

Smart Municipality Workforce - Response System

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Abstract - The proposed Smart Municipality Workforce System presents a practical solution aimed at improving transparency, accountability, and citizen participation in local government operations. The proposed system uses camera-based facial recognition along with GPS-based geofencing to ensure the actual presence of field workers and to eliminate proxy attendance. To include workers who do not own smartphones, a supervisor-assisted attendance mechanism is also provided, ensuring no one is excluded from the digital workflow.

To improve the reliability of fieldwork monitoring, the system applies AI-based verification on before-and-after task images, helping authorities validate work quality more effectively. Citizen engagement is strengthened through a multilingual and multimodal grievance portal that allows residents to submit complaints easily, while automated escalation mechanisms ensure timely resolution. The system supports offline data capture and uses multi-channel notifications to maintain smooth coordination across departments. Additionally, analytics dashboards provide actionable insights that assist administrators in making informed, data-driven decisions. Overall, the proposed model offers a scalable and sustainable approach to enabling efficient and participatory smart urban governance.

Keywords: Smart City, Human Resource Management, Facial Recognition, AI-Based Verification, Citizen Grievance System, Urban Governance

1. INTRODUCTION:

As cities continue to expand rapidly, municipal corporations are under growing pressure to manage large workforces efficiently while delivering services to citizens on time. Conventional practices, such as paper-based attendance systems and disconnected reporting mechanisms, often fail to meet these demands. These methods are not only time-consuming but also vulnerable to issues like proxy attendance and inaccurate reporting, which ultimately weaken transparency, accountability, and public confidence in local administration.

Advancements in digital technologies now provide effective alternatives to these limitations. The use of artificial intelligence, facial recognition, and GPS-enabled monitoring allows for reliable, real-time verification of workforce presence and activities. At the same time, digital platforms for citizen engagement enable systematic grievance submission, tracking, and resolution. In this context, this paper proposes a Smart Municipality Workforce and Response System that integrates AI-based attendance management, automated task validation, and a multilingual grievance portal. The proposed approach supports improved service delivery, strengthens administrative accountability, and enables municipalities to adopt data-driven decision-making for sustainable and efficient urban governance.

2. LITERATURE REVIEW

Effective management of municipal personnel and prompt resolution of citizen grievances have become key concerns in modern urban governance. In response, several municipal corporations across India have begun adopting digital technologies to strengthen workforce accountability and service delivery. For instance, the Greater Hyderabad Municipal Corporation (GHMC) deployed an AI-enabled facial recognition system to automate staff attendance, significantly reducing inaccuracies linked to manual record-keeping [1]. Similarly, the Vadodara Municipal Corporation (VMC) implemented a geofencing-based attendance mechanism to verify employee presence within assigned work zones during official hours [2]. The Nagpur Municipal Corporation (NMC) also

introduced facial recognition for sanitation workers, which exposed attendance inconsistencies and emphasized the importance of continuous, real-time monitoring [3]. Other cities, including Kanpur [4], Chandigarh [5], Prayagraj [6], and Gurgaon [7], have experimented with biometric and mobile application-based attendance systems to improve transparency and ensure that salary disbursement aligns with verified attendance records.

In parallel with workforce monitoring initiatives, municipalities have made notable efforts to strengthen citizen grievance redressal systems. Digital platforms such as the Smart Complaint Management System [8], Jan Suvidha [9], and the Smart Complaint Portal [10] enable citizens to register complaints, track progress, and demand accountability from local authorities. More advanced solutions, including City Solution [11], leverage artificial intelligence to automatically classify and prioritize grievances, illustrating the role of intelligent systems in improving municipal service efficiency. Despite these advancements, most existing solutions remain siloed, addressing either workforce attendance or grievance management independently, without a unified, real-time operational framework.

The proposed Smart Municipality Workforce and Response System extends these earlier initiatives by integrating AI-based attendance verification, GPS-enabled workforce monitoring, real-time task validation, and a multilingual citizen grievance portal into a single platform. By consolidating these functionalities, the system overcomes the limitations of fragmented approaches, enhances operational transparency, improves administrative efficiency, and encourages stronger citizen participation in municipal governance.

3. SYSTEM ARCHITECTURE AND METHODOLOGY:

3.1 Project Architecture

The Smart Municipality Workforce and Response System is designed around a scalable and integrated architecture that streamlines the way urban services are managed and delivered. It unifies municipal workforce operations, citizen interaction, and administrative monitoring within a single digital ecosystem. Secure authentication and role-based access control ensure that workers, supervisors, citizens, and administrators can access only the functionalities relevant to their responsibilities, thereby maintaining system integrity and data security.

