Project Design Phase

Solution Architecture

Date	05 June 2025
Team ID	LTVIP2025TMID30991
Project Name	Sustainable Smart City Assistant Using IBM Granite LLM
Maximum Marks	4 Marks

Solution Architecture Description

The **Sustainable Smart City Assistant** is built using a modular and scalable architecture that connects urban sustainability challenges with advanced AI-driven solutions. The architecture supports natural language input/output, file uploads, real-time analytics, and seamless user interaction — all within an accessible web interface.

Key Architectural Components:

Layer	Technologies Used	Functionality
Frontend/UI Layer	Gradio (Hosted on Google Colab)	Provides a user-friendly interface for citizens to interact with all features (waste, energy, policies).
LLM Processing Layer	IBM Watsonx Granite LLM (via Hugging Face Transformers)	Powers text generation tasks like summarization, Q&A, eco-tips, and feedback analysis.
Data Management Layer	Pandas, CSV, Excel	Manages user feedback, energy data, resource usage files, and anomaly detection inputs.
Forecasting Engine	Linear Regression (via Pandas/NumPy)	Performs water/energy KPI forecasting using historical data.
Anomaly Detection Module	Statistical analysis (mean, std deviation)	Detects unusual patterns in uploaded resource usage data.
File Upload Handler	Gradio File component	Allows users to submit CSV files for processing.
Deployment Layer	Google Colab (with Pyngrok tunnel for public URL)	Lightweight, free deployment environment during development/testing.

Data Flow Overview:

1. **User Input**: Users enter text queries or upload CSV files via Gradio UI.
2. **Processing Layer**:
    - If text input: Prompt is sent to the IBM Granite LLM for generation (tips, summaries, Q&A).
    - If file input: Data is loaded and processed (forecasting, anomaly detection).
3. **Response Layer**: Output is formatted and displayed in styled textboxes using Gradio.
4. **Feedback Logging**: Submissions are timestamped and stored in an Excel file (smart_city_feedback.xlsx) for future analysis.

Development Phases Covered:

- **Phase 1 – Ideation & Requirement Gathering**: Defined urban sustainability needs and citizen pain points.
- **Phase 2 – Solution Design & Architecture**: Designed modular, AI-powered architecture.
- **Phase 3 – Implementation**: Developed and integrated 9+ modules using Gradio and IBM LLM.
- **Phase 4 – Testing & Optimization**: Performed functional/performance tests and UI enhancements.
- **Phase 5 – Deployment**: Hosted and tested via Google Colab + Pyngrok link.

Architecture: