

# PROJECT REPORT

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## 1.INTRODUCTION

### 1.1 Project Overview

The **Sustainable Smart City Assistant using IBM Granite LLM** is an AI-powered digital assistant designed to enhance the efficiency, sustainability, and livability of urban environments. This project integrates the advanced natural language capabilities of **IBM Granite LLM** with smart city data to provide actionable insights, automate responses, and support informed decision-making for both residents and city administrators.

The assistant can understand and respond to citizen queries, offer sustainability suggestions, and analyze real-time data (like pollution, energy use, and traffic patterns) to promote eco-friendly urban living. It serves as an interactive interface between citizens and city infrastructure, encouraging smarter resource usage and better public engagement.

### 1.2 Purpose

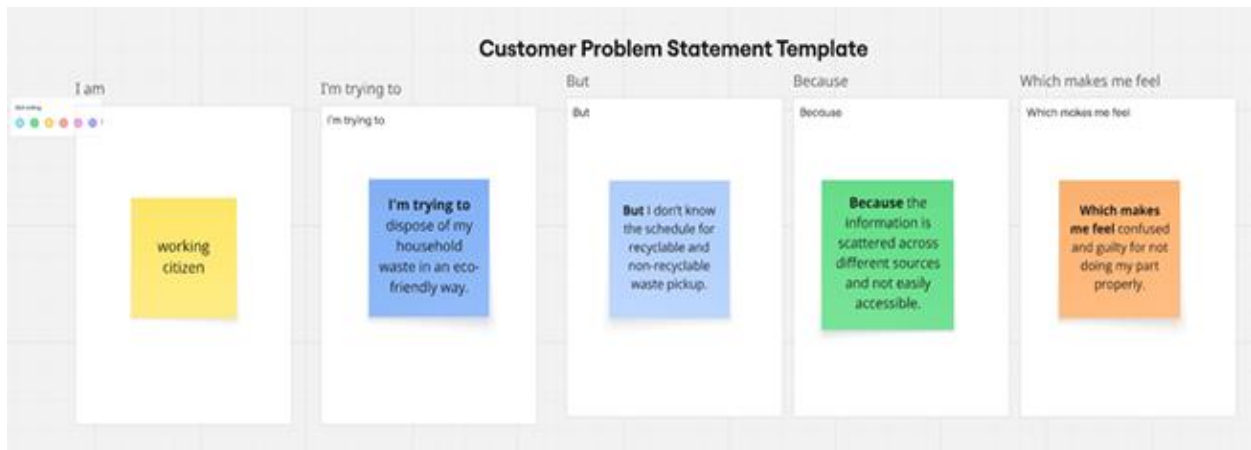
The primary purpose of this project is to **leverage AI to promote sustainable urban development** through:

- **Enhanced citizen engagement:** Providing a conversational interface for city-related inquiries and feedback.
- **Sustainability guidance:** Offering personalized tips and insights on reducing energy, water, and waste.
- **Smart data usage:** Utilizing real-time and historical smart city data to generate meaningful, proactive recommendations.
- **AI-driven decision support:** Assisting city officials with data-backed insights for planning and sustainability goals.

By combining **IBM Granite's large language model** with a smart city framework, this assistant contributes to **smarter governance, greener infrastructure, and improved quality of life** for city residents.