To ensure reliability and build trust in operational data, the system employs AI-driven facial recognition combined with GPS-based location verification to confirm staff attendance and on-site presence. Citizens are provided with an intuitive grievance interface that supports text, image, and audio submissions, allowing issues to be reported easily and accurately. Each complaint is automatically associated with the appropriate service type and geographical location, enabling efficient assignment to the responsible workforce. Field activities are tracked through digital task monitoring, where workers submit

before-and-after evidence of completed work. AI-assisted validation helps verify task completion and quality, reducing dependence on constant manual supervision. Real-time alerts and notifications keep all stakeholders updated on task status and complaint resolution. Furthermore, centralized data management and analytical dashboards offer actionable insights that assist municipal authorities in making informed decisions and planning more effective urban services.

System Architecture: Smart Municipality Workforce & Response System

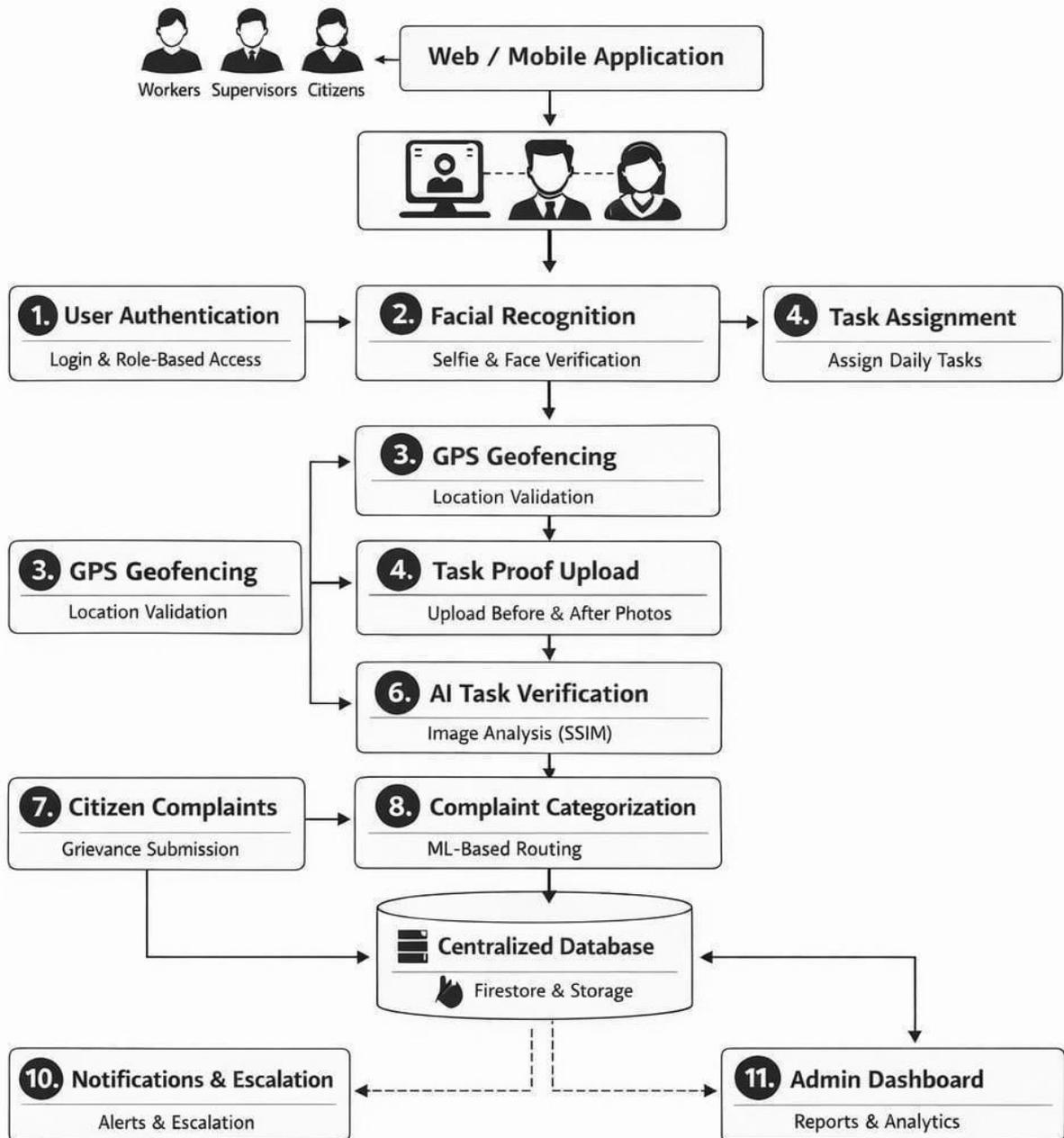


Figure 3.1: Project Architecture of Smart Municipality Workforce & Response System

