

Sustainable Smart City Assistant using IBM Granite LLM

1. INTRODUCTION

1.1 Project Overview :

The "Sustainable Smart City Assistant using IBM Granite LLM" is a comprehensive AI-powered web application aimed at transforming urban governance through intelligent automation, citizen-centric services, and sustainable living support. It integrates various smart modules including chat-based assistance, eco tips, KPI forecasting, anomaly detection, policy summarization, and sustainability report generation. Built using Streamlit (frontend), FastAPI (backend), and IBM Granite LLM, the system leverages advanced NLP and ML capabilities to deliver a greener, smarter, and citizen-friendly urban experience.

1.2 Purpose:

The purpose of this project is to build an interactive and intelligent platform that empowers citizens and city administrators with real-time sustainability insights, AI-driven assistance, and actionable recommendations to foster smarter and more eco-conscious urban living.

2. IDEATION PHASE

2.1 Problem Statement:

Urban citizens lack a unified and intelligent platform to access real-time sustainability data, personalized eco-tips, and smart policy assistance. Current systems are fragmented and lack AI integration for forecasting, anomaly detection, and natural language-based interactions.

2.2 Empathy Map Canvas

- **Say:** "I want to know how my city is performing sustainably."
- **Think:** "I wish there was one platform to answer all my city-related queries."
- **Do:** Search multiple websites for city policies and sustainability metrics.
- **Feel:** Confused, frustrated, and disconnected from governance decisions.

2.3 Brainstorming

- Use of AI to answer citizen questions.
- Dashboard showing clean energy usage, recycling rates, and pollution levels.
- Forecast and detect anomalies in city sustainability metrics.
- Generate eco tips and sustainability reports.
- Chatbot and semantic search for policies.

3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

1. User visits Smart City Assistant.
2. Explores dashboard insights.
3. Uploads data for forecasting.
4. Asks chat assistant questions.
5. Receives eco tips and policy summaries.
6. Submits feedback.

3.2 Solution Requirement

- Natural language-based chatbot using IBM Granite LLM.
- Forecasting module for KPIs.
- Anomaly detection for threshold breaches.
- Dashboard for sustainability metrics.
- Semantic search using Pinecone.

3.3 Data Flow Diagram User (Input) -> Streamlit UI -> FastAPI Backend -> AI/NLP Layer (IBM Granite) + ML Modules -> Output (Forecasts, Reports, Responses)

3.4 Technology Stack

- **Frontend:** Streamlit
- **Backend:** FastAPI
- **AI/NLP:** IBM Granite LLM
- **Visualization:** Matplotlib, Plotly
- **Vector DB:** Pinecone
- **Modeling:** Scikit-learn (Linear Regression)

4. PROJECT DESIGN

4.1 Problem-Solution:

The Lack of centralized smart city services is addressed by combining AI-driven chat, analytics, and eco modules in a single assistant.

4.2 Proposed Solution:

A modular, AI-integrated dashboard that offers chat interaction, eco advice, real-time insights, policy summarization, anomaly detection, and forecasting via a friendly Streamlit UI and FastAPI backend powered by IBM Granite LLM.

4.3 Solution Architecture

- Streamlit UI (Chat, Eco Tips, Dashboard)
- FastAPI (Routing, APIs)
- IBM Granite LLM (Chat, Summarization)
- KPI Forecasting (Linear Regression)

- Anomaly Detection (Threshold)
- Pinecone (Semantic Search, optional)

5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning Sprint 1: Setup & Architecture (13 SP)

- Set up FastAPI and Streamlit UI
- Integrate IBM Granite LLM
- Deploy chatbot interface

Sprint 2: Core Features (21 SP)

- Eco-tip generation
- Feedback form
- Document upload & policy summarization

Sprint 3: Intelligence & Forecasting (21 SP)

- Linear regression for KPI forecasting
- Threshold-based anomaly detection
- Sustainability report generation

Sprint 4: Optimization (13 SP)

