# 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**

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| --- | --- | --- | --- | --- | --- |
| **No.** | **Module** | **User Action 1** | **User Experience Before** | **System Action 1** | **User Experience After** |
| 1 | ♻️ Recycle Management Advisor | User enters a waste item (e.g., plastic cup) | Curious | System suggests how to dispose or recycle it responsibly | Informed & Motivated |
| 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**

1. **As a city planner**, I want to generate visual concepts of sustainable environments, so that I can share them with stakeholders.
2. **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**

1. **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.
2. **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**

1. **As a citizen**, I want to monitor my city's air, traffic, and waste metrics, so that I can stay aware of environmental health.
2. **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**

1. **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