Here's The operation of the system follows a clear, step-by-step workflow designed to improve transparency, accountability, and efficiency in both municipal workforce management and citizen complaint handling. The system is supported by a combination of advanced technologies, including artificial intelligence, facial recognition, GPS-based geofencing, and centralized data analytics. The process begins with user authentication. Municipal workers, supervisors, citizens, and administrators access the platform through dedicated web or mobile applications. Workforce attendance is recorded using facial recognition technology, which is further validated through GPS location data to confirm on-site presence. For workers who do not possess smartphones, attendance can be recorded through a supervisor-assisted mechanism, ensuring inclusivity without compromising accuracy.

Citizens interact with the system through a multilingual grievance portal that allows them to submit complaints by selecting the issue category and tagging the relevant location. At the same time, supervisors assign daily tasks to field workers using the administrative dashboard. All incoming data—including attendance records, task updates, images, and citizen complaints—is securely stored in a centralized database. Artificial intelligence plays a key role in validating field activities by analyzing before-and-after task images to confirm work completion and quality. Citizen complaints are automatically categorized and routed to the appropriate department based on the nature of the issue and its location. Finally, analytical dashboards compile this data to present insights on workforce performance, attendance trends, complaint resolution status, and escalations. These insights enable administrators to make informed decisions and ensure the smooth and effective delivery of municipal services.

4. IMPLEMENTATION:

The Smart Municipality Workforce & Response System is a full-stack, AI-enabled platform designed to enhance transparency and operational efficiency in municipal governance. It enables real-time tracking of municipal workers, monitors task progress, and ensures prompt resolution of citizen complaints. By leveraging mobile and web technologies along with machine learning, geolocation services, and cloud-based data management, the system empowers city authorities to efficiently manage their workforce, respond to issues quickly, and make well-informed, data-driven decisions instead of relying on assumptions.

4.1 Technology Stack

The system uses a modular and scalable technology stack that is designed to handle real-time data, carry out AI-based checks, and allow different parts of the platform to communicate with each other in a secure manner. At the backend, Python acts as the main backbone, handling data processing, machine learning operations, and overall system coordination. Flask is used to build lightweight web APIs that manage user authentication, attendance tracking, task handling, and complaint management. For tasks that involve facial recognition or image analysis, TensorFlow and OpenCV are used to verify identities and ensure that assigned work has been completed. Scikit-learn adds intelligence to the system by helping categorize complaints and predict which ones are likely to escalate. Login security and session management are handled using JSON Web Tokens (JWT).

The frontend is created with a strong emphasis on ease of use and responsiveness. HTML, CSS, and JavaScript are used to develop the user interface, while Bootstrap ensures the design adjusts smoothly across different screen sizes. With the help of frameworks like React or Flutter, users can access the system comfortably on both mobile devices and laptops, making it user-friendly for workers, supervisors, and citizens. For handling data, Firebase Firestore functions as a real-time NoSQL database where attendance details, task information, complaints, and system logs are stored. Images such as facial data and before-and-after work photos are securely saved in Firebase Storage. The Google Maps API is used for

location tracking and geofencing to verify that workers are physically present at their assigned locations. Cloud Functions operate in the background to send notifications and manage tasks such as checking whether a complaint needs to be escalated. For development and deployment, commonly used tools are employed, including Git and GitHub for version control, Postman for API testing, and Docker for running the application in containerized environments.

4.2 Facial Recognition Attendance Implementation

The attendance feature is designed around a combination of facial recognition and GPS-based geofencing to make the process reliable and secure. At the time of enrollment, each worker is registered by capturing several facial photographs taken from different angles and under varying lighting conditions. These images are then converted into facial embeddings, which serve as unique digital "faceprints" and are stored for later comparison. To mark attendance, the worker takes a realtime selfie through the application. The system uses OpenCV to detect the face, after which a deep learning model

extracts the facial features and compares them with the stored facial data. Along with facial verification, the application also collects the device's GPS coordinates and checks whether the worker is physically present at the assigned work location. Attendance is successfully recorded only when both the facial match and location validation are confirmed.

This dual-verification method significantly reduces the chances of false or proxy attendance and helps maintain accurate records. In cases where a worker does not own a smartphone, a supervisor is allowed to assist with marking attendance, ensuring that all workers are included in the system. This dual-verification method significantly reduces the chances of false or proxy attendance and helps maintain accurate records. In cases where a worker does not own a smartphone, a supervisor is allowed to assist with marking attendance, ensuring that all workers are included in the system.