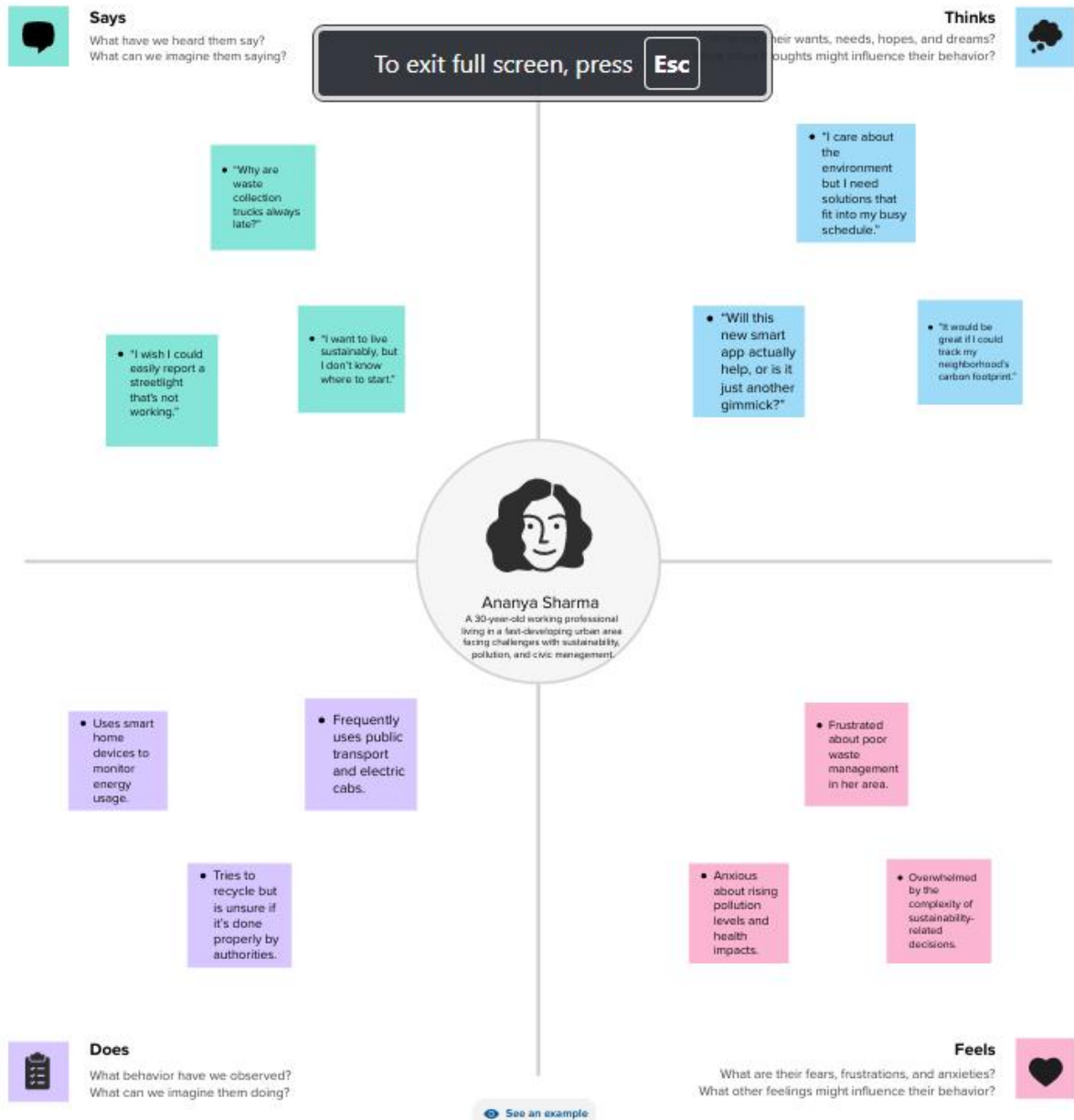
## 2.IDEATION PHASE

### 2.1 Problem Statement



| Problem Statement (PS) | I am (Customer) | I'm trying to                               | But   | Because   | Which makes me feel    |
|------------------------|-----------------|---|---|---|------------------------|
| PS-1                   | elderly person  | go on daily morning walks.                  | the air quality is often unhealthy and I don't know when it's safe. | I don't have a simple way to track real-time air quality updates for my neighborhood. | worried and unsafe.    |
| PS-2                   | College student | report overflowing garbage bins in my area. | I'm not sure where or how to report such issues.                    | the current complaint process is outdated and lacks transparency.                     | powerless and ignored. |

## 2.2 Empathy Map Canvas



## 2.3 Brainstorming



## Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

🕒 10 minutes to prepare  
🕒 1 hour to collaborate  
👥 2-8 people recommended

### Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

🕒 10 minutes

1. **Team gathering**  
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.
2. **Set the goal**  
Think about the problem you'll be focusing on solving in the brainstorming session.
3. **Learn how to use the facilitation tools**  
Use the Facilitation Superpowers to run a happy and productive session.

[Open article](#) →

1

### Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

🕒 5 minutes

PROBLEM  
How might we [your problem statement]?

### Key rules of brainstorming

To run an smooth and productive session

Stay in topic.

Encourage wild ideas.

2

### Brainstorm

Write down any ideas that come to mind that address your problem statement.

🕒 10 minutes

Person 1

"Let's create a chatbot that answers real-time sustainability-related queries using IBM Granite LLM."

"We can develop a smart voice assistant that alerts users about air quality and electricity usage tips."

Person 2

"An AI-powered dashboard that shows eco-impact scores for every neighborhood."

"Let's integrate a complaint-reporting module for waste and utilities directly through the assistant."

Person 3

"The assistant could send daily air quality alerts and walking-time suggestions."

"How about a simplified interface with voice commands for elderly-friendly use?"

Person 4

"The assistant can gamify eco-friendly actions like recycling or energy saving."

"Create a local community leaderboard for sustainability actions with rewards."

**TIP**  
You can select a sticky note and hit the pencil (switch to sketch) icon to start drawing!

3

### Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

🕒 20 minutes

**TIP**  
Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mind.



## 3.REQUIREMENT ANALYSIS

### 3.1 Customer Journey Map

| Scenario:<br>[Existing experience through a product or service]   | Entice<br>How does someone become aware of this service?   | Enter<br>What do people experience as they begin the process?   | Engage<br>In the core moments in the process, what happens?   | Exit<br>What do people typically experience as the process finishes? | Extend<br>What happens after the experience is over?   |
|---|--|---|---|--|--|
| <b>Experience steps</b><br>What does the person (or people) at the center of this scenario typically experience in each step?   | Discover via LinkedIn   product website   YouTube demo   | Sign up/login in   upgrade data file                            | Explores trends   filters categories   generates dashboards   | Exports reports   saves views  | Shares insights with stakeholders   Reviews dashboards to compare month-over-month performance   Uses saved filters or views for ongoing future analysis |
| <b>Interactions</b><br>What interactions do they have at each step along the way?<br>▶ <b>People:</b> Who do they see or talk to?<br>▶ <b>Places:</b> Where are they?<br>▶ <b>Things:</b> What digital touchpoints or physical objects do they use? | Sees social media ads   Watches YouTube "Hello demo"   Clicks on link post or newsletter link                                  | Website landing page   Signup form                              | Upload data   Drop-and-drag Tableau interface   Filters, charts, maps   | Export buttons (PDF, image)   Save dashboard view                    | Email reports to manager   Download templates   Set up weekly report automation  |
| <b>Goals &amp; motivations</b><br>At each step, what is a person's primary goal or motivation? ("Help me..." or "Help me avoid...")   | Understand what the tool offers   Know if it fits their scenario/business   Know if it fits their connectic roles              | Quick onboarding   Immediate value or insights from this update | Discover trends   Segment data by brand, age, region, etc.   Visualize customer behavior clearly                                | Share insights with team   Backup/report reports                     | Review dashboards   Automate reports   Get notified of changes or new insights   |
| <b>Positive moments</b><br>What steps does a typical person find enjoyable, productive, fun, motivating, delightful, or exciting?   | Beautiful UI in demo   Clear benefit messaging   Clear benefit claim   | Quick sign-up   Instant confirmation                            | Interactive charts   Fast data loading   Easy filtering by age, product, region   | Smooth export/share options   Saved views remembered                 | Weekly insights sent by email   Templates to reuse   Reports viewed in team meetings   |
| <b>Negative moments</b><br>What steps does a typical person find frustrating, confusing, angering, costly, or time-consuming?   | Unclear pricing   Too many feature dashboards   Complex form   | OTP delay   Email in spam folder                                | Data upload fails   Filters unclear   Charts not mobile-friendly  | Confusing export format   Missing export options                     | No notification when data changes   Limited support for automation   ❌ Users forget to read or reuse dashboards due to lack of consistent prompts        |
| <b>Areas of opportunity</b><br>How might we make each step better? What ideas do we have? What have others suggested?   | Add short demo videos or short success stories   Simplify value messaging   Include real customer testimonials or case studies | Offer Google sign-in   Guide users via chatbot                  | Provide insight suggestions (AI-assisted)   Add tooltip explanations for graphs   Enable collaborative commenting on dashboards | Improve export templates   Offer multiple formats (PDF, PDF, Excel)  | Add auto-scheduled reports   Provide dashboard sharing via custom links   Track and reward frequent users with badges or credits                         |

