

# Smart City and Urban Sustainability: Harnessing AIoT for a Greener Tomorrow

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## Abstract

In the era of Artificial Intelligence, the Internet of Things is also enhanced to become Artificial Intelligence of Things (AIoT) which is the basis of Smart Cities. The goal of this paper is to introduce a superapp which facilitates Urban sustainability in Smart cities for harnessing a greener tomorrow. In this paper we will discuss a township management system which is very user friendly yet most powerful tool to enhance citizen awareness and participation in municipal affairs. The app incorporates broadcasting channel of various departments for complaint redressal in natural language, AI processing it to frame a formal complaint and returning a token to user for tracking. The channels can also broadcast important announcements from the municipal body to existing users for awareness.

**Keywords:** Artificial Intelligence (AI), Internet of things (IoT), Artificial Intelligence of things (AIoT), Smart City, Urban Sustainability, Natural Language Processing.

## 1. Introduction

Cities are densely populated areas and generally has a complex structure comprising of citizens, transportation, communication. services and businesses, utilities interconnected for better lifestyle. The seamless integration of these bodies is facilitated by technology and knowledge.

With advancement in technology, all the objects in an environment are being upgraded to Smart Object. The smart devices when connected throughout a city enabling seamless connectivity, security and ease of life to the citizens, it is called Smart City. Our paper is about Township Management system which is a software that takes care of governing in a smart city for better harnessing the resources and

promoting sustainable urban developed. For the unversed, Smart Objects are those 'things' in a Internet of Things systems which when connected to the system helps monitoring the environment and report the anomalies. When the smart devices have computing and decision making capability the system transforms to Artificial Intelligence of Things. In AIoT set up, the nodes take informed decisions, predict future trends basing on past information. For an example, The Helmet detection system, speed cameras are installed at regular intervals on the roads in cities. These camera capture images of bikers passing by and with trained data, they distinguish the defaulters. In IoT setup, the visuals are analyzed at server and no node computing takes place, but in AIoT the edge computing makes the speed camera issue speed tickets to the guilty people instantly. The monitoring of thefts, hit and run cases can also be analyzed by such cameras providing security to the citizens.

In this paper, we will cover a software system for township management, the AIoT setup for enhanced security. The township management system is React.js based application. It consists of two modules Broadcasting module and complaint redressal module. The User Interface of the Resolver is inspired from whatsapp where instead of contact, the dashboard of the application has two tabs. One is for receiving notifications and other is for dealing with complaints.

Broadcasting tab is a community tab where all the citizens are added as recipients, each government organization like electricity dept, Public Health Dept, Town Police, District collector's office, urban local body, etc. all these departments are mentioned as different communities and each community has an admin. Only admins can send the messages. These messages are for public notice like strikes, interruptions in services, emergencies, etc. for mass communication. This enables the users to be aware of what is happening in their township.

Complaint Redressal tab is also a tab consisting of the same departments as in broadcasting but this is a Peer to peer type communication. In this interface, the sender writes his complaint to the department he has issue with for example there is no power at senders home since hours and he wish to lodge a complaint at electricity department, he will open electricity department chat and describe the issue in English language and send the message. The recipient of the messages in this case is an AI Chatbot that processes the message using Natural Language Processing and produces formal complaint to the electricity department for action. The AI returns a token number that uniquely identifies the complaint of the user for tracking and resolution.

These two interfaces are a must for a smart city. These features removes the delays that are common at government places. Because AI can work 24\*7, the automatic complaint management system is never interrupted, this makes the mechanism sustainable. The application proposed is simple and functional which bridges the gap between the government and its citizens.

As an add-on service, the various departments can place IoT devices at specific locations like, Poles, pipes, bins may have computing devices which keeps track of its surrounding and inform anomalies with it. For example, smart bins, these are normal bins which have ability to detect poisonous gases, flammables, etc. and report it to the municipality to get the bin cleared. This can be done using Smoke

and odour detection sensors along with a computing module that sends a message to the municipality using complaint redressal module which intimates the department and prevents disasters. This is the power of edge computing, the whole process will take fraction of seconds which otherwise would have been left undetected or delayed response.

The Proposed system will be sustainable when the integration of all the discrete services result in error free data transmission without delay and comprise.

