**SUSTAINABLE SMART CITY ASSISTANT – PROJECT REPORT**

**1. INTRODUCTION**

**1.1 Project Overview**

The **Sustainable Smart City Assistant** is an AI-powered dashboard designed to support sustainability initiatives in urban environments. It leverages IBM Watsonx (Granite LLM), FastAPI, Streamlit, and machine learning to enable data-driven decision-making across key areas such as anomaly detection, KPI monitoring, policy assistance, and eco-conscious citizen engagement.

**1.2 Purpose**

The primary objective of this project is to empower citizens, city administrators, and sustainability officers with intelligent digital tools to better understand, monitor, and enhance urban sustainability metrics.

**2. IDEATION PHASE**

**2.1 Problem Statement**

Urban areas often struggle with efficient environmental data management, anomaly detection in utility usage, and effective citizen communication regarding sustainability policies. The lack of centralized, AI-driven platforms makes achieving sustainability goals more difficult.

**2.2 Empathy Map Canvas**

* **Who:** Citizens, City Administrators
* **Think & Feel:** Desire for clean cities, transparency, and eco-friendly solutions
* **See:** Fragmented data, slow and unresponsive systems
* **Hear:** Concerns about pollution, waste, and infrastructure issues
* **Say & Do:** Seek better feedback mechanisms and clear policy guidance

**2.3 Brainstorming**

We identified key issues such as:

* Poor air quality tracking
* Absence of real-time anomaly alerts in water/electricity usage
* Lack of an AI-driven assistant for sustainability insights

This led to the concept of a centralized Smart City Assistant dashboard.

**3. REQUIREMENT ANALYSIS**

**3.1 Customer Journey Map**

User → Accesses dashboard → Uploads KPI data → Receives insights → Asks policy-related questions → Gets eco-tips → Provides feedback

**3.2 Solution Requirements**

* Real-time anomaly detection
* AI-powered natural language assistant
* Simple and intuitive KPI upload dashboard
* Eco-suggestion generation and feedback form
* Semantic document search using vector embeddings

**3.3 Data Flow Diagram**

User

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Streamlit Frontend

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FastAPI Backend

├──→ IBM Watsonx Granite (LLM)

├──→ ML Anomaly Detection Model

└──→ Pinecone Vector DB for Smart Search

**3.4 Technology Stack**

* **Frontend:** Streamlit
* **Backend:** FastAPI
* **Large Language Model (LLM):** IBM Watsonx Granite
* **Machine Learning:** Scikit-learn
* **Vector Database:** Pinecone
* **Embeddings:** Sentence Transformers
* **Other Tools:** Pandas, NumPy, Uvicorn

**4. PROJECT DESIGN**

**4.1 Problem-Solution Fit**

The project addresses the need for an integrated AI-driven platform that combines sustainability analytics, user interaction, and data visualization in one place.

**4.2 Proposed Solution**

A unified assistant that enables:

* KPI data uploads (CSV format)
* Automatic anomaly detection
* Interactive feedback collection
* Eco-tip recommendations
* Natural language chat powered by LLM
* Smart search over uploaded policy documents

**4.3 Solution Architecture**

Frontend (Streamlit)

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

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External Services:

├─ IBM Watsonx Granite (LLM)

├─ Pinecone Vector DB

└─ Custom ML Models

**5. PROJECT PLANNING & SCHEDULING**

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| --- | --- | --- |
| **Phase** | **Timeline** | **Tasks** |
| Week 1 | Ideation & UI Design | Empathy map, wireframing |
| Week 2 | Backend Development | FastAPI routing, ML integration |
| Week 3 | Frontend Integration | Streamlit UI components |
| Week 4 | Testing & Debugging | Unit tests, performance testing |
| Week 5 | Deployment & Docs | GitHub deployment, documentation, screenshots |

**6. FUNCTIONAL & PERFORMANCE TESTING**

**6.1 Performance Testing**

* Chat and anomaly detection APIs respond in under 2 seconds
* Streamlit frontend tested across modern browsers
* Swagger UI used for API endpoint validation

**7. RESULTS**

**7.1 Output Snapshots**

* **Dashboard Home**
* **Policy Chat Interface**
* **KPI Upload Form**
* **Anomaly Detection Output**
* **Feedback Submission Form**

**8. EVALUATION**

**Advantages**

* Integrates LLM, ML, and vector search into one dashboard
* Highly interactive and user-friendly design
* Adaptable to different smart city scenarios

**Limitations**

* Requires internet connectivity for LLM and APIs
* Free-tier LLM usage may incur costs at scale
* Currently supports only CSV format for KPIs

**9. CONCLUSION**

The Sustainable Smart City Assistant demonstrates the potential of combining AI, machine learning, and modern web frameworks to support urban sustainability. It simplifies data-driven governance and enhances citizen engagement in green initiatives.

**10. FUTURE SCOPE**

* Support for additional file formats (Excel, JSON)
* Integration with IoT sensors for real-time updates
* Alert systems via SMS/Email
* Multi-language support for the chat assistant
* Admin login and role-based access control

**11. APPENDIX**

* **Source Code:** **-** <https://github.com/vasanthi664/Sustainable-Smart-City-Assistant-Using-IBM-Granite-LLM>