Functional & Technical Requirements Analysis

🌍 Project Overview

The Sustainable Smart City Assistant is an AI-powered platform designed to empower citizens, urban planners, and local authorities with tools that promote environmental sustainability, informed decision-making, and smart urban living. Built as a modular web-based assistant, it integrates generative AI, data analytics, and user-friendly interfaces to address key urban challenges.

🧩 Functional Modules

- 🧩 Recycle Management Advisor – Guides eco-friendly waste disposal and recycling practices.
- 🧩 AI Image Generator – Generates visual representations of sustainable city environments.
- 🧩 Problem & Solution Finder (RAG-based) – Provides AI-generated insights and document-based responses to urban issues.
- 🧩 City Health Dashboard – Allows comparison of environmental health metrics across city
- 🧩 City Comparison Tool – Compares two cities side-by-side based on key sustainability indicators like air quality, traffic levels, waste management, and public health metrics.

📄 Customer Journey Map – Sustainable Smart City Assistant

No.	Module	User Action 1	User Experience Before	System Action 1	User Experience After
1	♻️ Recycle Management Advisor	User enters a waste item	Curious	System suggests how to dispose or	Informed & Motivated

		(e.g., plastic cup)		recycle it responsibly	
2	◈ AI Image Generator	User types a prompt describing a sustainable city scene	Imaginative	System generates an image and allows download	Inspired & satisfied
3	📓 Problem & Solution Finder (RAG-based)	User submits a local issue (e.g., water wastage)	Concerned	System provides document-based solutions with summaries	Reassured & empowered
4	📊 City Health Dashboard	User opens dashboard to view metrics like air quality	Alerted	Interacts with charts and insights for awareness	Engaged & Aware
5	🏙️ City Comparison Tool	User selects two cities to compare key sustainability data	Curious	Dashboard presents side-by-side comparison with export option	Analytical & Decisive

🔍 Insight: Clear, timely, and readable feedback at each step helps users stay engaged and make informed decisions.

⁉️ Solution Requirements

- ## ✅Functional Requirements:

  - Accepts user input for waste items via text box.
  - Returns disposal/recycling advice and sustainability tips.
  - Accepts user prompts describing a sustainable city scene.
  - Sends prompt to an image generation model (e.g., Stable Diffusion).

- Displays generated image and allows download
- Stores past prompts and images for session reference
- Accepts user input describing an urban problem.
- Collects and visualizes metrics (e.g., air quality, energy use, traffic).
- Displays interactive charts and tables using Altair
- Allows users to select two cities.
- Fetches real-time/static sustainability data for both.

- **□ Non-Functional Requirements:**

- **Performance**: Each module is going to return the output within 10 seconds except LLM Interaction
- **Responsiveness**: UI is adaptable for desktop
- **Security**: Handle user input safely and avoid injection or unauthorized access.
- **Usability**: Easy-to-navigate interface with input examples.
- **Reliability**: Modules must respond without crashes, even with incomplete or invalid inputs.
- **Scalability**: Should allow more cities, documents, and user inputs over time.
- **Compatibility**: Should work seamlessly in browsers (preferably via Stream lit)
- **Portability**: Compatible with VS code

User Stories:

♻ Recycle Management Advisor

1. **As a citizen**, I want to enter a household waste item, so that I can know how to dispose or recycle it correctly.
2. **As a user**, I want location-based tips on nearby recycling centres, so that I can contribute to sustainability easily.

◈ AI Image Generator

3. **As a city planner**, I want to generate visual concepts of sustainable environments, so that I can share them with stakeholders.

4. **As a student**, I want to visualize my eco-friendly city ideas using AI, so that I can include them in my school project.

📘 Problem & Solution Finder (RAG-based) – User Stories

5. **As a concerned resident**, I want to describe a city problem and get AI-generated solutions with policy references, so that I can advocate for change.
6. **As a government employee**, I want to upload a policy document and get a summarized view, so that I can quickly grasp its main points.

📊 City Health Dashboard – User Stories

7. **As a citizen**, I want to monitor my city's air, traffic, and waste metrics, so that I can stay aware of environmental health.
8. **As a researcher**, I want access to time-based city data visualizations, so that I can analyse trends and patterns.

🏭 City Comparison Tool – User Stories

9. **As a policy analyst**, I want to compare two cities based on sustainability indicators, so that I can evaluate which city performs better.

10. **As a journalist**, I want to export city comparison reports, so that can include visuals in my environmental articles.

❓ Data Flow Diagram

Simplified Flow:

📊 Core System Flow

1. Functionality Selection Gateway

User → Main Dashboard → Functionality Selector → Selected Module

Decision Point: User selects one of five available functionalities:

- ♻️ Recycle Management Advisor
- 🔷 AI Image Generator
- 📄 Problem & Solution Finder (RAG)
- 📊 City Health Dashboard
- 🏙️ City Comparison Tool

🔄 Individual Module Data Flows

♻️ Recycle Management Advisor

Input: Waste Type/Location

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Waste Classification Engine

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Local Recycling Database Query

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Guidelines Generator

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Output: Disposal Instructions & Eco-Tips

🔷 AI Image Generator

Input: City Description (Imaginary)

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Natural Language Processing

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AI Image Generation Model

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Image Post-Processing & Optimization

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Output: Sustainable City Visualization

📘 Problem & Solution Finder (RAG-based)

Input: Urban Problem Query

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Query Processing & Intent Recognition

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Document Retrieval System

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Knowledge Base/Vector Database Search

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RAG Processing Engine

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Contextual Solution Generation

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Output: AI-Generated Solutions with Source

📊 City Health Dashboard

Input: City Selection

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Multi-Source Data Aggregation

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[Environmental APIs | Health Metrics DB | Real-time Sensors]

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Data Processing & Analytics Engine

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Visualization Generation

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Output: Interactive Health Dashboard

🏭 City Comparison Tool

Input: Two Cities Selection

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Parallel Data Retrieval for Both Cities

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[Air Quality APIs | Traffic Data | Waste Management | Health Metrics]

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Comparative Analysis Engine

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Side-by-side Metrics Processing

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Output: Comprehensive Sustainability Comparison Report

Flow Description:

Users authenticate and access a dashboard with five key modules: ♻️ Recycle Advisor, 🔷 AI Image Generator, 📓 RAG-based Problem Solver, 📊 Health Dashboard, and 🏙️ City Comparison Tool.
Each module processes inputs using specialized engines—AI models, document retrievers, or data aggregators—while pulling real-time data from APIs, sensors, and city databases.
The system outputs personalized results like recycling tips, generated images, solution summaries, dashboards, or comparative city reports.

▯ Technology Stack

- Frontend: stream lit UI
- Backend: Python
- AI Models: IBM Granite, Stable Diffusion
- Hosting: Vs Code (Model Execution)
- Visualization: Altair