## 2. Literature Review

Artificial Intelligence of things is a recent advancement of technology which gives the inanimate objects decision making power. The use of AI for quick decision making improves the efficiency of the system and saves lot of time taken for transmitting of such information over the internet. Networking models like GSM, LTE, Low Energy BLUETOOTH and IoT dedicated bandwidth makes the transmission of information faster and reliable.<sup>[1]</sup>

A central command center for data storage and process is a must in any AIoT setup. For smart cities it is more critical, such command centres are usually placed in highly secure government offices and all measures are taken to keep the data safe. Centre command center governs the devices and their connectivity to other devices, cloud.<sup>[2]</sup>

As discussed earlier, urban cities are crowded and with more population comes more complaints and queries. From simple power cuts to hazards, reporting theft to deaths the maintenance of such record for a population in crores for cities like Mumbai and Delhi. The municipal corporation, electricity board, other bodies deals with everyday. The solution to this is digital complaint redressal system for municipal corporation. The web application takes complaint from the citizens, store it in database and assures quick redressal.<sup>[4]</sup>

One of the most noticed issues in urban areas is waste management. It is not surprising that the urban development authorities deal with tons of solid, liquid and gaseous waste in a day. We notice most of the time the bins are full to the brim and stinking. Once implemented with a smart waste management system, which consists of a network of smart bins, a user interface and a network of trucks. The bins are placed at various places and connected with software, when 90% full turn red on a user interface situated at the office of concerned department. The location is relayed to nearest truck to clear it.<sup>[3]</sup>

The crime rate in urban areas is also a undeniable truth. Snatching. Bullying. Drunk and drive are mostly reported in dark and remote areas of the cities.

To battle darkness and be energy efficient smart lights are used, these lights are connected to sensors which can sense the movement of the surrounding to activate light and disable once movement fades. These save a lot of energy. The round the clock surveillance by CCTVs, the analysis of these data realtime and finding of anomaly i.e. suspicious behavior can alert the authorities in time and prevent accidents.<sup>[7]</sup>

The mentioned anomaly/suspicious activity are analyzed by a system which is trained using machine learning techniques involving the use of Convolutional Neural Network, a deep learning model applied frame by frame to the cctv footage, which is additionally passed through autoencoders and echo state networks. Being trained and validates by such powerful techniques, anomaly detection is a trusted mechanism.<sup>[8]</sup>

The smart cities also consists of various multisensors which keep track of multiple vital parameters related to the environment they are operating on like humidity, smoke, flame, gases, etc. these parameters helps in assessing the temperature, water content in air, presence of fires , etc. These parameters are continuously monitored and analyzed. Suspicious or dangerous levels of readings are reported for further analysis.<sup>[9]</sup>

Multimedia Wireless sensor networks are responsible for video data communication in a IoT setup in smart cities. The cross-layer optimization helps the transfer of audio visual information more fast and reliable.<sup>[10]</sup>

Data are foundation of smart cities, these data include important information like address, name, identity information of citizens, can represent lifestyle of the resident. For an example, the monitoring equipment when captures details of a individual for few days, it can easily assess the usual time of the individual being out and if fallen in hands of miscreants can cause disaster. So such information is encrypted and stored in distributed manner. The process to deal with such data is discussed in this paper.<sup>[11]</sup>

The sensors play most important role in any AIoT setup. The sensors are the primary receivers of stimulus from the environment, these sensors have evolved from being mechanical to now electronics, the modern sensors come with a WiFi connectivity, these sensors consume less power, have a sleep and wakeup current which causes the power efficiency and makes them work for longer cycles.<sup>[14]</sup>

The communication of the connected components in a AIoT setup omrpising of stakeholder like city government bodies, citizens, the IoT sensors, the connected interface should be faster and reliable. Incase of emergencies, early warnings can be generated to localize damage. AI is a evolving technology, but it can be 100% trusted. Human intervention along

with constant development of AI is the road to smart cities. Without human supervision, AI alone can't create future cities.<sup>[16]</sup>

### **3. Proposed Work**

The proposed software is a one stop solution to get updates in the locality and to raise complaints for the issues faced by the citizens in a township or city. The UI is designed to two interfaces, one is a broadcasting module where different urban bodies can announce and keep the citizens informed. The other interface is a complaint redressal system. The various departments of the governing body are listed, all are assigned chatbots. Once a user starts the chat. The chatbot registers the messages to a formal complaint, analyzes the complaint and prioritizes at the backend system for optimal redressal. It generates the reference number through which the user can track the complaint. Assuming that the cities have IoT solutions like Smart Surveillance, Waste management or to be implemented in the future, a interface is designed which can take inputs from various sensors and report it to the backend system using the chatbots.

#### **3.1. The Base Software**

The User interface is inspired from whatsapp as it is a popular messaging platform and the users are acquainted with the design elements. Study proves that people tend to motor memory and based on past memory tend learn and use the app easily and hence such design is selected [14].