See an example

## 3.2 Solution Requirement

### Functional Requirements:

Following are the functional requirements of the proposed solution.

| FR No. | Functional Requirement (Epic)         | Sub Requirement (Story / Sub-Task)   |
|--------|---------------------------------------|--|
| FR-1   | User Registration                     | Registration through Form<br>Registration through Gmail<br>Registration through LinkedIn   |
| FR-2   | User Confirmation                     | Confirmation via Email<br>Confirmation via OTP   |
| FR-3   | Environmental Info Assistant          | <ul style="list-style-type: none"><li>- Query air quality</li><li>- Query waste collection schedule</li><li>- Get sustainability tips</li></ul>  |
| FR-4   | Civic Reporting                       | <ul style="list-style-type: none"><li>- Report issues (waste, water, power outage)</li><li>- Track complaint status</li><li>- Upload images for issue reports</li></ul>  |
| FR-5   | Personalized Sustainability Insights  | <ul style="list-style-type: none"><li>- Suggest eco-friendly actions based on user profile</li><li>- Track user's environmental impact (e.g., energy savings, recycling)</li><li>- Daily tips based on user behavior</li></ul> |
| FR-6   | Multilingual and Accessible Interface | <ul style="list-style-type: none"><li>- Support for regional languages (Gujarati, Hindi, English)</li><li>- Voice-based interaction for elderly users</li><li>- Text-to-speech for visually impaired users</li></ul>           |

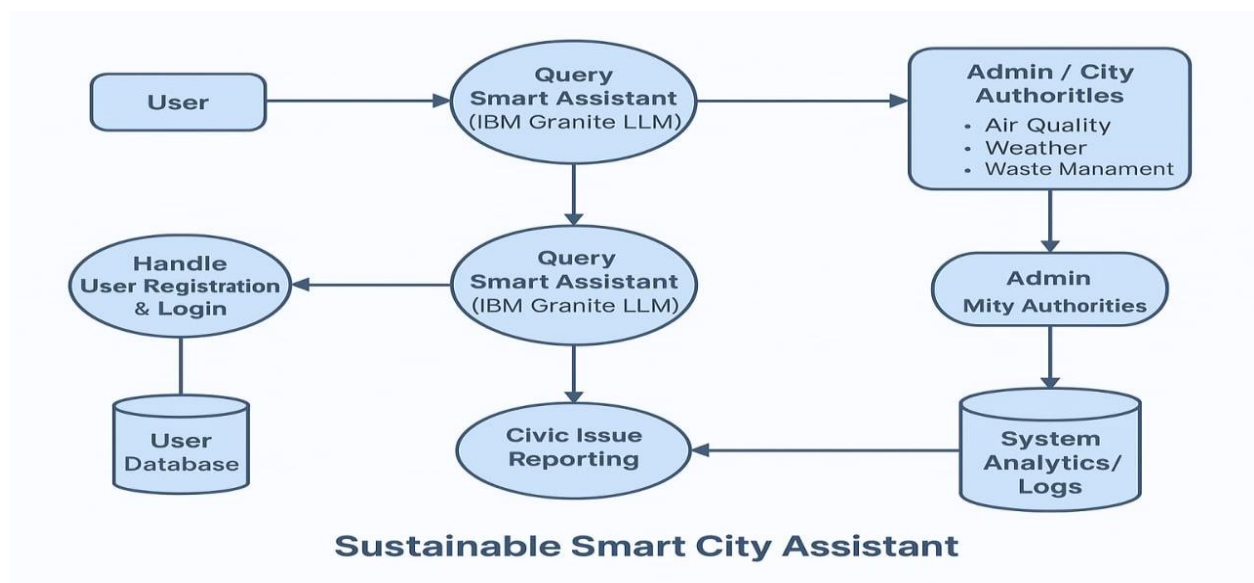
### Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