4.3 Machine Learning Models Used

4.3.1 Face Recognition Model

Facial recognition in the system is implemented using a Convolutional Neural Network (CNN). The model extracts distinctive facial features and converts them into embeddings, which are then compared during attendance marking using similarity scores. This approach allows the system to maintain reliable accuracy even when there are changes in lighting conditions or surrounding environments.

4.3.2 Task Verification Model

Task verification is carried out by requiring workers to upload before-and-after images of their assigned work, such as cleaning or repair activities. The system analyzes these images using the Structural Similarity Index (SSIM), edge detection techniques, and region-based comparisons to identify visible changes and confirm that the task has been performed. Based on the results of this analysis, tasks are classified as completed, partially completed, or not completed. Any task that does not meet the required criteria is flagged for supervisor review. This process reduces the need for manual inspections while helping maintain consistent service quality.

4.3.3 Complaint Categorization Model

The system uses a supervised text classification model to automatically analyze and categorize incoming complaints. This ensures that each complaint is quickly directed to the appropriate team, enabling faster and more efficient resolution.

5. RESULTS:

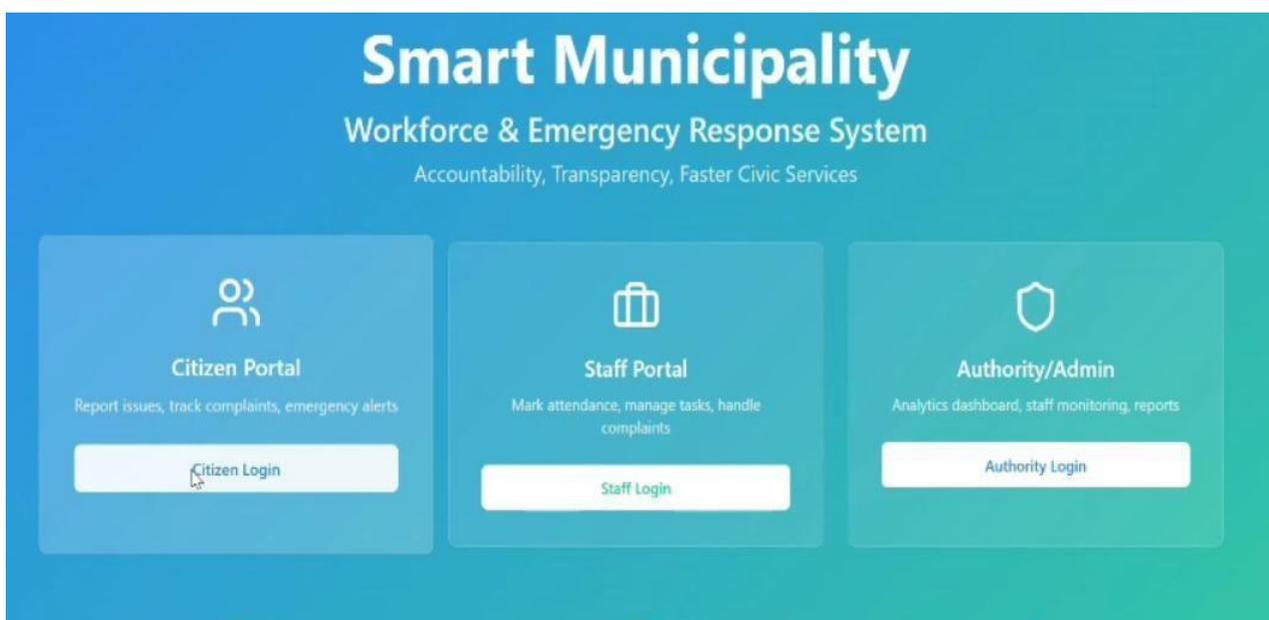


Figure : Home page

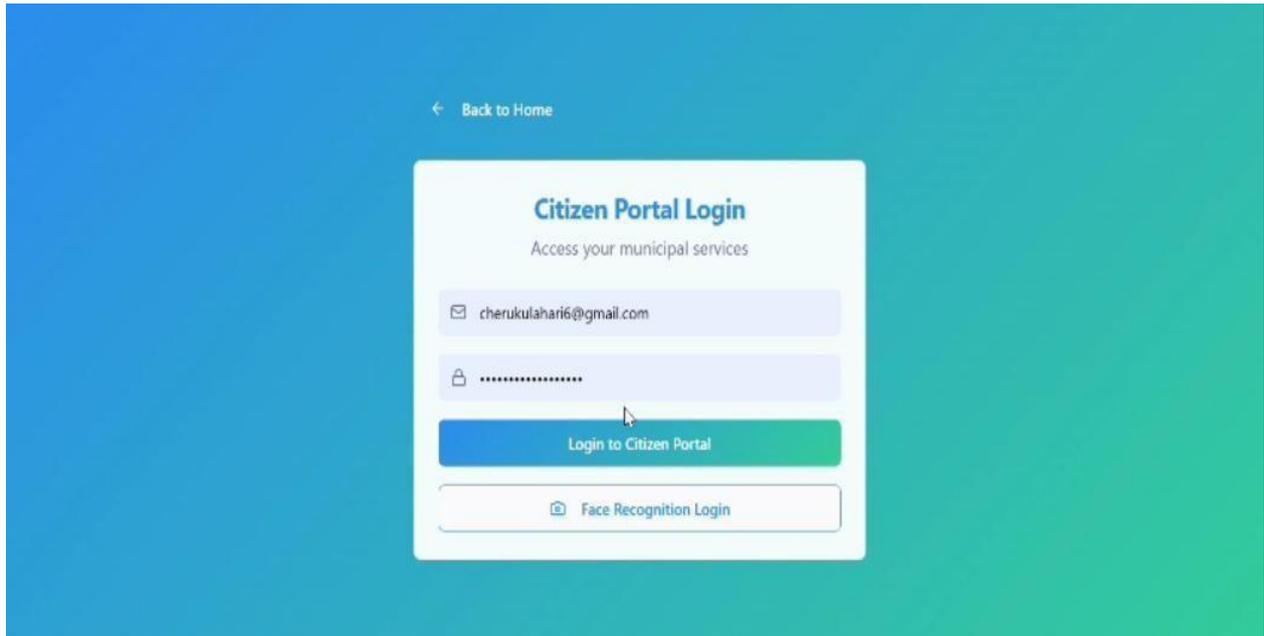


Figure: Citizen Portal Login

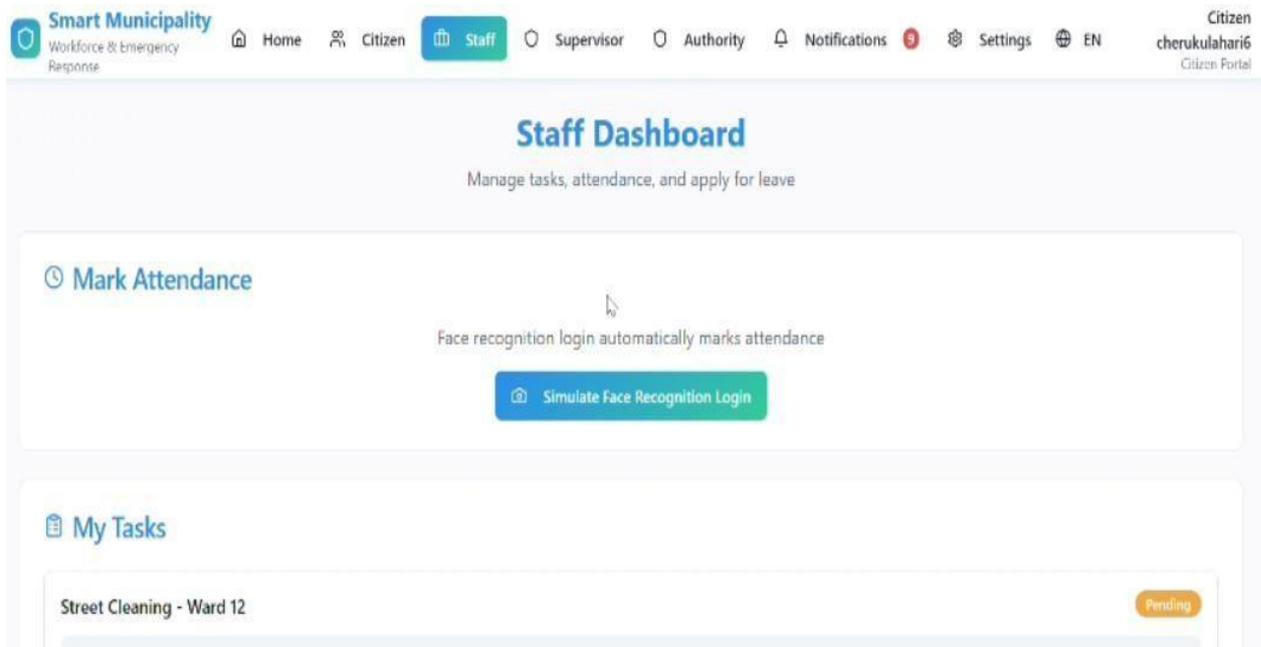


Figure: Staff Dashboard

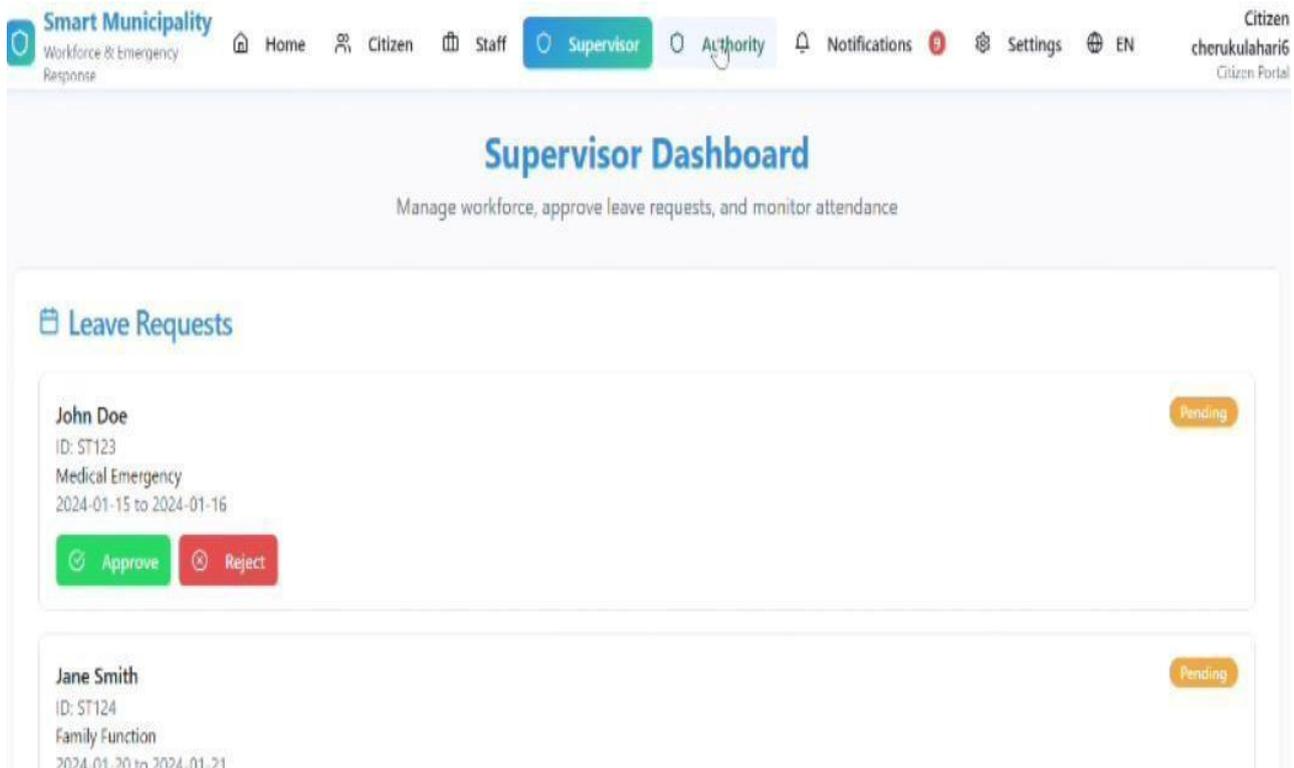


Figure: Supervisor Dashboard

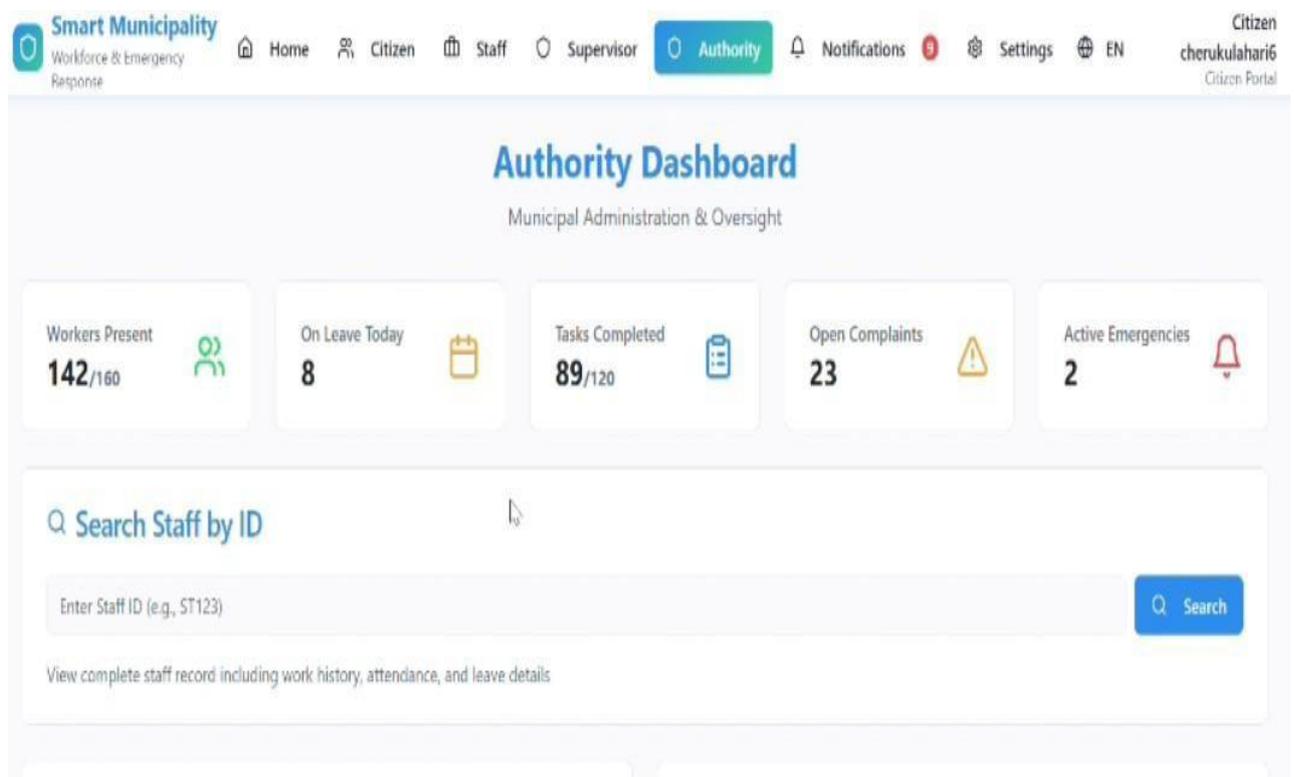


Figure: Authority Dashboard