The community tab is a receive only interface for clients and the admins who are usually department heads of various organisations have the access to send messages. The sent message is encrypted and is broadcasted to everyone. The complaint module consists of various department instances like the chats in any normal application, the chat interface is a container with the logo and name of organization in top-left. The input area is center aligned with the integrated send button and a button to engage mic to send audio message. The option to send proof documents and images is also allowed.



fig 1. Control Flow Chart for Complaint redressal system

### 3.2. AI Chatbot With priority recognizing model

An LLM based Ai model like chatgpt API with custom instructions is employed to understand the user input in the complaint system, it uses deep learning and NLP to formulate the complaint to a format and processes the complaint to the database. A backend priority recognizing model evaluates the seriousness of the complaint and prioritizes it in the backend system for swift action by concerned authority. The AI chatbot replies a token number and expected resolution timeline. It also asks for feedback and additional queries from the user.

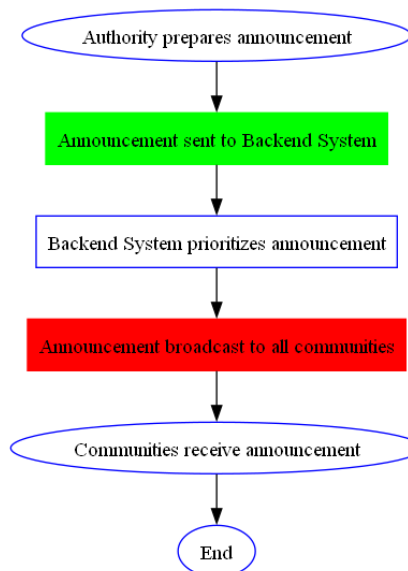


Fig 3. Control Flow Chart for broadcasting system

### 3.3. Integration of monitoring module to complaint redressal model

Multisensors are connected to their respective edge computing services and are interconnected to seamlessly communicate the findings. The AIoT system themselves are good at assessing their surrounding, continuous monitor and update the data in cloud. But in special cases like accident, suspicious activities like bully, theft, drunk and drive, where the surveillance equipment detect abnormalities and communicate it to a special authority, we will use the AI chatbot of complaint redressal to be connected to the network of such equipment. When serious offense are recorded by these equipment passing a threshold value are alerts not to concerned department but to an array of authorities, at the same time release a warning in the communities. In such cases community can be informed.

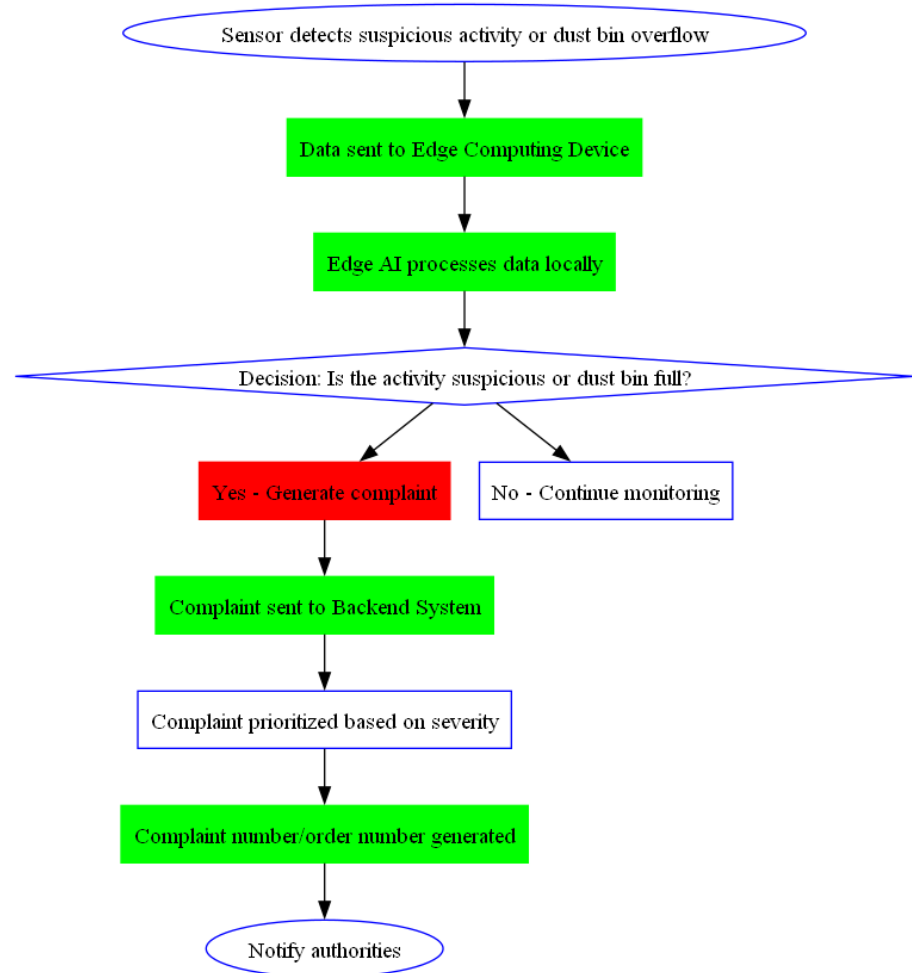


Fig 3. Control Flow Chart for AIoT integrated system

## 4. Methodology

The user interface is inspired by WhatsApp, where the broadcasting functionality is inspired from community feature and the traditional chat window for complaint registering. The Township management system ‘Resolver’ consists of 3 modules, The front end UI for user and admin to communicate. A Backend system which process complaints from the user and sends the token to user. An AI model which uses advanced technologies to understand and reply the users