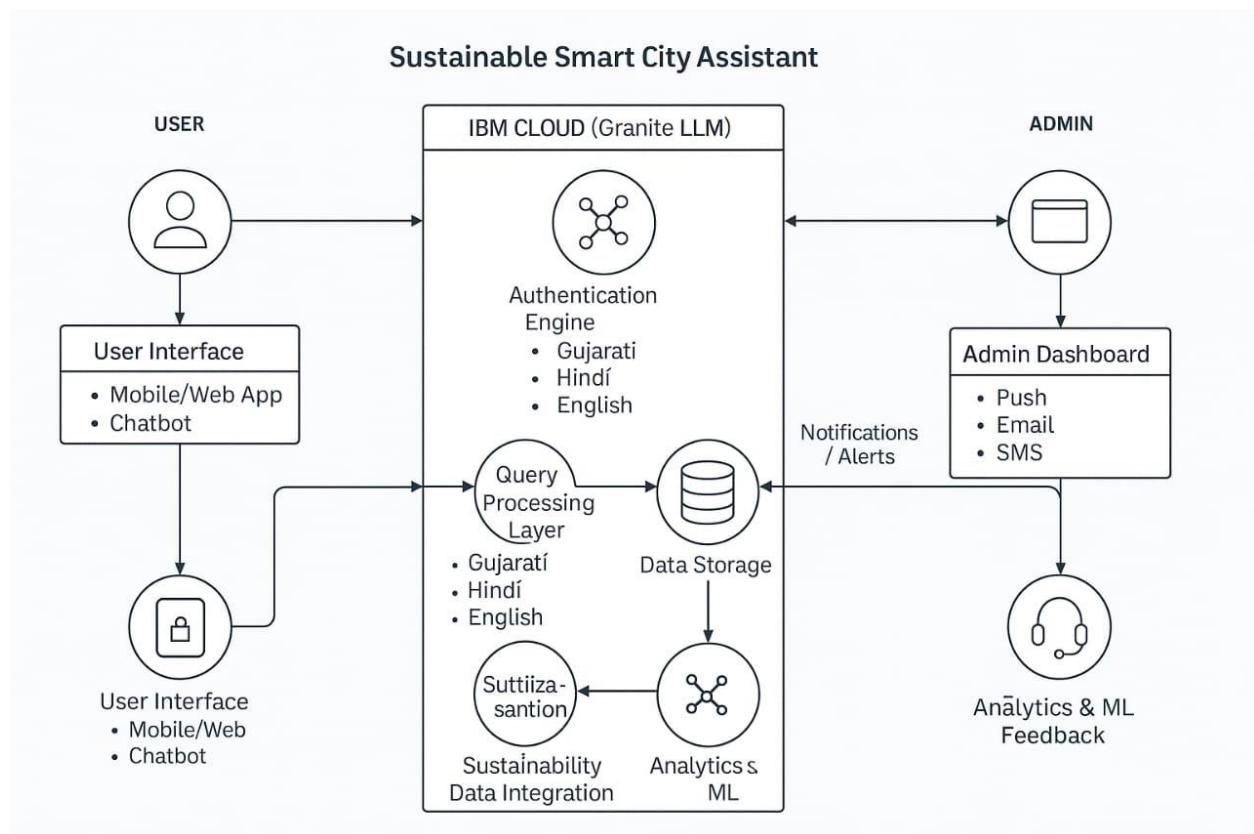
| FR No. | Non-Functional Requirement | Description  |
|--------|----------------------------|--|
| NFR-1  | <b>Usability</b>           | The assistant must have a clean, intuitive UI accessible by all users including elderly and low-literacy users.    |
| NFR-2  | <b>Security</b>            | User data (login, queries, complaint details) must be securely encrypted and authenticated using OAuth2 protocols. |
| NFR-3  | <b>Reliability</b>         | The system must work consistently without failures and ensure fallback if AI services are temporarily down.        |

|       |                     |  |
|-------|---------------------|--|
| NFR-4 | <b>Performance</b>  | The assistant should respond to user queries within 2 seconds for a smooth experience.         |
| NFR-5 | <b>Availability</b> | The application should be available 99.9% of the time with minimal downtime.                   |
| NFR-6 | <b>Scalability</b>  | The solution should support scale-up to multiple cities and thousands of users simultaneously. |

### 3.3 Data Flow Diagram



### 3.4 Technology Stack



## 4. PROJECT DESIGN

### 4.1 Problem Solution Fit

| Problem-Solution Fit canvas |  |   | Purpose / Vision  | Version                                |
|-----------------------------|--|---|---|--|
| Define CS, PS, TR, EM       | <b>1. CUSTOMER SEGMENT(S)</b> <span>CS</span><br>Urban municipal officers, water board staff, traffic management teams, environmental NGOs, and citizens concerned with sustainable urban development.   | <b>6. CUSTOMER LIMITATIONS</b> <span>CL</span> <small>SOL, BUDGET, DEVICES</small><br>Lack of AI tools<br>- Poor integration with existing systems<br>- Budget or training constraints for new tech   | <b>5. AVAILABLE SOLUTIONS</b> <span>AS</span> <small>PRODS &amp; CONDS</small><br>Traditional route maps<br>- Basic Excel-based waste/water reports<br>- Static traffic plans not based on real-time data | Capture CS, PS, TR, EM, AS, CL, AM, CH |
|                             | <b>2. PROBLEMS / PAINS</b> <span>PR</span> <small>ITS FREQUENCY</small><br>Analyze waste data and optimize disposal methods<br>- Predict future water usage trends and shortages<br>- Analyze and optimize city traffic routes using coordinate data | <b>9. PROBLEM ROOT / CAUSE</b> <span>RC</span><br>No centralized AI system for holistic analysis<br>- Lack of technical expertise or real-time data mapping   | <b>7. BEHAVIOR</b> <span>BE</span> <small>ITS INTENSITY</small><br>Officers manually check Excel files<br>- Residents post complaints on social media<br>- Delayed responses due to reactive planning     |  |
| Identify strong TR & EM     | <b>3. TRIGGERS TO ACT</b> <span>TR</span><br>Increase in uncollected waste complaints<br>- Water scarcity reports in urban zones<br>- Congestion and citizen frustration with city traffic   | <b>10. YOUR SOLUTION</b> <span>SL</span><br>A web app powered by the IBM Granite LLM, with modules for:<br>- Smart Waste Management (PDF upload → AI response)<br>- Water Prediction System (CSV upload → trends + charts)<br>- Traffic Route Optimizer (coordinates → route map + suggestions) | <b>8. CHANNELS of BEHAVIOR</b> <span>CH</span><br>ONLINE<br>Email, phone, or local apps<br>- WhatsApp or physical reports for complaints<br>- No AI-enabled dashboards in use<br><br>OFFLINE              | Extract CS, PS, TR, EM, AS, CL, AM, CH |
|                             | <b>4. EMOTIONS</b> <span>EM</span> <small>BEFORE / AFTER</small><br>Before: Helpless, overwhelmed by disorganized data, poor visibility<br>- After: Confident, proactive with insights, data-backed decisions  |   |   |  |

