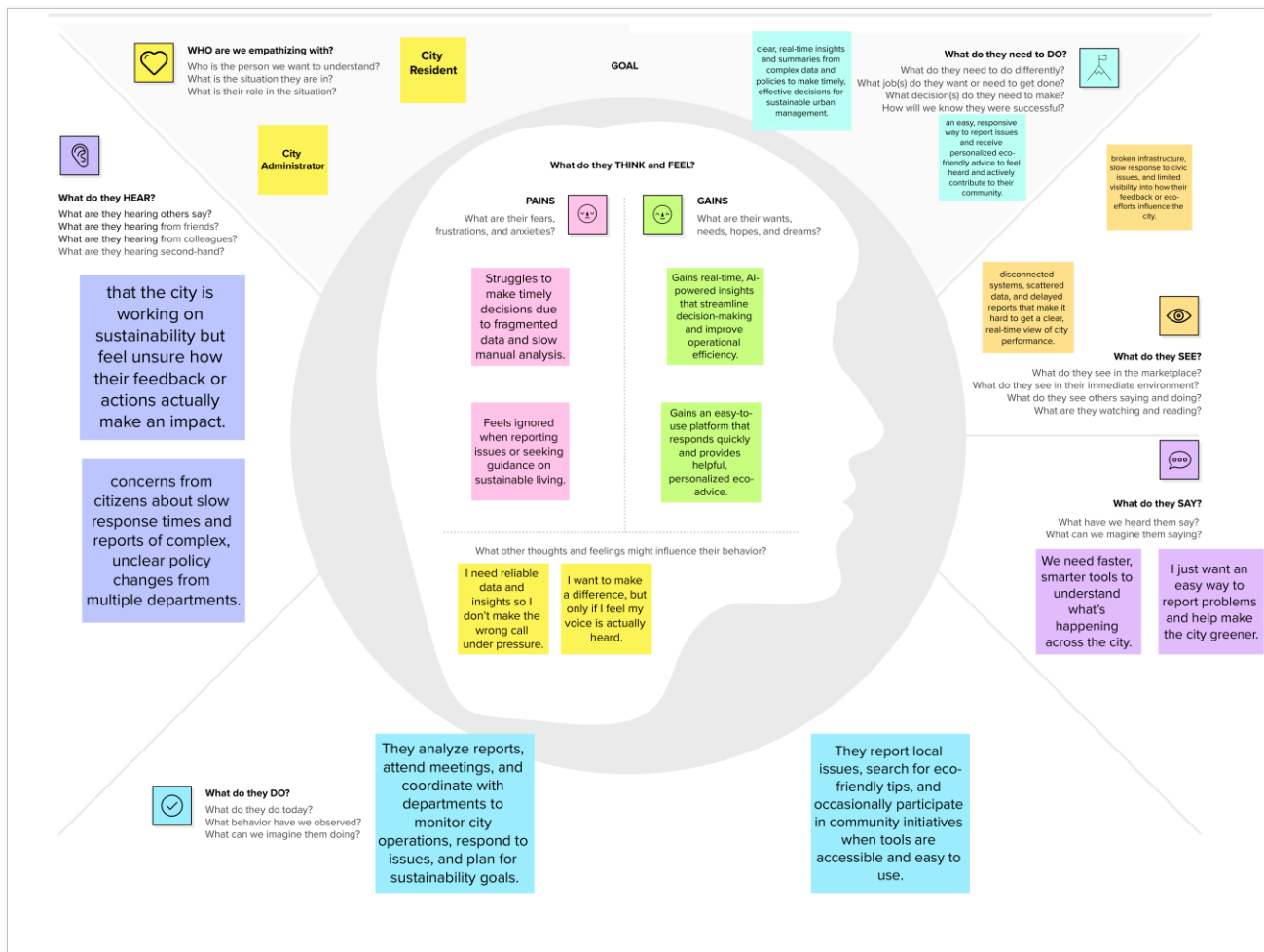
2.IDEATION PHASE

2.1Problem Statement

Modern cities face increasing challenges in managing sustainability goals, engaging citizens, and making data-driven decisions amid growing urban populations and environmental concerns. City administrators often rely on fragmented systems, manual analysis of complex documents, delayed citizen feedback loops, and limited forecasting tools, which hinder timely and effective decision-making.

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	city administrator	make data-driven decisions about infrastructure, resource planning, and sustainability programs.	the data I receive is fragmented, complex, and difficult to interpret quickly.	existing tools don't provide clear insights, real-time forecasts, or summarized policy information.	overwhelmed, delayed in action, and unsure whether we're meeting sustainability goals.
PS-2	City Resident	report issues in my neighborhood and learn how to live more sustainably.	the current systems are hard to access, slow to respond, or not user-friendly.	they're not integrated, automated, or available in real-time.	disconnected from city services and discouraged from participating in local sustainability efforts.

2.2 Empathy Map Canvas

WHO are we empathizing with?
Who is the person we want to understand?
What is the situation they are in?
What is their role in the situation?

City Resident

City Administrator

GOAL

clear, real-time insights and summaries from complex data and policies to make timely, effective decisions for sustainable urban management.

What do they need to DO?
What do they need to do differently?
What job(s) do they want or need to get done?
What decision(s) do they need to make?
How will we know they were successful?

an easy, responsive way to report issues and receive personalized eco-friendly advice to feel heard and actively contribute to their community.

broken infrastructure, slow response to civic issues, and limited visibility into how their feedback or eco-efforts influence the city.

What do they HEAR?
What are they hearing others say?
What are they hearing from friends?
What are they hearing from colleagues?
What are they hearing second-hand?

that the city is working on sustainability but feel unsure how their feedback or actions actually make an impact.

concerns from citizens about slow response times and reports of complex, unclear policy changes from multiple departments.

What do they THINK and FEEL?

