🏙️ Sustainable Smart City Assistant – Project Report

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1. INTRODUCTION

1.1 Project Overview

Sustainable Smart City Assistant is an AI-powered dashboard designed to enhance sustainability efforts in urban environments. It leverages IBM Watsonx LLM, FastAPI, Streamlit, and machine learning to support data-driven decision-making in areas like anomaly detection, KPI monitoring, policy assistance, and eco-friendly citizen engagement.

1.2 Purpose

The primary goal is to empower citizens, city administrators, and sustainability officers with intelligent tools to understand, monitor, and improve urban sustainability metrics effectively.

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2. IDEATION PHASE

2.1 Problem Statement

Urban cities face challenges in efficiently managing environmental data, detecting anomalies in utilities, and communicating policies clearly to citizens. Lack of centralization and AI tools makes it harder to achieve sustainability targets.

2.2 Empathy Map Canvas

Who: Citizens, City Administrators
Think & Feel: Want clean cities, transparency, eco-solutions
See: Fragmented data, unresponsive systems
Hear: Complaints about pollution, waste, and poor infrastructure
Do & Say: Demand better feedback mechanisms and guidance

2.3 Brainstorming

We explored problems like poor air quality tracking, lack of anomaly alerts in water/electricity usage, and the absence of AI-based sustainability chat. The idea evolved into a central dashboard assistant for smart cities.

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3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

User → Enters dashboard → Uploads KPI → Gets insights → Asks policy questions → Receives tips → Gives feedback

3.2 Solution Requirements

- Real-time anomaly detection

- Natural language chat assistant
- User-friendly data upload & dashboard
- Feedback collection and eco-suggestions
- Vector-based smart search

3.3 Data Flow Diagram

User → Streamlit Frontend → FastAPI Backend →

|→ Watsonx Granite (LLM)

|→ ML Model (Anomaly Detection)

|→ Pinecone (Smart Search Vector DB)

3.4 Technology Stack

- Frontend: Streamlit
- Backend: FastAPI
- LLM: IBM Watsonx Granite
- ML: Scikit-learn
- Vector DB: Pinecone
- Embeddings: Sentence Transformers
- Others: Pandas, NumPy, Uvicorn

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4. PROJECT DESIGN

4.1 Problem-Solution Fit

We observed the need for a single platform combining AI, sustainability insights, and interactivity. Our solution provides all-in-one capability to handle KPIs, generate insights, and interact with city data.

4.2 Proposed Solution

A unified assistant that allows:

- CSV upload for KPIs
- Auto anomaly detection
- Feedback collection
- Eco tip display
- AI chat with LLM
- Smart semantic search on documents

4.3 Solution Architecture

Frontend (Streamlit)

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Backend (FastAPI with routers: /chat, /feedback, /eco, /anomaly, /kpi, /vector)

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External APIs/Models: IBM Watsonx LLM, Pinecone Vector DB, ML models

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5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Phase	Timeline	Tasks
Week 1	Ideation & UI design	Empathy map, wireframes
Week 2	Backend setup	FastAPI routes, ML model
Week 3	Frontend integration	Streamlit components
Week 4	Testing & Debugging	Unit and performance tests
Week 5	Final deployment	GitHub, documentation, screenshots

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6. FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

- Response time for chat and anomaly endpoints: < 2s
- Streamlit UI tested across browsers
- API tested using Swagger for correctness

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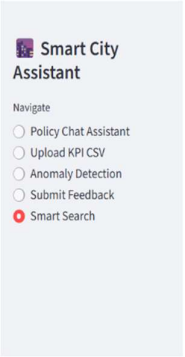
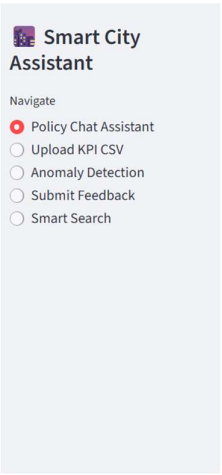
7. RESULTS

