



Sustainable Smart City Assistant – Project Report

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.

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.

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

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)



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



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

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

6. FUNCTIONAL AND PERFORMANCE TESTING

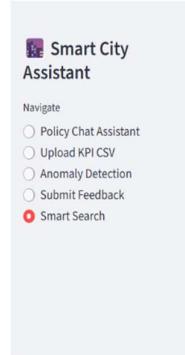
6.1 Performance Testing

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

7. RESULTS

7.1 Output Screenshots

- Home/Dashboard



Smart City Assistant

Navigate

- Policy Chat Assistant
- Upload KPI CSV
- Anomaly Detection
- Submit Feedback
- Smart Search

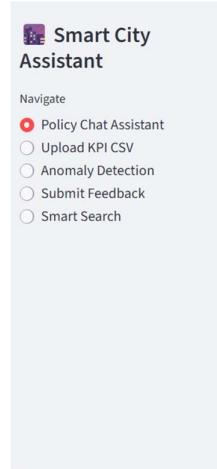
Smart Search or Summary Card

Smart City Summary

Energy Saved	Water Saved	Waste Recycled
1,200 kWh	8,000 L	2 Tons
↑ 10%	↑ 5%	↑ 12%

This section will later support smart search or document summaries using vector embeddings or GPT-powered Q&A.

- Policy Chat Interface



Smart City Assistant

Navigate

- Policy Chat Assistant
- Upload KPI CSV
- Anomaly Detection
- Submit Feedback
- Smart Search

Policy Chat Assistant

Ask a question about sustainability:

What are the key policies for improving air quality in smart cities?

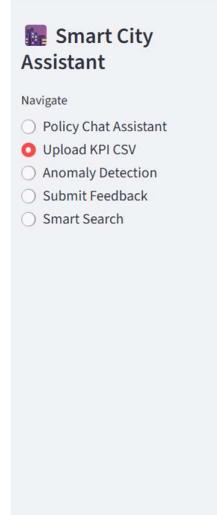
Ask

Chat Response:

```
{
  "response": "AI says: What are the key policies for improving air quality in smart cities?"
}
```

AI says: What are the key policies for improving air quality in smart cities?

- KPI Upload Form



Smart City Assistant

Navigate

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Upload KPI CSV

Upload KPI CSV

Drag and drop file here
Limit 200MB per file • CSV

Browse files

kpi.csv 76.0B

CSV Preview

	parameter	value
0	Air Quality	Good
1	Water Consumption	120
2	Energy Usage	450

Submit

- Anomaly Detection Results

The screenshot shows the Smart City Assistant dashboard. On the left, a sidebar titled "Smart City Assistant" has a "Navigate" section with the following options:

- Policy Chat Assistant
- Upload KPI CSV
- Anomaly Detection
- Submit Feedback
- Smart Search

The main area is titled "Anomaly Detection". It includes a search bar for "KPI Metric (e.g., Water Consumption)" containing "Air quality", a value input field set to "200.00" with a slider, and a "Check Anomaly" button. Below this, a "Backend Response:" section displays a JSON object:

```

    {
      "anomaly": true,
      "metric": "Air quality"
    }
  
```

A pink callout box at the bottom right says "⚠️ Anomaly Detected in Air quality!".

- Feedback Submission Form

The screenshot shows the Smart City Assistant dashboard. On the left, a sidebar titled "Smart City Assistant" has a "Navigate" section with the following options:

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- Anomaly Detection
- Submit Feedback
- Smart Search

The main area is titled "Citizen Feedback". It includes fields for "Your Name" (Madhu), "Type of Issue" (Garbage, selected from a dropdown), and a "Describe the issue" text area (Please clean). A "Submit Feedback" button is present, and a green callout box at the bottom right says "Thanks for your feedback!".

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)

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.

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
-

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