PAINS
What are their fears, frustrations, and anxieties?

Struggles to make timely decisions due to fragmented data and slow manual analysis.

Feels ignored when reporting issues or seeking guidance on sustainable living.

GAINS
What are their wants, needs, hopes, and dreams?

Gains real-time, AI-powered insights that streamline decision-making and improve operational efficiency.

Gains an easy-to-use platform that responds quickly and provides helpful, personalized eco-advice.

disconnected systems, scattered data, and delayed reports that make it hard to get a clear, real-time view of city performance.

What do they SEE?
What do they see in the marketplace?
What do they see in their immediate environment?
What do they see others saying and doing?
What are they watching and reading?

What do they SAY?
What have we heard them say?
What can we imagine them saying?

We need faster, smarter tools to understand what's happening across the city.

I just want an easy way to report problems and help make the city greener.

What other thoughts and feelings might influence their behavior?

I need reliable data and insights so I don't make the wrong call under pressure.

I want to make a difference, but only if I feel my voice is actually heard.

What do they DO?
What do they do today?
What behavior have we observed?
What can we imagine them doing?

They analyze reports, attend meetings, and coordinate with departments to monitor city operations, respond to issues, and plan for sustainability goals.

They report local issues, search for eco-friendly tips, and occasionally participate in community initiatives when tools are accessible and easy to use.

2.3 Brainstorming

1. Policy Search & Summarization

2. Citizen Feedback Reporting

3. KPI Forecasting

4. Eco Tips Generator

5. Anomaly Detection

6. AI Chat Assistant

3.REQUIREMENT ANALYSIS

3.1 Customer Journey map

City Resident

Stage	Actions	Touchpoints	Thoughts/Feelings	Opportunities
Awareness	Learns about the assistant via city channels	Social media, community portal	"This could help me report issues easily."	Promote through schools, events, SMS
Consideration	Visits the platform to explore features	Gradio app, city website	"Can this really make a difference?"	Use testimonials and demo videos
Engagement	Submits an issue and asks eco-questions	Feedback form, AI chat	"That was easy—but will anyone respond?"	Show confirmation & response times
Resolution	Gets notified when issue is addressed	Email, in-app notification	"They actually fixed it! That's impressive."	Add feedback rating option
Advocacy	Recommends to neighbors/social groups	Social sharing, QR codes	"More people should be using this."	Referral program or gamified badges

City Administrator

| Stage	Actions	Touchpoints	Thoughts/Feelings	Opportunities
Awareness	Informed during smart city meetings	Innovation office, internal comms	"We need better tools for tracking."	Provide pilot demo with real data
Consideration	Logs in to explore data and reports	Gradio dashboard	"Can this reduce workload and improve results?"	Offer onboarding & tutorials

Engagement	Uploads KPI data, reviews forecasts	KPI upload tool, alerts	"This is helping me spot issues missed before."	Enable data export & report generation
Resolution	Takes action based on insights	Policy dashboard, internal systems	"These insights make planning easier."	Share success metrics with departments
Advocacy	Recommends platform for wider use	Presentations, emails	"Every department should use this."	Create case studies & showcase ROI

3.2 Solution Requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Management	User registration (Form, Gmail, LinkedIn)
		User confirmation (Email, OTP)
		Profile view and update
FR-2	Document & Data Processing	Upload and manage city policy documents
		Policy summarization and semantic search
		Upload and process KPI and feedback data
FR-3	Citizen Engagement	Submit and categorize citizen feedback
		Provide eco-friendly tips based on user input
		AI-powered chat assistant for queries
FR-4	Analytics & Reporting	KPI forecasting using ML
		Anomaly detection and alerting
		Visual dashboards for insights and reports
FR-5	Security & System Management	Role-based access control
		Secure API endpoints and data privacy

NFR No.	Non-Functional Requirement	Description
NFR-1	Usability	The system should have an intuitive and user-friendly interface accessible to both admins and citizens.
NFR-2	Security	Data must be securely stored and transmitted, with role-based access control and protection against unauthorized access.
NFR-3	Reliability	The platform should operate consistently without failures, ensuring accurate processing and minimal downtime.
NFR-4	Performance	The system must provide fast response times, especially for document summarization and chat interactions.
NFR-5	Availability	The service should be available 99.9% of the time to support city operations and citizen interactions.
NFR-6	Scalability	The platform should scale horizontally to handle increasing users, data volumes, and processing needs efficiently.