7.1 Output Screenshots

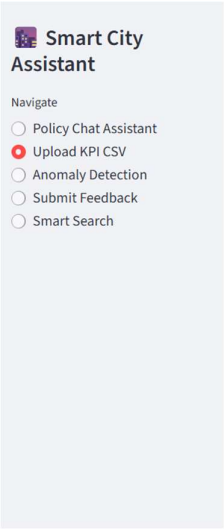
- Home/Dashboard

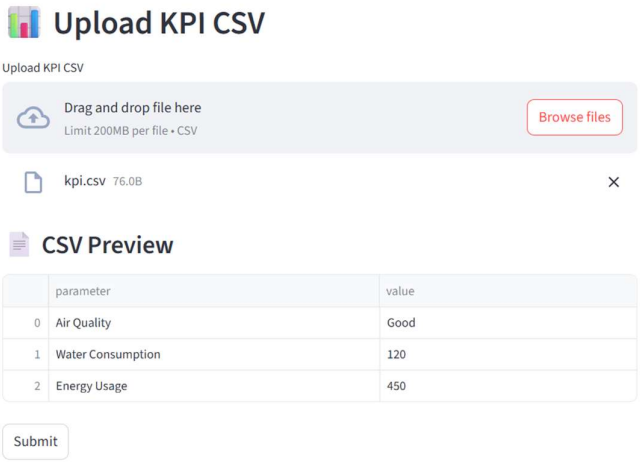


- Policy Chat Interface

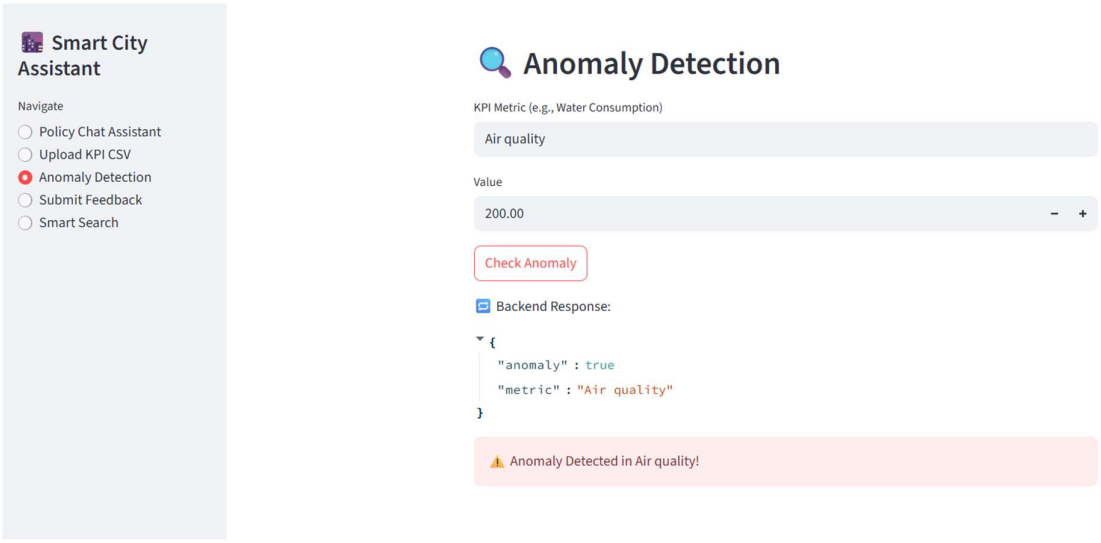


- KPI Upload Form

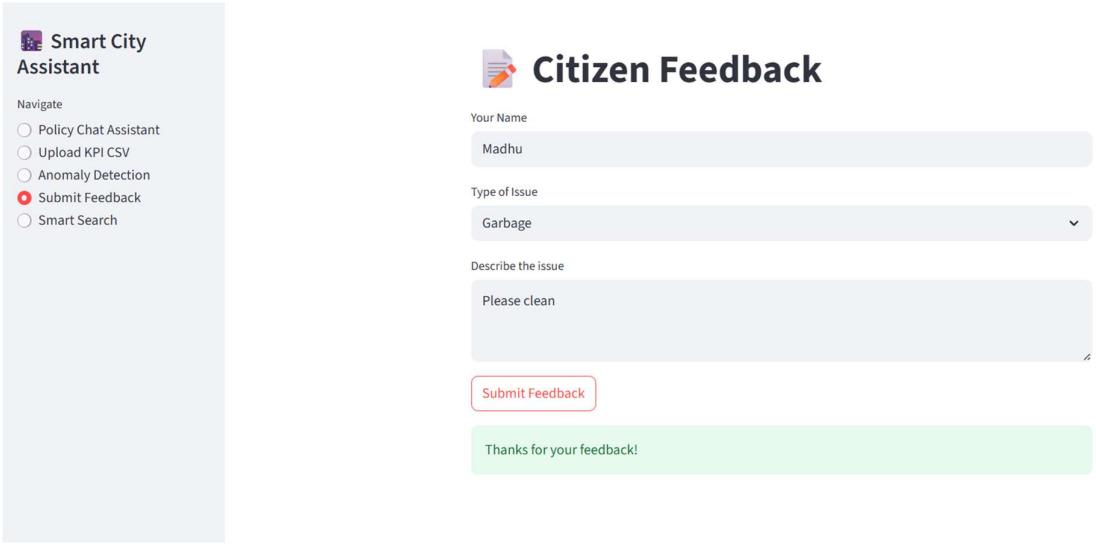




- Anomaly Detection Results



- Feedback Submission Form



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8. ADVANTAGES & DISADVANTAGES

Advantages

- Integrates LLM, ML, and search in one dashboard
- Interactive and intuitive design
- Customizable for any smart city

Disadvantages

- Requires internet connectivity
- LLM inference may be costly without free-tier APIs
- Limited KPI formats (currently only CSV)

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9. CONCLUSION

The Sustainable Smart City Assistant showcases the effective use of AI and data science in urban development. It simplifies sustainability tracking and promotes actionable insights for citizens and administrators.

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10. FUTURE SCOPE

- Expand data formats (Excel, JSON)
- Add alert notifications via email/SMS
- Enable real-time IoT sensor integration
- Multi-language chat support
- Admin login and role-based access

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11. APPENDIX

🔗 **Source Code**

https://github.com/Madhuharshitha5/Smart-City-Assistant

📊 **Dataset Link**

https://raw.githubusercontent.com/Madhuharshitha5/Smart-City-Assistant/main/sample_kpi.csv.csv