- Prompt refinement
- Testing and deployment
- Usability improvements

Velocity: $68/4 = 17$ SP per sprint

6. FUNCTIONAL AND PERFORMANCE TESTING

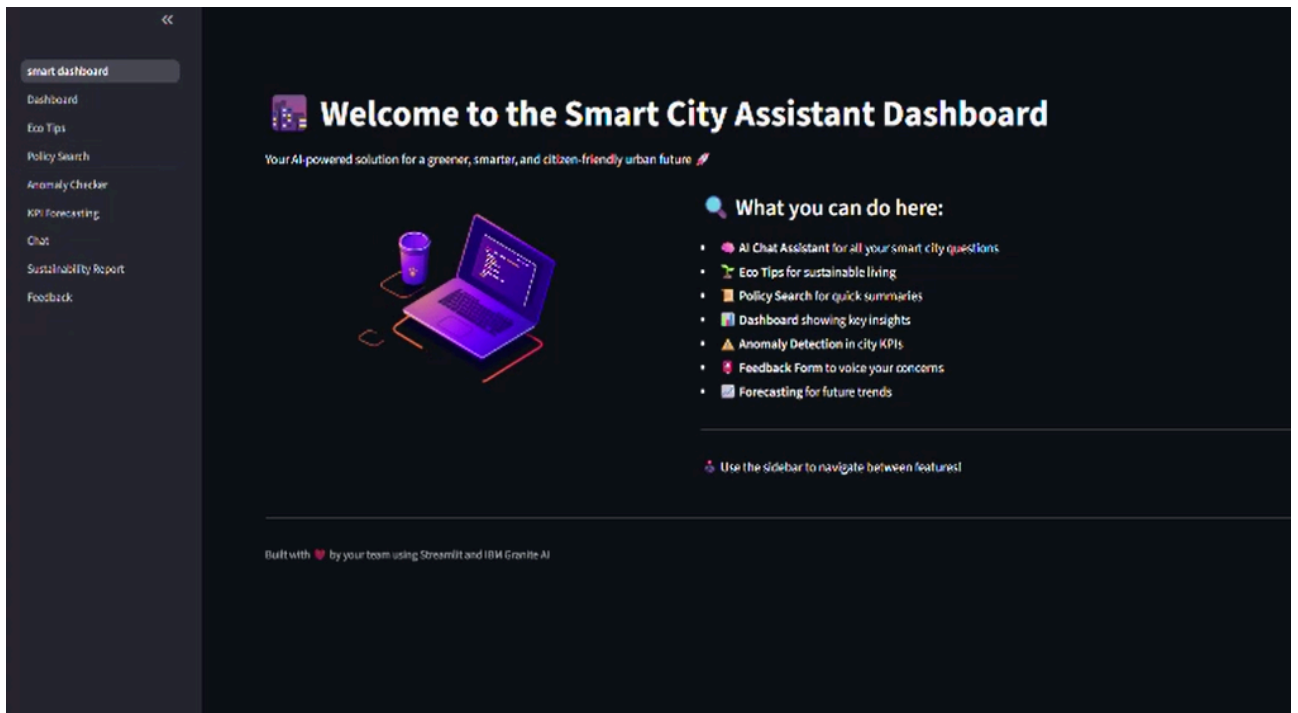
6.1 Performance Testing

- Forecasting tested with time-series KPI CSVs.
- Chat latency tested for prompt response.
- Edge cases validated for empty data, corrupted files, and invalid inputs.