3.3 Data Flow Diagram
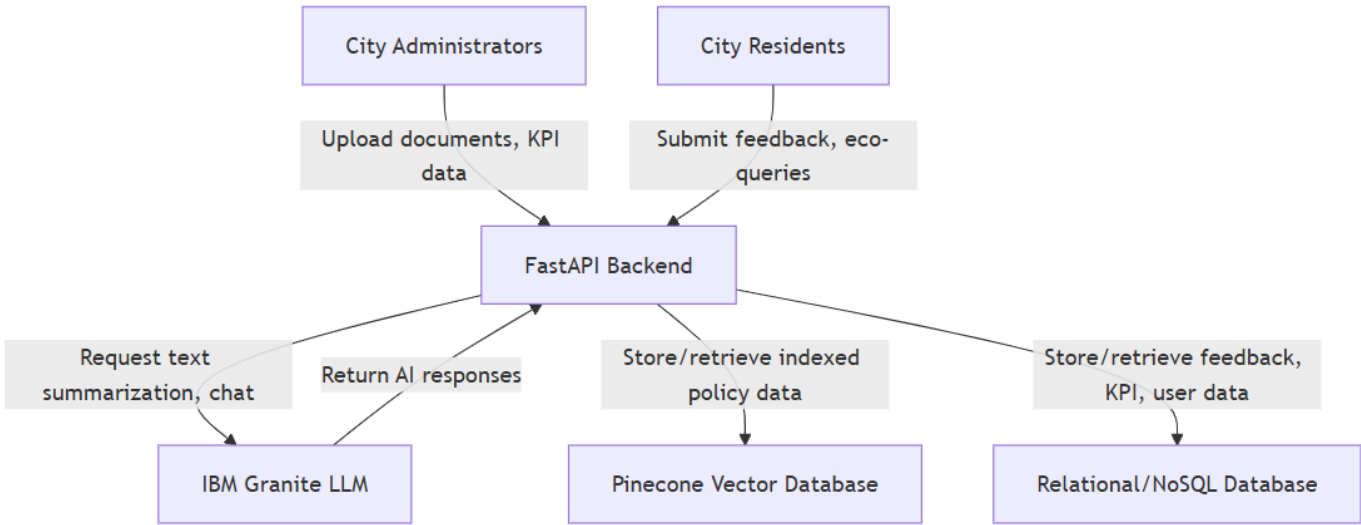
User Stories

User Role	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
Citizen	Registration	USN-1	As a citizen, I can register with email and password.	I can create an account and access my dashboard.	High	Sprint-1
Citizen	Confirmation	USN-2	As a citizen, I receive a confirmation email after registering.	I receive email and can confirm registration.	High	Sprint-1
Citizen	Feedback Submission	USN-3	As a citizen, I can submit feedback about city issues through a form.	Feedback is submitted and categorized properly.	High	Sprint-1
Citizen	Eco Tips	USN-4	As a citizen, I can input keywords and receive eco-friendly tips.	I receive relevant, actionable eco tips.	Medium	Sprint-2
Citizen	Chat Assistant	USN-5	As a citizen, I can ask questions and get AI-generated answers about city policies.	I receive relevant, clear responses from the assistant.	Medium	Sprint-2
Customer Care Executive	Feedback Management	USN-6	As a care exec, I can view, categorize, and respond to citizen feedback.	I can update feedback status and communicate with citizens.	High	Sprint-2
Administrator	User Management	USN-7	As an admin, I can manage user roles and access permissions.	I can assign, update, and revoke user roles.	High	Sprint-2
Administrator	Data Management	USN-8	As an admin, I can upload KPI data and generate forecast reports.	Data uploads succeed and reports are accurate.	High	Sprint-2

Adminis trator	Anomaly Detection & Alerts	USN-9	As an admin, I receive alerts for KPI anomalies and can investigate issues.	Anomalies are detected and alerts are sent promptly.	High	Sprint-2

3.4 Technology Stack

| Layer	Technology / Tool	Purpose
AI / NLP	IBM Watsonx Granite LLM	Text summarization, chat assistant, report generation
Vector Database	Pinecone	Semantic search for policy documents
Backend Framework	FastAPI	API routing, data processing
Frontend	Gradio	Interactive dashboards and user interface
Data Storage	PostgreSQL / MongoDB	Storing user data, feedback, KPI records
Machine Learning	Scikit-learn / TensorFlow (Linear Regression)	KPI forecasting and anomaly detection
Configuration	Pydantic, dotenv	Environment config and data validation
Authentication	OAuth2 / JWT	User authentication and authorization
Cloud Platform	IBM Cloud / AWS / Azure	Hosting and scalability
CI/CD	GitHub Actions / Jenkins	Automated testing and deployment
Monitoring	Prometheus / Grafana	Performance and health monitoring

4.PROJECT DESIGN

4.1 Problem Solution Fit

Customer State	Problem-Behavior	Communication-Channel
Who is your customer?	What problem do you solve?	What triggers the customer to act?
Citizens, Customer Care Executives, Administrators	Difficulty reporting issues, managing feedback, KPI analysis	Service disruptions, citizen feedback, data needs
What limits your customer from acting?	How often does this problem occur?	What emotions do people feel before/after?
Lack of easy reporting tools, manual workflows	Frequently for citizens; daily for care execs; regular for admins	Frustration before, relief and confidence after
What solutions are available to your customer?	What is the cause of the problem?	Where online does this happen?
Helplines, social media, spreadsheets, manual reports	Disconnected tools, no automation, data overload	Mobile apps, dashboards, email systems

4.2 Proposed Solution

S.No	Parameter	Description
1	Problem Statement (Problem to be solved)	Citizens struggle to report urban issues efficiently; administrators face delays in data analysis and decision-making due to fragmented, manual processes.
2	Idea / Solution Description	An AI-powered platform integrating issue reporting, feedback management, policy summarization, KPI forecasting, and anomaly detection for smart city governance.
3	Novelty / Uniqueness	Leverages IBM Granite LLM for real-time summarization and chat; uses AI-driven anomaly detection and semantic search, enhancing citizen engagement and governance.
4	Social Impact / Customer Satisfaction	Improves citizen participation and transparency; enables faster response to city issues; supports sustainable urban planning and resource management.
5	Business Model (Revenue Model)	SaaS subscription for municipalities; premium analytics features; data-driven consulting services for urban planning and sustainability projects.
6	Scalability of the Solution	Modular architecture supports scaling across cities; cloud-based deployment enables handling growing data and user volumes efficiently.