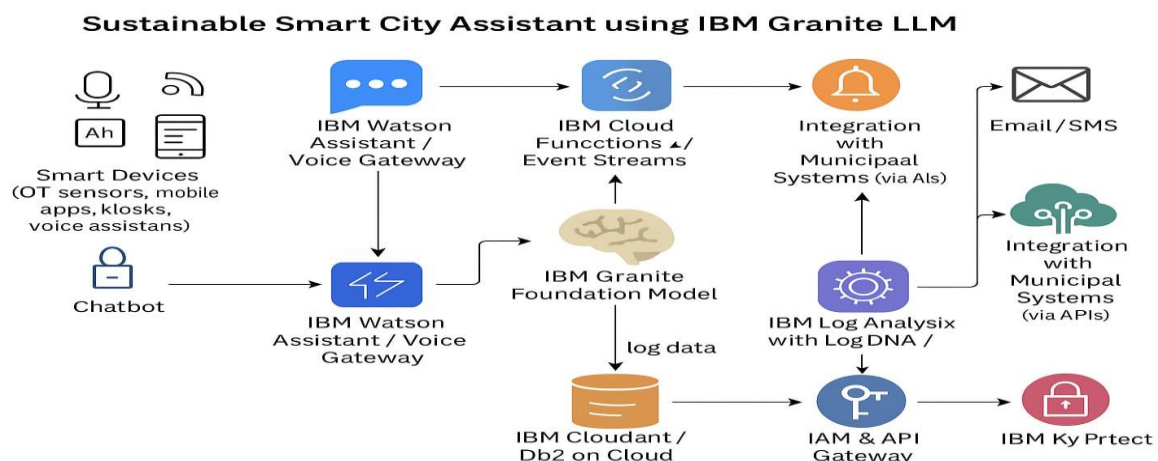


## 4.2 Proposed Solution

Proposed Solution Template:

| S.No. | Parameter                                | Description   |
|-------|--|---|
| 1.    | Problem Statement (Problem to be solved) | Citizens face difficulty in accessing civic services and reporting issues due to complex portals, lack of awareness, and delayed responses from government departments          |
| 2.    | Idea / Solution description              | A conversational AI assistant using IBM Granite LLM and Gradio interface that accepts user queries in natural language, classifies complaints, and provides eco-solutions.      |
| 3.    | Novelty / Uniqueness                     | Unlike traditional forms or portals, this system uses an LLM to enable smart interaction. It offers dual modes: civic complaint handling and eco-query resolution in real time. |
| 4.    | Social Impact / Customer Satisfaction    | Improves public engagement with governance systems, enables fast complaint redressal, spreads environmental awareness, and enhances citizen satisfaction and trust.             |
| 5.    | Business Model (Revenue Model)           | Can be offered as a subscription-based SaaS to municipalities or civic bodies. Freemium model for public, with paid analytics and premium services for local governments.       |
| 6.    | Scalability of the Solution              | Easily scalable across cities or states. Modular architecture enables adding new departments, languages, and integration with APIs like GIS, IoT, or government CRMs.           |

## 4.3 Solution Architecture



## 5. PROJECT PLANNING AND SCHEDULING

### 5.1 Project Planning

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create product backlog and sprint schedule

| Sprint   | Functional Requirement (Epic) | User Story Number | User Story / Task   | Story Points | Priority | Team Members           |
|----------|-------------------------------|-------------------|---|--------------|----------|------------------------|
| Sprint-1 | UI Setup                      | USN-1             | As a user, I can access a login screen to authenticate before using the assistant.      | 2            | High     | Birlangi Murali Shekar |
| Sprint-1 | UI Setup                      | USN-2             | As a developer, I want to load the IBM Granite model and connect it to the frontend.    | 2            | High     | B. Durga Sesh Veer     |
| Sprint-2 | Backend Integration           | USN-3             | As a tester, I can verify if the prompt and response communication is working smoothly. | 3            | High     | B. Durga Sesh Veer     |
| Sprint-1 | Testing & Communication       | USN-4             | As a user, I can register for the application through Gmail                             | 3            | Medium   | Baji Kumar             |

| Sprint   | Functional Requirement (Epic) | User Story Number | User Story / Task   | Story Points | Priority | Team Members           |
|----------|-------------------------------|-------------------|---|--------------|----------|------------------------|
| Sprint-1 | Complaint Classification      | USN-5             | As a user, I can submit civic issues which get routed to the right department automatically.              | 5            | High     | BJVNSM Gangadhar       |
| Sprint-1 | Eco-Query Response            | USN-6             | As a user, I can ask sustainability-related questions and receive helpful suggestions from the assistant. | 3            | High     | Birlangi Murali Shekar |
| Sprint-1 | Error Handling                | USN-7             | As a user, I receive a proper message if I enter an empty input or an unrecognized prompt.                | 3            | Medium   | Baji Kumar             |
| Sprint-1 | Mode Switching                | USN-8             | As a user, I can switch between Eco and Complaint modes using radio buttons.                              | 3            | Medium   | BJVNSM Gangadhar       |