Google’s firebase API is used for login management. It enables the information gathering useful as these details are received from Google using the mail of the user registered. The front-end interface of the application which consists of two tabs is written in HTML/CSS. The React as Javascript library is used for designing the software. React is a light weight library, it reduces loading time and makes the interface attractive and dynamic. The webpage consists of Broadcast channels of various government bodies, with their logo. The admin of these communities can only send messages, these are also the top leadership in the specified urban body. The Complaint acceptance window is a container with traditional features of sending images, docs, audio, video and plain text messages. The difference is the receiver is a Ai and not a person. The reply time is very short. GPT like LLM model is used to train the Ai so the responses are human understandable. The prompts by user are to be processed by the model while also getting the parallel execution of formatting the complaint.

A special interface for prompts from various AIoT setups is designed, it is a minimal interface where the messages are received in signals processed to text for easier handling at the software.

## 5. Results and Discussions

The webpage is designed containing the admin only broadcasting module, a chat based complaint registering module with ChatGPT API integration is done for testing, a small community is created, likewise some test organisations are created. A humidity data of last 30days is collected from our humidity monitoring module. Intentionally spikes to the data are added to generate warnings. A test announcement is done which is received by all members, a complaint at electricity department is processed and a reply is received. The insights from analysis of the humidity monitor are manually given to Ai which generated a warning in the community. All these are the testcases to test the software’s functionality. The AI expects text messages and hence the existing AIoT systems should be worked on to generate output which can be picked up by AI to do the further execution. The limitation is, there is no widely accepted configuration so that every IoT system have similar output characteristics.



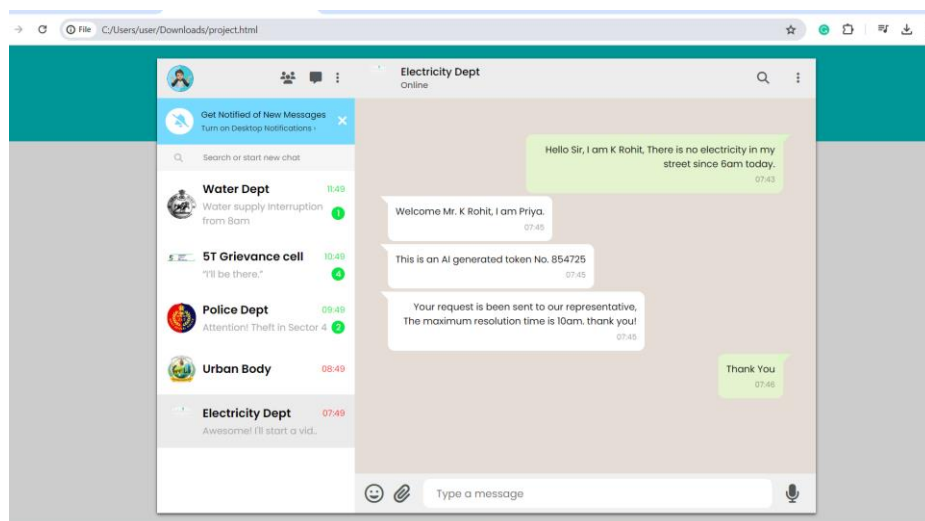


Fig 5.1 User Interface in development stage

## Conclusion

The population is rapidly shifting to urban areas for better facilities, major metropolitan cities have started developing satellite town to manage crowd. India being most populous country will see more satellite towns being created GIFT city of Gujarat is just one of them. Planning AIoT solutions and AI based township management systems will be the major drivers. The proposed complaint redressal system will be a must as the population in such cities can't wait in long queues for getting services they need faster redressal.

The concept of keeping the cities well connected isn't new, our approach is being a one stop solution, be a bridge between citizens and the authorities, addressing the queries of users and also drawing attention to important matters happening the neighborhood. Integrating the existing AIoT system is an icing on cake, this makes the cities for sustainable. The application encourages the developer s to build IoT systems which are interoperable as it can reduce costs and become more stable. This can also help in better management of data which makes it better to keep safe.

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