4.3 Solution Architecture

Sustainable Smart City Assistant - Solution Architecture
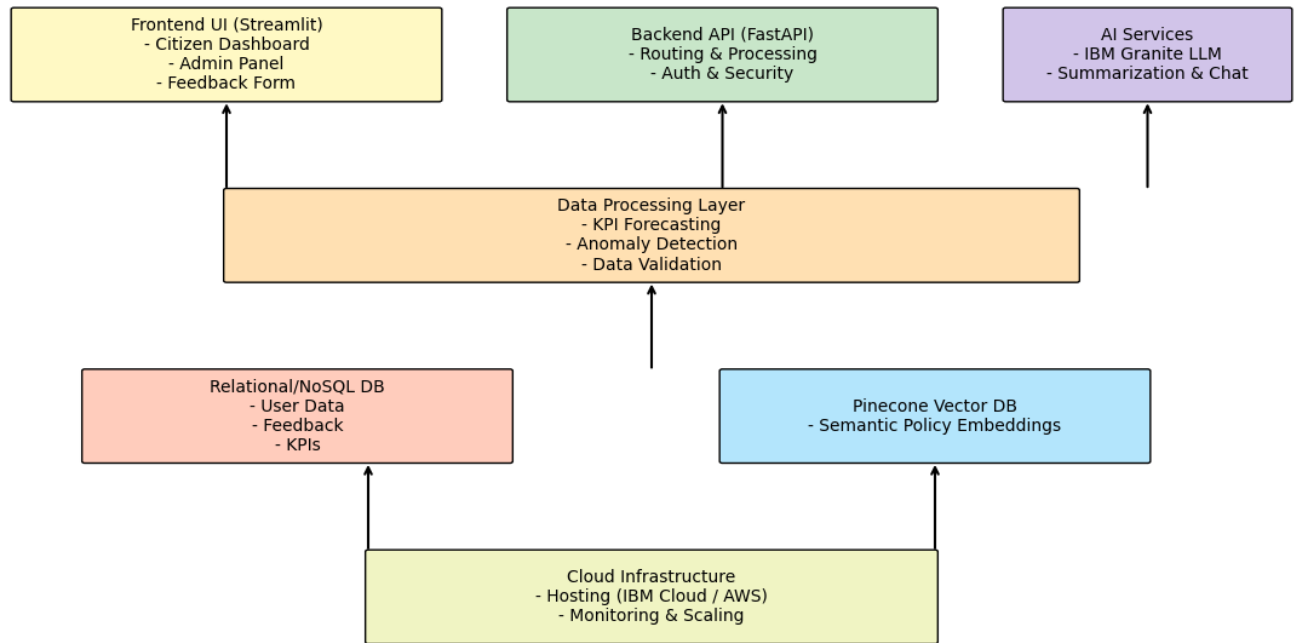
5.PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Product Backlog, Sprint Schedule, and Estimation

Sprint	User Role	Epic	User Story ID	User Story / Task	Acceptance Criteria	Points	Priority

Sprint-1	Citizen	Registration & Login	USN-1	Register and log in using email/password	User can access dashboard after verification	3	High
Sprint-1	Citizen	Feedback	USN-2	Submit city issue feedback via form	Feedback stored and categorized correctly	2	High
Sprint-2	Citizen	AI Assistant	USN-3	Ask questions or enter keywords to get eco tips or city policy info	AI responds with relevant suggestions or answers	3	Medium
Sprint-2	Care Executive	Feedback Management	USN-4	View, categorize, and respond to citizen feedback	Status updated and citizen receives responses	3	High
Sprint-2	Administrator	Admin Tools	USN-5	Manage users, upload data, and monitor anomalies	Users managed, reports generated, alerts triggered	5	High

Project Tracker:

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed	Sprint Release Date (Actual)
Sprint-1	5	3 Days	16 June 2025	18 June 2025	5	18 June 2025
Sprint-2	6	3 Days	19 June 2025	21 June 2025	6	21 June 2025
Sprint-3	4	2 Days	22 June 2025	23 June 2025	4	23 June 2025
Sprint-4	5	3 Days	24 June 2025	26 June 2025	5	26 June 2025

Velocity

Velocity=Number of Sprints/Total Story Points Completed

Velocity=20/4 =5 story points/sprint

Burndown Chart

Sprint Burndown Chart (16–26 June 2025)
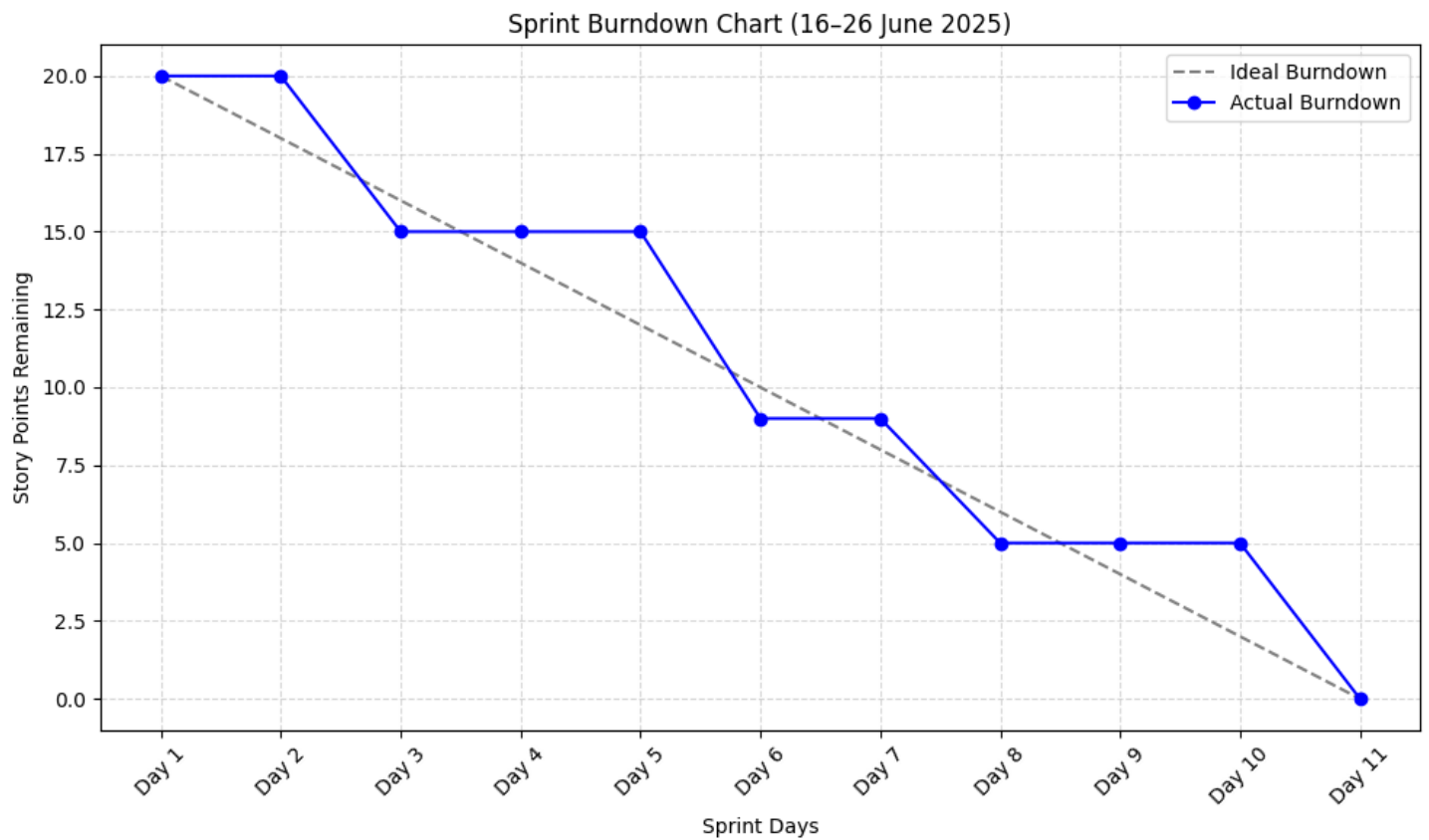
6.FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