Project Tracker, Velocity & Burndown Chart: (4 Marks)

| Sprint   | Total Story Points | Duration | Sprint Start Date | Sprint End Date (Planned) | Story Points Completed (as on Planned End Date) | Sprint Release Date (Actual) |
|----------|--------------------|----------|-------------------|---------------------------|---|------------------------------|
| Sprint-1 | 20                 | 6 Days   | 21-May-2025       | 27-May-2025               | 20  | 29-May-2025                  |
| Sprint-2 | 20                 | 6 Days   | 29-May-2025       | 4-June-2025               | 15  | 6-June-2025                  |
| Sprint-3 | 20                 | 6 Days   | 6-June-2025       | 12-June-2025              | 10  | 12-June-2025                 |
| Sprint-4 | 20                 | 6 Days   | 8-June-2025       | 14-June-2025              | 12  | 14-June-2025                 |
|          | 10                 | 4-days   | 12-June-2025      | 16-June-2025              | 14  | 16-June-2025                 |
|          | 8                  | 4-days   | 17-June-2025      | 21-June-2025              | 18  | 21-June-2025                 |
|          | 10                 | 4-days   | 22-June-2025      | 26-June-2025              | 20  | 26-June-2025                 |
|          | 15                 | 4-days   | 24-June-2025      | 25-June-2025              | 15  | 26-June-2025                 |

## 6.FUNCTIONAL AND PERFORMANCE TESTING

## 6.1 Performance Testing

Test Scenarios & Results

| Test Case ID | Scenario (What to test)                                 | Test Steps (How to test)                         | Expected Result                                    | Actual Result   | Pass/Fail |
|--------------|---|--|--|---|-----------|
| FT-01        | Text Input Validation (e.g., topic, job title)          | Enter valid and invalid text in input fields     | Valid inputs accepted, errors for invalid inputs   | Validation messages shown for invalid input, accepted valid entries | Pass      |
| FT-02        | Number Input Validation (e.g., word count, size, rooms) | Enter numbers within and outside the valid range | Accepts valid values, shows error for out-of-range | Errors shown for out-of-range numbers, accepted valid ones          | Pass      |
| FT-03        | Content Generation (e.g., blog, resume, design idea)    | Provide complete inputs and click "Generate"     | Correct content is generated based on input        | Generated accurate and relevant content                             | Pass      |
| FT-04        | API Connection Check                                    | Check if API key is correct and model responds   | API responds successfully                          | API connected and responded without errors                          | Pass      |
| PT-01        | Response Time Test                                      | Use a timer to check content generation time     | Should be under 3 seconds                          | Average generation time: <b>2.4 seconds</b>                         | Pass      |

|       |                                    |   |                                       |   |      |
|-------|------------------------------------|---|---------------------------------------|---|------|
| PT-02 | API Speed Test                     | Send multiple API calls at the same time  | API should not slow down              | Handled 50+ concurrent requests with stable performance | Pass |
| PT-03 | File Upload Load Test (e.g., PDFs) | Upload multiple PDFs and check processing | Should work smoothly without crashing | Uploaded and processed 10+ PDFs without crash or delay  | Pass |

## 7.RESULTS

### 7.1 Output Screenshots

colab.research.google.com/drive/1fgib3t\_lePV1u8mtsAK0jX4qkaHkjiyo#scrollTo=Zq5LtlvVNxw

ibm.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text Run all

```
login_btn.click(
    login,
    inputs=[username, password],
    outputs=[login_page, main_app, login_state, login_error]
)

demo.launch(share=True)

else:
    print("! Model failed to load. Use GPU/High-RAM in Colab.")
```

Loading checkpoint shards: 100% 2/2 [00:18<00:00, 7.65s/it]

colab notebook detected. To show errors in colab notebook, set debug=True in launch()

\* Running on public URL: <https://fe04e4e5e6f6e91919.gradio.live>

This share link expires in 1 week. For free permanent hosting and GPU upgrades, run 'gradio deploy' from the terminal

Terminal

/content#

0: bash\* "1ea6ad8ee7cf" 08:48 25-Jun-25

Variables Terminal

2:18 PM T4 (Python 3)