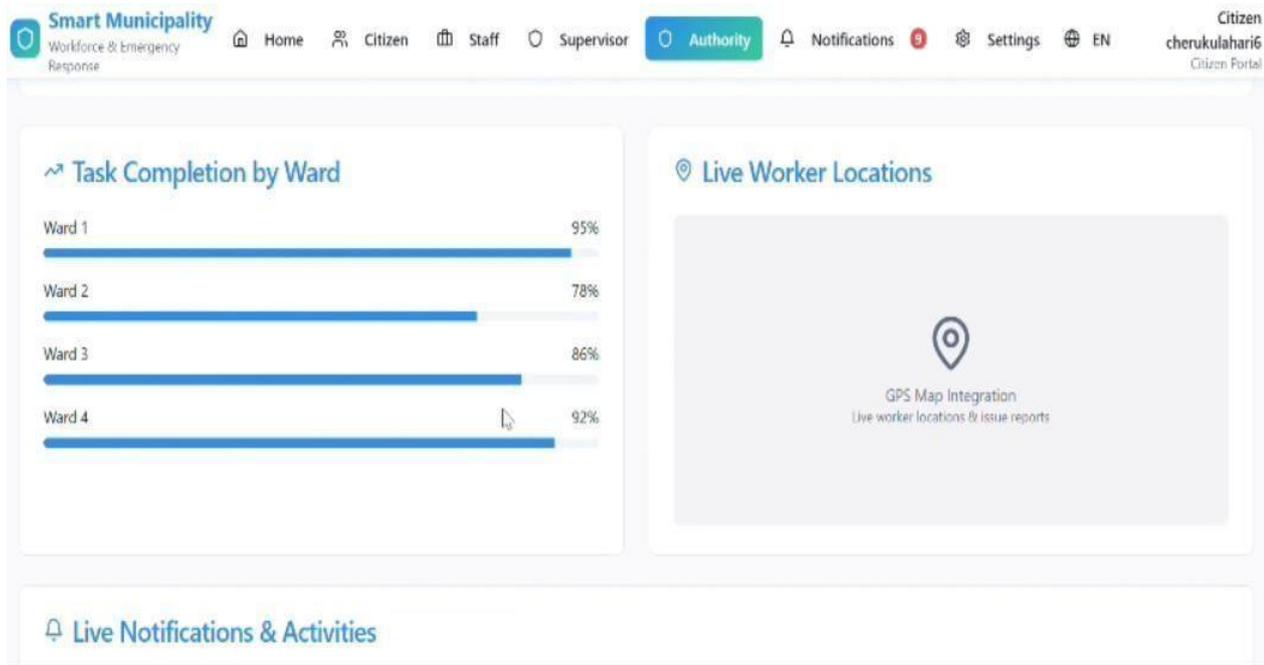


Figure: Working Progress

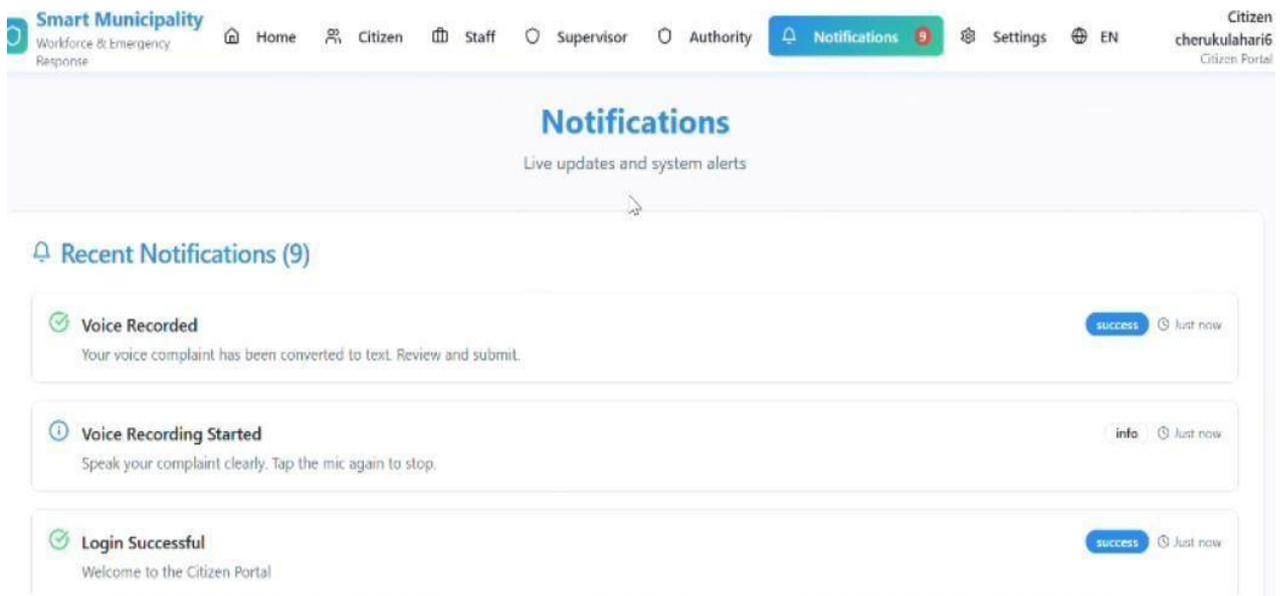


Figure: Notifications

6. CONCLUSION AND FUTURE WORK:

6.1.1 Conclusion

We set out to build a Smart Municipality Workforce and Response System, and it truly makes a difference. By bringing together facial recognition-based attendance, GPS geofencing, AI-driven task verification, and a digital platform for citizen complaints, we addressed some of the major challenges in municipal operations. This system ensures accurate workforce attendance, eliminating issues like buddy punching and uncertainty about employee presence. AI-based task verification reduces dependency on manual inspections by enabling faster and more reliable work validation. Additionally, the grievance module allows citizens to raise complaints in real time, track their status, and see automatic escalations, creating greater transparency and trust between the public and the municipality. Administrators benefit from a comprehensive analytics dashboard that provides clear insights into workforce performance, complaint resolution times, and service-level efficiency. Overall, the system demonstrates how integrating AI,

cloud technologies, and location tracking can lead to smarter decision-making and improved urban management. It is designed to be scalable and adaptable, allowing deployment across multiple departments or even entire smart cities.

6.2 Future Work

Even though the system already brings big improvements, there's still room to make it stronger. Next steps? Start with deep learning models to make facial recognition work better—even when lighting's bad or faces aren't fully visible. For task verification, smarter computer vision and object detection can give a clearer picture of work quality.

Adding predictive analytics would help forecast complaint trends, workforce needs, and spot service bottlenecks before they happen. IoT sensors—think smart bins or air quality monitors—could feed in real-time data and help plan maintenance before things break down. If we analyze feedback from social media using natural language processing and sentiment analysis, we'd get an even better sense of how people feel about services.

Operationally, putting attendance and task records on a blockchain would lock down data integrity and boost trust. Making the interface multilingual and adding voice controls would help more people use it easily. And if we roll this system out across multiple cities and hook it up with other smart city platforms, we'll really see how well it scales in the real world.

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