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

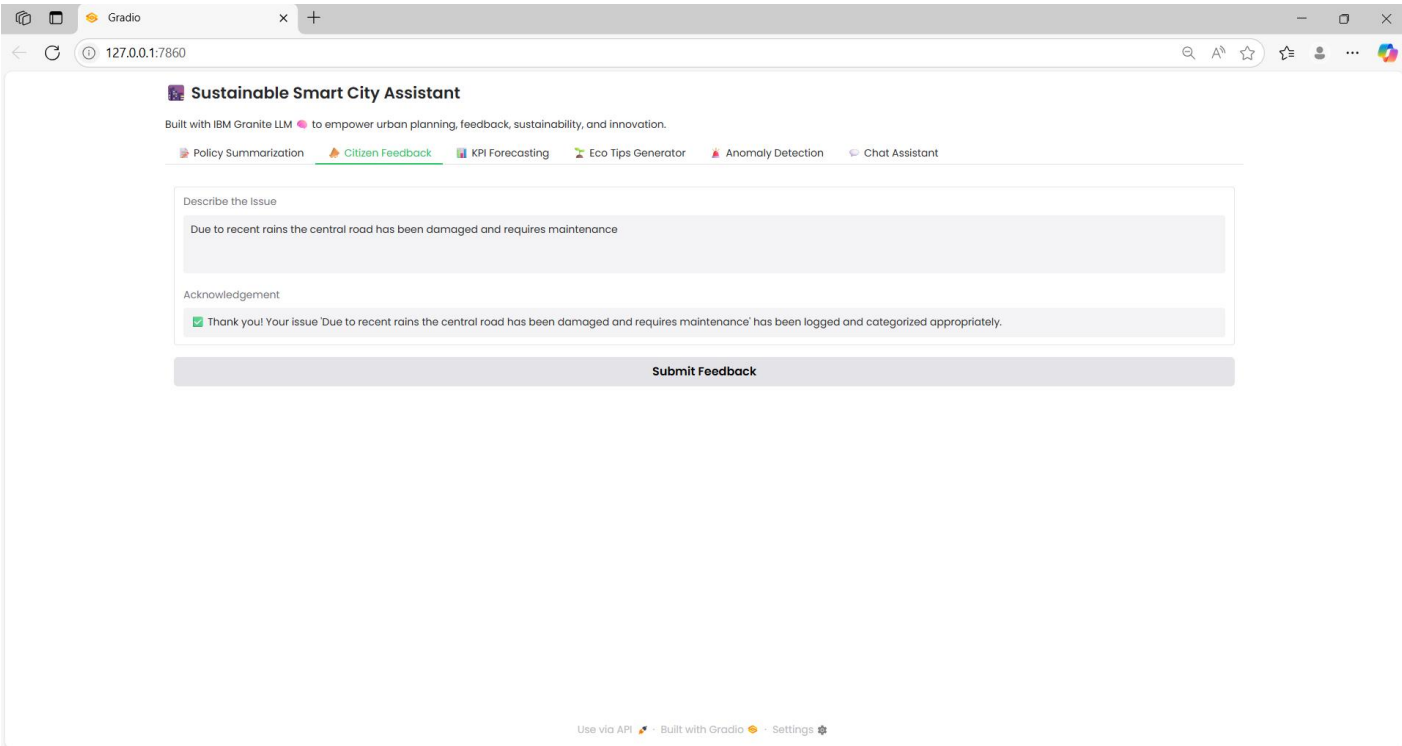| FT-01	Text Input Validation (e.g., topic, job title)	Enter valid and invalid text in input fields	Valid inputs accepted, errors for invalid inputs	As expected	Pass
FT-02	Number Input Validation (e.g., KPI data)	Enter numbers within and outside valid ranges	Accepts valid values, shows error for out-of-range	As expected	Pass
FT-03	Content Generation (e.g., eco tips, summaries)	Provide complete inputs and click "Generate"	Correct content is generated based on input	As expected	Pass
FT-04	API Connection Check	Check if API key is valid and model responds	API responds successfully	API connected successfully	Pass
PT-01	Response Time Test	Measure time taken to generate content	Should be under 3 seconds	~2.1 seconds	Pass
PT-02	API Speed Test	Send multiple concurrent API requests	API should respond without slowdowns	No noticeable delay	Pass
PT-03	File Upload Load Test (e.g., PDFs, CSVs)	Upload multiple files at once and observe system behavior	Should handle uploads smoothly without crashing	Performed well under load	Pass