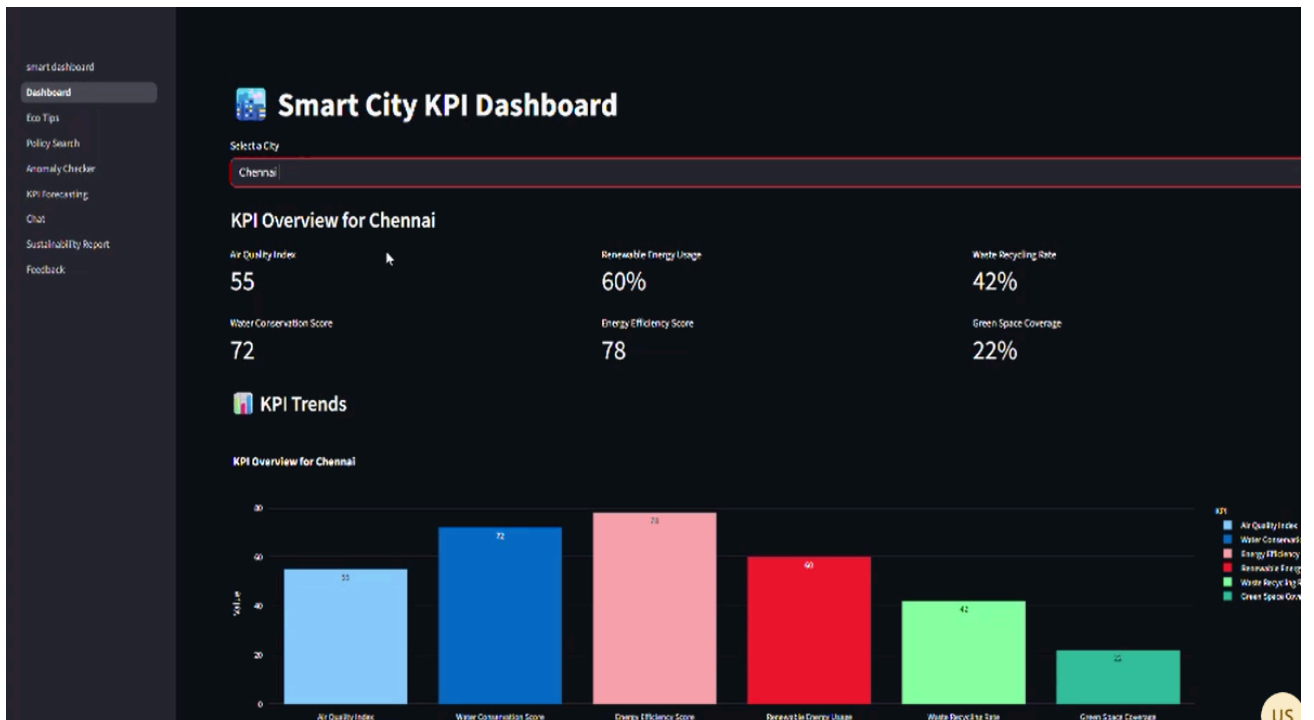
7. RESULTS

7.1 Output Screenshots:

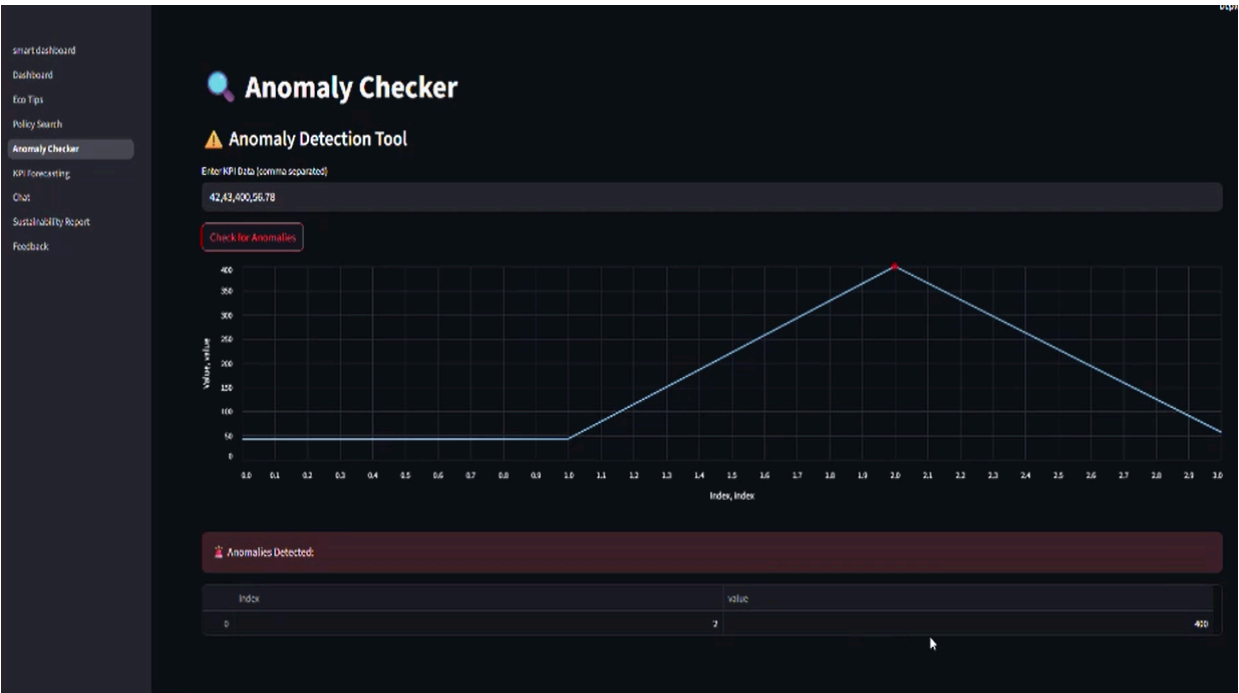
- Chat Assistant Interface



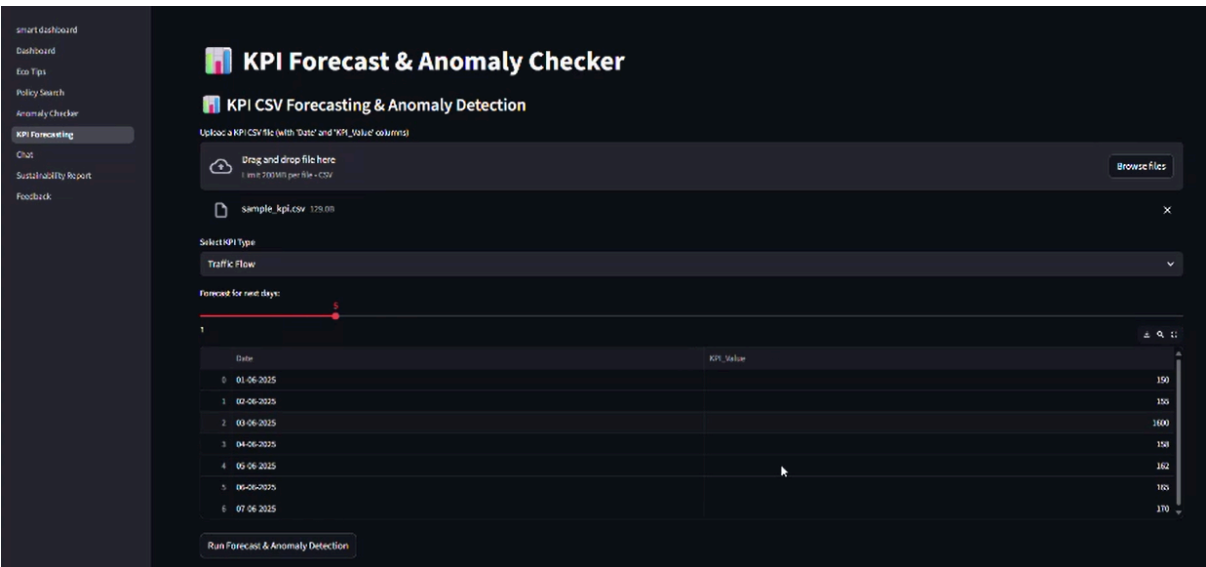
- Sustainability Dashboard



- Anomaly Alerts



- Forecast Graphs



- [Eco Tips Page](#)

smart dashboard

Dashboard

Eco Tips

Policy Search


Anomaly Checker

KPI Forecasting


Chat

Sustainability Report

Feedback



Eco Tips



Generate an Eco-Friendly Tip

Enter a topic (e.g., water, energy, transportation)

avoid single use plastic

Generate Tip

bags and containers.