d8a4a2bcd10edbf28c.gradio.live

## Login to Smart City Assistant

Username

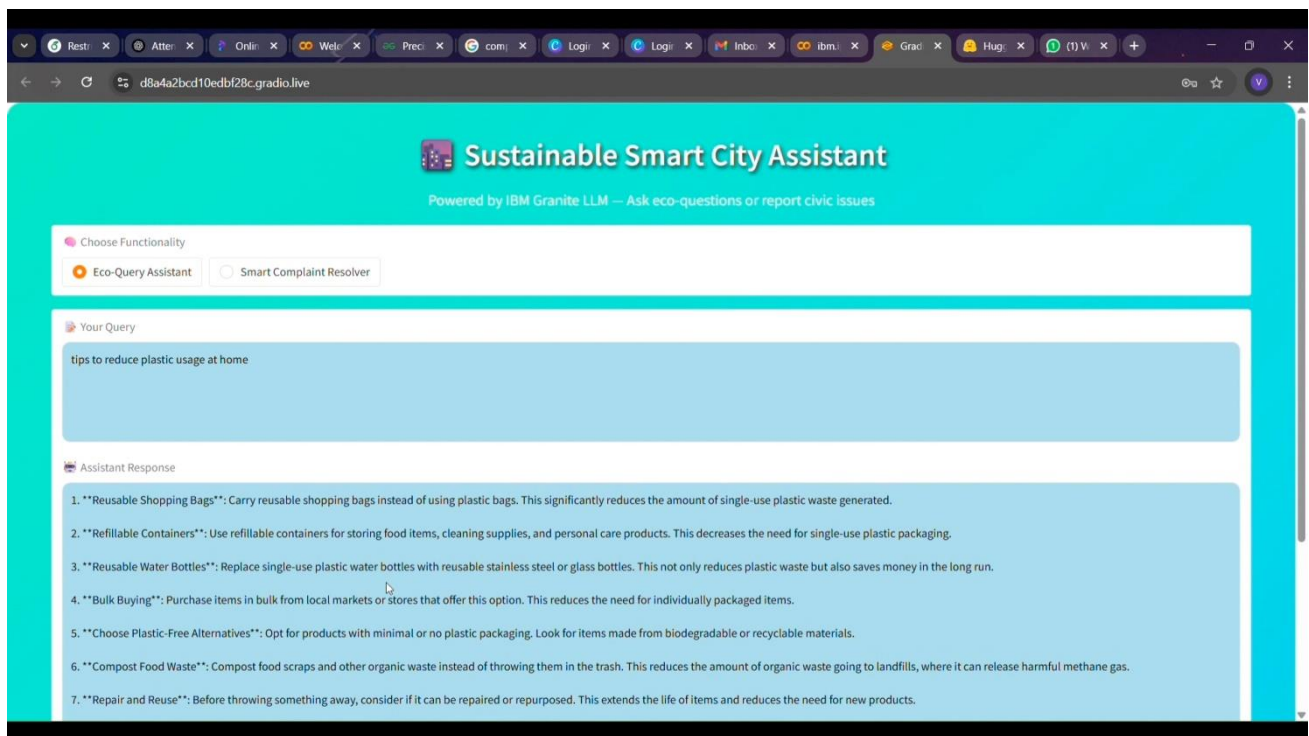
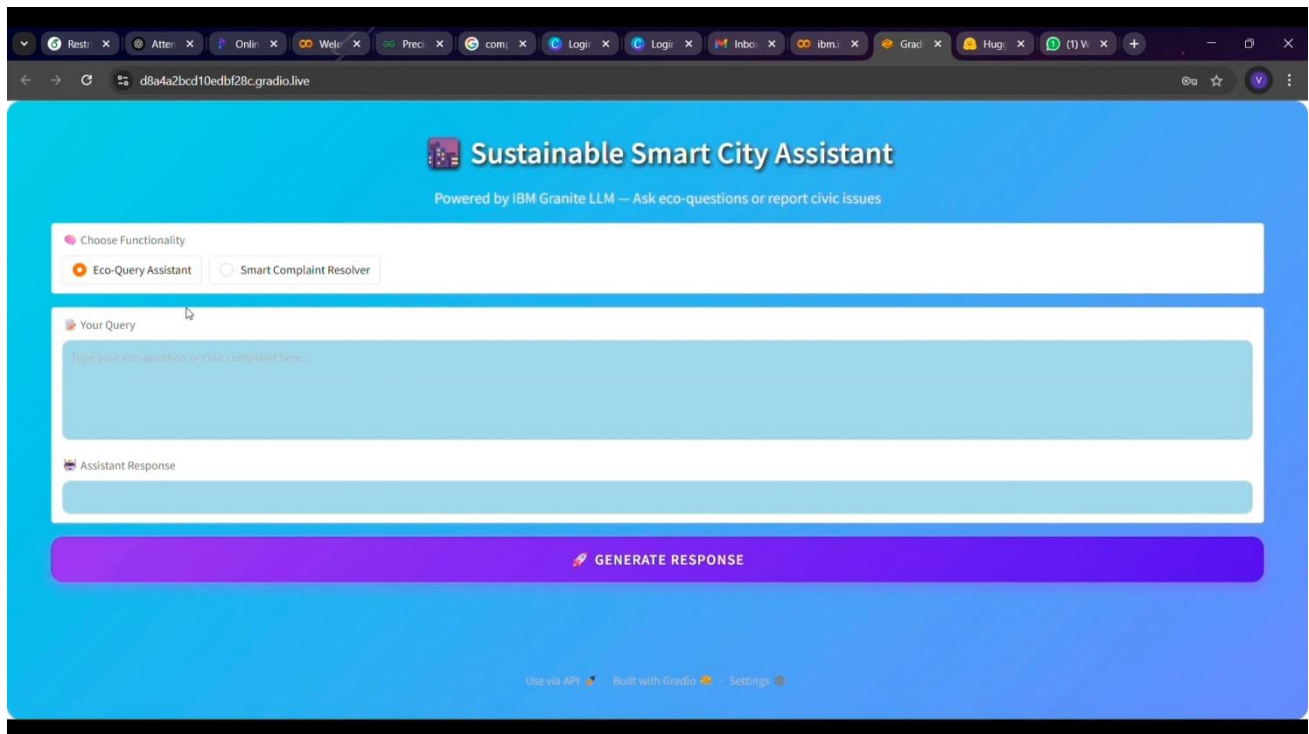
Enter username