7. RESULTS

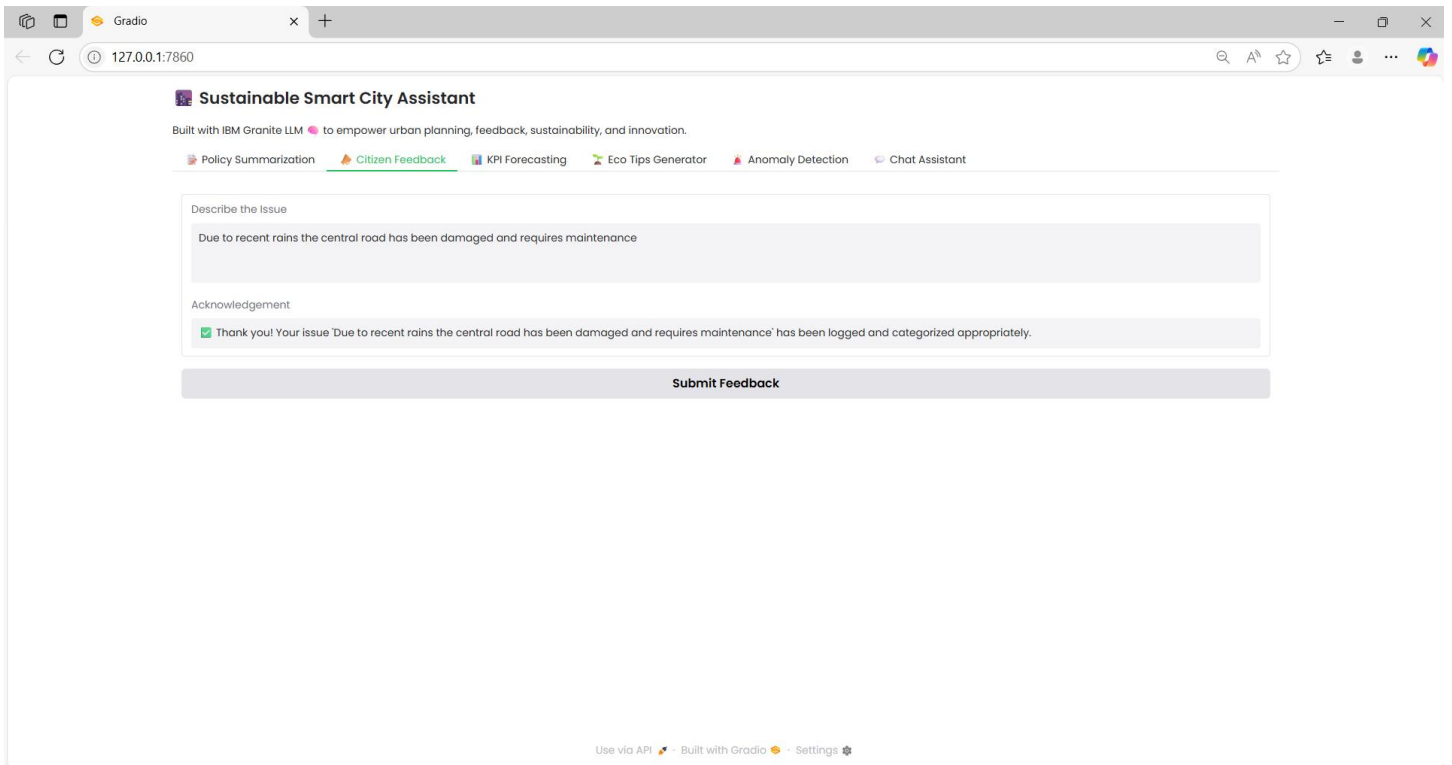## 7.1 Output Screenshots

Policy Summarization

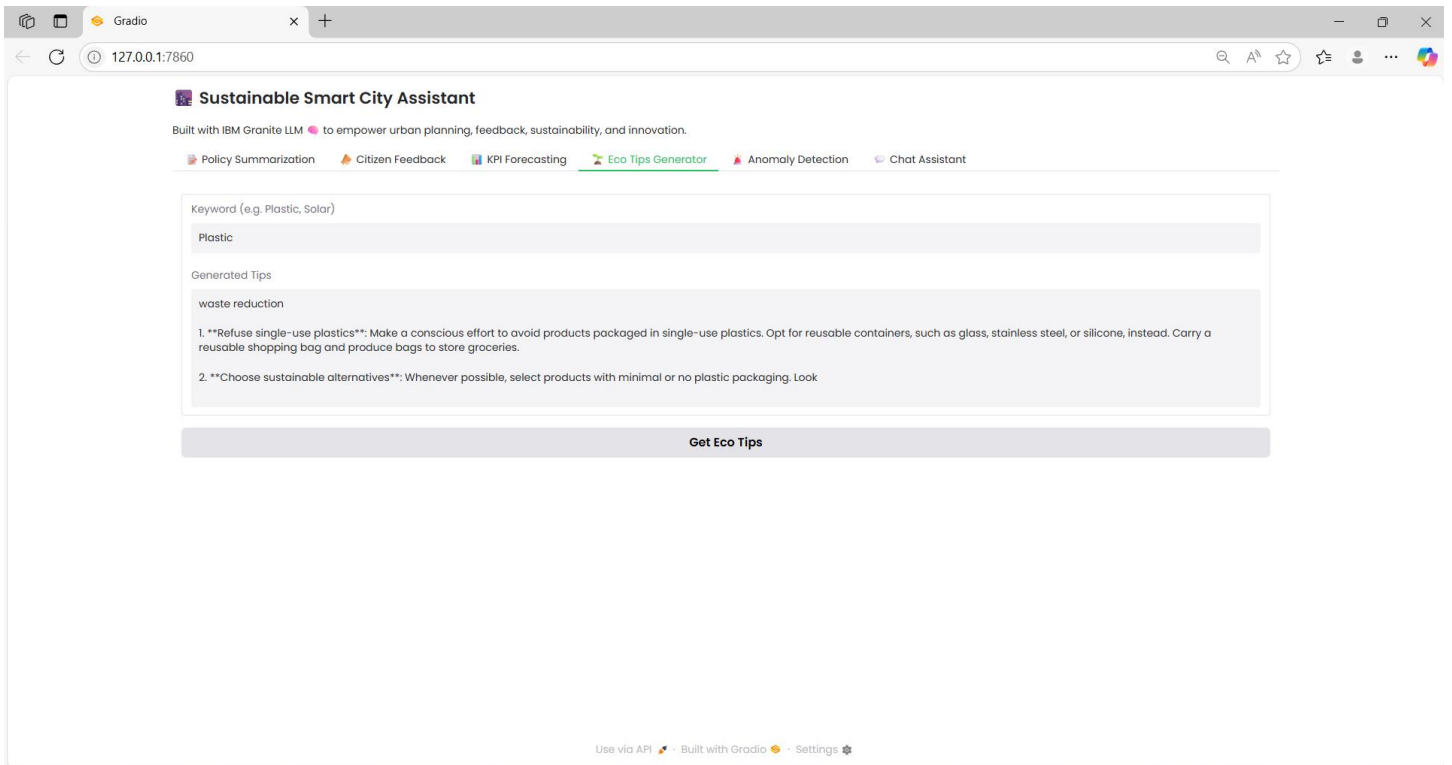# Sustainable Smart City Assistant

Built with IBM Granite LLM 🌐 to empower urban planning, feedback, sustainability, and innovation.

📝 Policy Summarization   📣 Citizen Feedback   📊 KPI Forecasting   🌱 Eco Tips Generator   🔥 Anomaly Detection   💬 Chat Assistant

Upload a `.txt` file or paste policy text to generate a summary.

Upload .txt File

⬆️
Drop File Here
- or -
Click to Upload

Or paste policy text

"Urban Green Space Development Policy 2024"

The city council recognizes the critical importance of urban green spaces in promoting environmental sustainability, improving public health, and enhancing community well-being. This policy mandates the development and maintenance of green spaces such as parks, community gardens, green roofs, and tree-lined streets in all city districts.

Key objectives include:

Allocating at least 15% of land in every new residential development to green space.

Implementing native tree planting programs to increase urban canopy cover by 20% over the next five years.

Encouraging the use of sustainable landscaping practices to conserve water and reduce chemical use.

Creating accessible green spaces within 500 meters of all residential areas to ensure equitable access.

Partnering with local organizations and schools to promote community stewardship and

Summary