A great eco-friendly tip to avoid single use plastic bags and containers is to invest in reusable shopping bags and containers made from sustainable materials like cotton, jute, bamboo, or silicone. Here are some practical suggestions:

- Reusable Grocery Bags:** Acquire a set of sturdy, reusable grocery bags made from sustainable materials like cotton, jute, or bamboo. These bags can hold a significant amount of items and are often more durable than single-use plastic bags.
- Produce Bags:** Opt for reusable produce bags made from lightweight, breathable fabrics like mesh or thin cotton. These bags are perfect for storing fruits and vegetables and can be washed and reused multiple times.
- Silicone Containers:** Replace single-use plastic containers with reusable silicone ones. These are lightweight, flexible, and can be used for storing leftovers, snacks, or even cooking in the oven or microwave.
- Beeswax Wraps:** Instead of using plastic wrap, consider using beeswax wraps to cover food items or wrap sandwiches. These reusable wraps are made from cotton fabric coated with beeswax, jojoba oil, and tree resin, providing a natural and eco-friendly alternative.
- Glass or Stainless Steel Containers:** For long-term food storage, switch to glass or stainless steel containers. These are microwave-safe, dishwasher-safe, and can be used for both freezing and reheating food.
- Water Bottles and Coffee Cups:** Instead of using disposable water bottles or coffee cups, invest in a reusable water bottle and a travel mug made from stainless steel, glass, or BPA-free plastic.
- Upcycle:** Get creative and repurpose old items like T-shirts or pillowcases as makeshift reusable bags for smaller items or produce.


By incorporating these sustainable alternatives into your daily routine, you can significantly reduce your reliance on single-use plastic bags and containers, contributing to a healthier environment.

- Policy Summarization Output

[SmartDashboard](#)
[Dashboard](#)
[Eco Tips](#)
[Policy Search](#)
[Compliance Checker](#)
[KPI Forecasting](#)
[Chat](#)
[Sustainability Report](#)
[Feedback](#)



Policy Summarizer


Policy Document Summarizer

Paste the policy document below

In bullet points:

- Purpose:** The purpose of this policy is to establish guidelines for the proper management, disposal, and recycling of waste materials within the organization to ensure environmental sustainability, compliance with regulations, and cost-effectiveness.
- Scope:** This policy applies to all employees, contractors, and visitors of the organization who generate waste materials. It covers all types of waste, including but not limited to, general waste, hazardous waste, electronic waste, and recyclable materials.
- Responsibilities:**
 - Employees:** All employees are responsible for adhering to the waste management procedures, segregating waste at the source, and participating in recycling programs.
 - Managers:** Managers are responsible for implementing the policy within their respective departments, providing necessary training, resources, and support to their teams.
 - Contractors:** Contractors are responsible for complying with the organization's waste management policies while on-site.
- Waste Segregation:** Waste materials should be segregated into appropriate categories at the point of generation. This includes:
 - General Waste:** Non-recyclable materials that can be disposed of in regular waste bins.
 - Hazardous Waste:** Materials that pose a risk to human health or the environment, such as chemicals, batteries, and medical waste. This must be managed in accordance with specific regulations.
 - Electronic Waste (e-waste):** Discarded electronic devices and components, which must be recycled through authorized channels.
 - Recyclable Materials:** Materials that can be processed and reused, such as paper, plastic, glass, and metal.
- Disposal and Recycling:**
 - Disposal:** Hazardous waste should be disposed of through licensed waste management companies to ensure compliance with regulations.
 - Recycling:** Recyclable waste should be collected and sent to authorized recycling facilities. The organization will provide designated recycling bins for this purpose.

- Feedback Form Submission

smart dashboard

Dashboard

Eco Tips

Policy Search

Anomaly Checker

KPI Forecasting

Chat

Sustainability Report

Feedback

Feedback

Citizen Feedback Form

Your Name

rama

Your Email

rama@gmail.com

Your Feedback / Message

good

Submit Feedback

Thanks for your feedback!

8. ADVANTAGES & DISADVANTAGES

Advantages:

- Centralized smart city services
- NLP-based citizen interaction
- Visual insights and trend forecasting
- Modular and scalable design

Disadvantages:

- Requires constant data updates
- Limited to structured KPI input
- Lacks real-time sensor integration

9. CONCLUSION

The Sustainable Smart City Assistant successfully combines AI with sustainability data, creating a useful and accessible platform for both citizens and city planners. It showcases how LLMs can power intelligent services for real-time urban management.

10. FUTURE SCOPE

- Integration with real-time IoT data from smart sensors
- Support for more cities and languages
- Deployment on cloud infrastructure for scalability
- Deep learning models for improved forecasting

11. APPENDIX

- **GitHub/Project Demo:** <https://github.com/SrikariSadvi/smart-city-assistant>