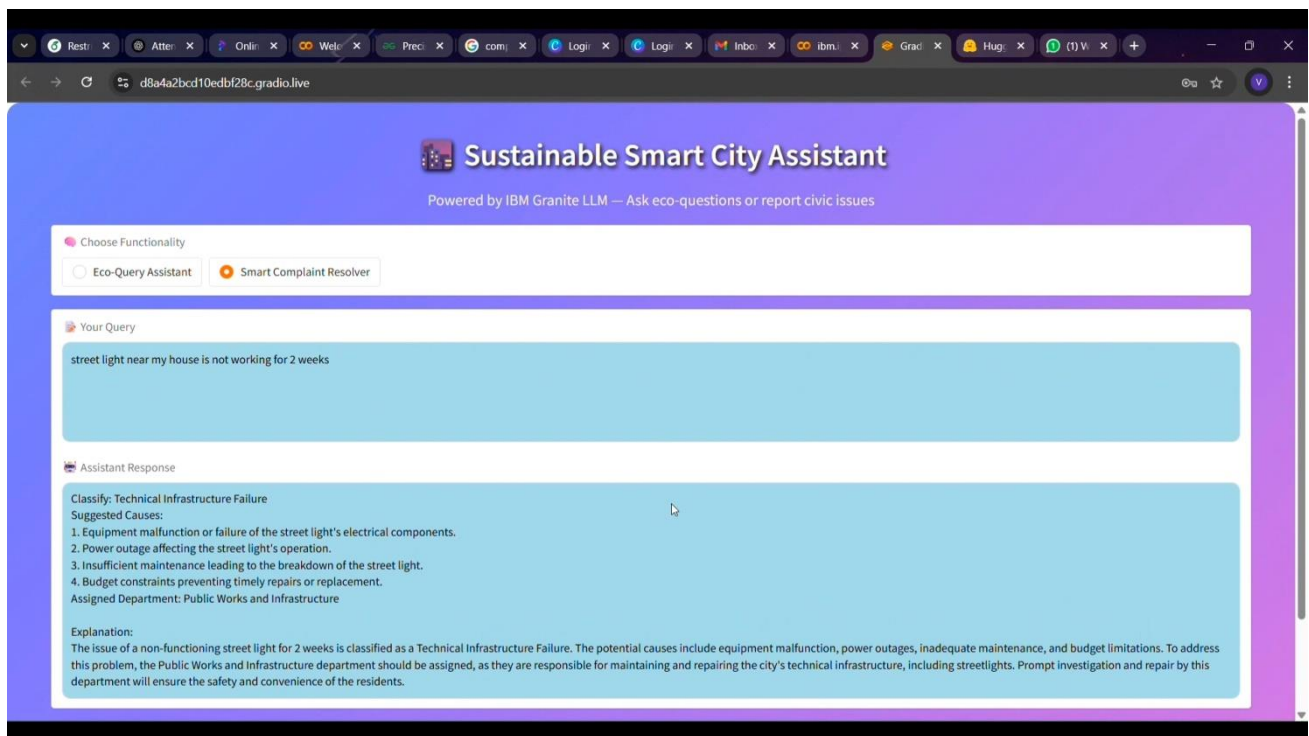
Password

Enter password

LOGIN

Use via API - Built with Gradio - Settings





## 8. ADVANTAGES AND DISADVANTAGES

### Advantages

- 1. AI-Powered Insights:**  
Utilizes IBM Granite LLM to provide intelligent, context-aware responses, making city services more accessible and responsive.
  - 2. Improves Sustainability:**  
Helps citizens and officials make environmentally responsible choices by offering energy, water, and waste management suggestions.
  - 3. Enhanced Public Engagement:**  
Residents can interact with the city digitally through a natural, human-like chat interface — improving communication and transparency.
  - 4. Data-Driven Decision Making:**  
Assists city administrators by analyzing smart city data and providing insights for infrastructure planning and resource optimization.
  - 5. Scalable and Modular:**  
The system can be extended to include new features (like voice support or regional languages) and can scale across different cities.
  - 6. Cloud-Based Flexibility:**  
Running the assistant via Google Colab makes it easy to test and demo the solution without the need for dedicated servers.
  - 7. Multilingual Support:**  
With the help of IBM Granite LLM, the assistant can be fine-tuned or extended to support multiple languages for inclusivity.
-

## Disadvantages

1. **Limited UI/UX (in Colab):**  
The user interface is basic if used within Google Colab, lacking the interactivity and polish of a web or mobile app.
2. **No Real-Time Backend Integration:**  
Without a dedicated backend server or database, real-time data storage, analytics, and multi-user support are limited.
3. **Dependency on API and Internet:**  
The assistant relies heavily on IBM Granite's cloud API, so it won't function offline and may be affected by latency or network issues.
4. **Data Privacy Concerns:**  
Handling of user queries and smart city data requires careful attention to privacy and security regulations, which may not be fully implemented in a prototype.
5. **Cost of Scaling:**  
IBM Granite API usage may incur costs, especially when scaled to serve a large population or when processing high volumes of queries.
6. **Lack of Advanced Personalization:**  
In its basic version, the assistant might not remember user context or preferences unless integrated with a database.

## 9.CONCLUSION

The **Sustainable Smart City Assistant using IBM Granite LLM** demonstrates how large language models can be effectively used to enhance urban living through intelligent automation and citizen interaction. By integrating IBM's powerful LLM with smart city data, the assistant provides real-time, meaningful responses to user queries, promotes sustainability, and supports data-driven governance.

The project successfully showcases a prototype where AI bridges the gap between complex city infrastructure and user-friendly access, empowering both residents and administrators to make smarter, greener decisions. Its flexible, scalable design makes it a strong foundation for further development and real-world deployment.

## 10. FUTURE SCOPE

1. **Web & Mobile App Deployment:**  
Extend the project from Colab to a fully responsive web or mobile application using MERN stack or Flutter.
2. **Voice Assistant Integration:**  
Integrate voice recognition and speech synthesis for hands-free interaction, enhancing accessibility.



3. **IoT Sensor Integration:**  
Connect with live IoT sensor data (e.g., pollution, traffic, water usage) for real-time responses and visual dashboards.
4. **Regional Language Support:**  
Fine-tune the assistant with IBM Granite to support Indian regional languages, making it more inclusive.
5. **User Profile & History Management:**  
Implement user login and data persistence to personalize suggestions and track sustainability impact.
6. **GIS & Smart Infrastructure Mapping:**  
Integrate with GIS systems to provide location-specific services like nearby recycling centers, public transport, etc.
7. **Predictive Analytics:**  
Use historical data and machine learning to predict future trends in energy consumption, traffic, or waste generation.
8. **Collaboration with Municipal Bodies:**  
Partner with local government for pilot testing and real-world adoption in smart city initiatives.

## 11. APPENDIX

### Video link:

<https://drive.google.com/file/d/1Yf0lgIcggPcomsiofbvfpsZt3-PVUJpI/view?usp=sharing>

### GitHub link:

<https://github.com/seshveer07/project-1.git>