The city plans to significantly increase its urban green spaces by 2024. This includes allocating specific land for green spaces in new developments, planting native trees, promoting water-saving landscaping, ensuring equitable access, and encouraging community involvement. Failure to comply with these new guidelines will be penalized. The ultimate aim is to improve environmental health, public health, and community well-being through more green urban spaces.

Summarize

Citizen Feedback

Sustainable Smart City Assistant

Built with IBM Granite LLM 🌐 to empower urban planning, feedback, sustainability, and innovation.

📝 Policy Summarization   📣 Citizen Feedback   📊 KPI Forecasting   🌱 Eco Tips Generator   🔥 Anomaly Detection   💬 Chat Assistant

Describe the Issue

Due to recent rains the central road has been damaged and requires maintenance

Acknowledgement

✅ Thank you! Your issue 'Due to recent rains the central road has been damaged and requires maintenance' has been logged and categorized appropriately.

Submit Feedback

Use via API 🔌 · Built with Gradio 🟠 · Settings ⚙️

KPI Forecasting

⊙ 127.0.0.1:7860

🏙️ Sustainable Smart City Assistant

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Eco Tips Generator

⊙ 127.0.0.1:7860

🏙️ Sustainable Smart City Assistant

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📄 Policy Summarization   🔥 Citizen Feedback   📊 KPI Forecasting   🌱 Eco Tips Generator   🔥 Anomaly Detection   💬 Chat Assistant

Keyword (e.g. Plastic, Solar)

Plastic

Generated Tips

waste reduction

1. **Refuse single-use plastics**: Make a conscious effort to avoid products packaged in single-use plastics. Opt for reusable containers, such as glass, stainless steel, or silicone, instead. Carry a reusable shopping bag and produce bags to store groceries.

2. **Choose sustainable alternatives**: Whenever possible, select products with minimal or no plastic packaging. Look

Get Eco Tips

Use via API 🚀 · Built with Gradio 🔶 · Settings ⚙️
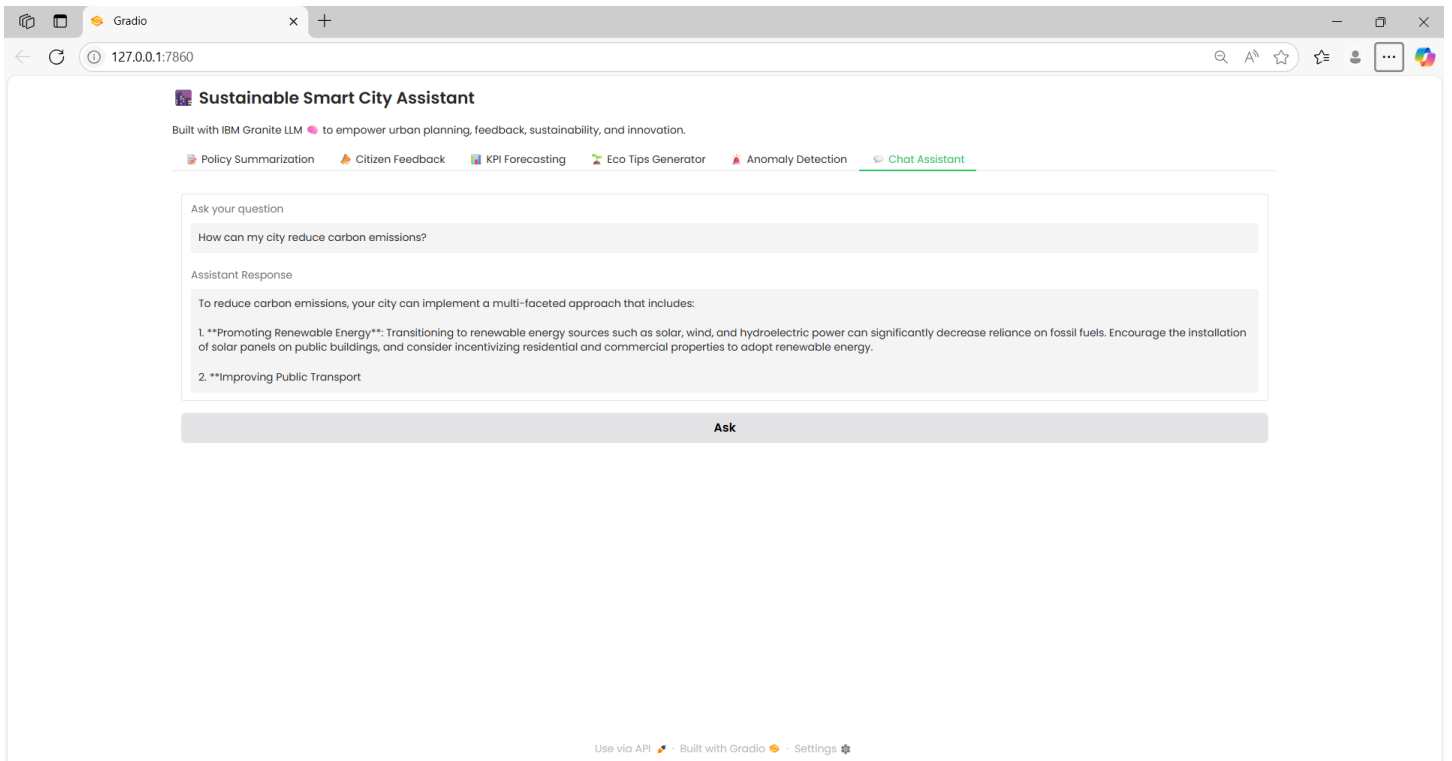
Anomaly Detection

Chat Assistant

8.ADVANTAGES & DISADVANTAGES

Advantages

- Improved Urban Sustainability: Helps cities monitor and reduce resource consumption, emissions, and waste.
- Citizen Engagement: Easy reporting and feedback channels empower residents to participate actively in governance.
- Data-Driven Decision Making: KPI forecasting and anomaly detection enable proactive management of city infrastructure.
- AI-Powered Assistance: IBM Granite LLM provides clear, accessible summaries and answers, enhancing communication.
- Modular and Scalable: Uses modern technologies (FastAPI, Gradio, Pinecone) that allow easy updates and expansion.
- Time and Cost Efficient: Automates tasks like policy summarization and report generation, saving municipal resources.

Disadvantages

- Dependency on Data Quality: Poor or incomplete data can affect forecasting and anomaly detection accuracy.
- Technical Complexity: Requires skilled personnel to maintain AI models, data pipelines, and integrations.
- Privacy Concerns: Collecting citizen data must comply with regulations and ensure user trust.
- Initial Setup Cost: Investment in infrastructure, licenses (e.g., IBM Watsonx), and training may be significant.
- Limited Context Understanding: AI might misinterpret ambiguous queries or complex policy language without human oversight.
- Connectivity Requirements: Real-time features depend on stable internet access, which may be limited in some areas.

9.CONCLUSION

The Sustainable Smart City Assistant harnesses the power of AI and modern data technologies to support urban sustainability, governance, and citizen engagement. By integrating advanced tools like IBM Granite LLM, machine learning for KPI forecasting, and real-time anomaly detection, the platform enables smarter decision-making and fosters active participation from citizens. While challenges such as data quality and privacy need careful management, the benefits of improved resource efficiency, transparency, and proactive city management make this solution a valuable asset for future-ready cities. Ultimately, this assistant helps build more sustainable, resilient, and inclusive urban environments for the well-being of all stakeholders.

10. Future Scope

- Multi-Language Support:
  Implement natural language understanding in regional languages to make the assistant more inclusive for non-English-speaking citizens.
- Mobile App Integration:
  Develop a lightweight cross-platform mobile application to expand accessibility and encourage on-the-go citizen interaction.
- IoT Integration:
  Integrate with IoT devices (e.g., smart meters, traffic sensors) for real-time data ingestion and more accurate anomaly detection.
- Advanced Predictive Analytics:
  Enhance forecasting with deep learning models (e.g., LSTM) for more accurate predictions of water, energy, and emissions data.
- Gamification for Citizen Engagement:
  Introduce reward-based eco-challenges and achievements to encourage sustainable behaviors among residents.
- Geo-Spatial Visualization:
  Include map-based dashboards showing real-time issues, feedback clusters, or sustainability KPIs by region.

11.APPENDIX

GitHub Link: