Urban Infrastructure Accessibility Monitoring System

Addressing the critical lack of systematic urban accessibility monitoring, this project introduces a crowdsourced platform. It aims to revolutionize how we assess and improve city infrastructure for people with disabilities.

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Problem and Societal Impact

Global Disability

As of 2023 from kun.uz **13.5%** of the Uzbekistan's population lives with some form of disability.

Officially, in 2022, **845,300** people or 2.3% of the total population were recognized as persons with disabilities.

This highlights a significant need for accessible infrastructure.

Current Challenges

Existing assessment methods are often manual and inconsistent.They fail to provide comprehensive, real-time insights into urban accessibility.

Target Users

The system empowers citizens, professional inspectors, and city administrators. Each role plays a vital part in data collection and management.

Government compliance

Helps government agencies meet international accessibility standards (UN CRPD, ISO 40500) and national disability rights legislation through systematic monitoring and reporting

Social Impact

This platform promotes inclusivity and improves quality of life. It fosters a more accessible urban environment for everyone.

Economic impact

Accessible infrastructure boosts economic growth by enabling 13.5% of the population to participate fully in commerce, education, and employment. Every $1 invested in accessibility yields $7 in economic returns.

Technical Architecture Overview
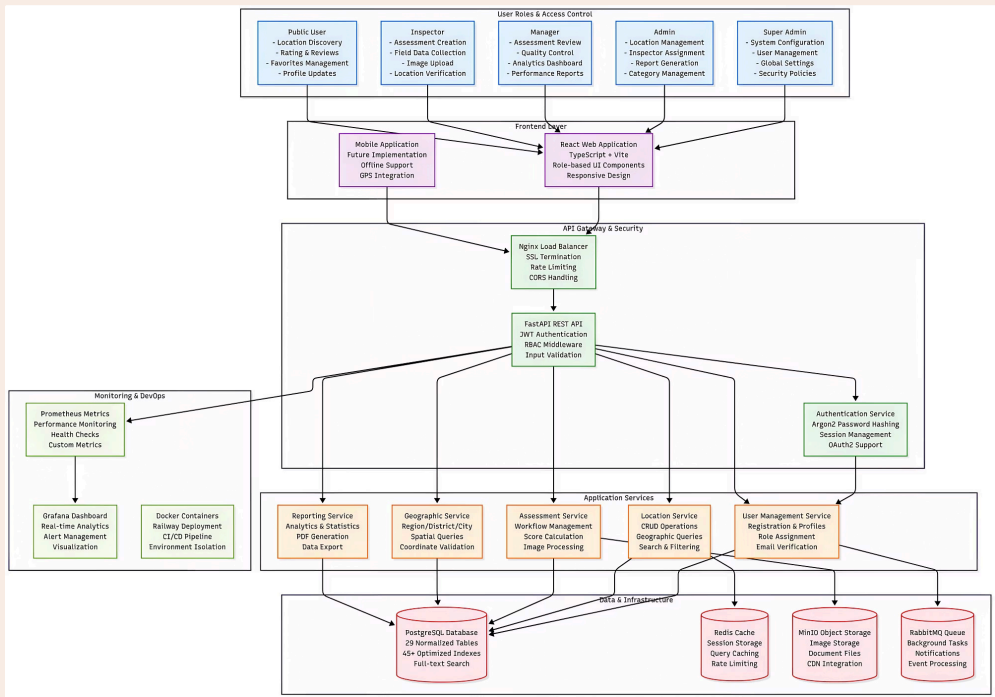
Backend: FastAPI

Built with Python 3.12+, featuring 17+ API routers and robust JWT authentication.

Frontend: React 18

Developed with TypeScript 5+, ensuring type safety and real-time features.

Database: PostgreSQL

A highly normalized schema with 29 tables, adhering to 3NF principles.

Infrastructure

Deployed using Docker containers on Railway cloud for scalability and reliability.

Database Design Excellence

Our PostgreSQL database boasts 29 highly normalized tables, meticulously designed following 3NF principles. This ensures data integrity and efficiency.

Complex relationships, such as Users to Assessments to Locations, are carefully modeled. This intricate design facilitates robust data management. Performance optimization is achieved through strategic indexing and triggers. This ensures rapid data retrieval.

The database architecture is built for scalability. It can handle a growing volume of data and users without compromising performance.

Key Features Showcase

Assessment Workflow

A streamlined process: Submit, Review, Verify, and Reject. This ensures data accuracy.

Interactive Maps

Visualize accessibility data with location clustering and real-time updates.

Role-Based Access

Secure authentication with distinct roles for citizens, inspectors, and admins.

Analytics

Comprehensive data visualization with accessibility trends, regional statistics, and real-time KPIs for informed decision-making

Image Upload

Easy drag-and-drop functionality for submitting visual evidence with assessments.

Technical Challenges Solved

Repository Pattern & Unit of Work

Implemented Repository Pattern with Unit of Work for transaction management, dependency injection, and clean separation of business logic from infrastructure.

Robust Security

Achieved through JWT for authentication and comprehensive role-based access control.

Database Optimization

Implemented 3NF schema with 29+ tables, 45+ indexes, materialized views, and automated triggers for optimal data integrity and query performance

Environment-Based Configuration

Pydantic-based settings management with nested configurations for database, auth, storage, messaging, and SMTP - enabling seamless multi-environment deployment

Results and Performance Metrics

150...
Lines of Code

A substantial production-ready codebase, reflecting comprehensive development.

200...
API Response Time

Ensuring a swift and highly responsive user experience across the platform.
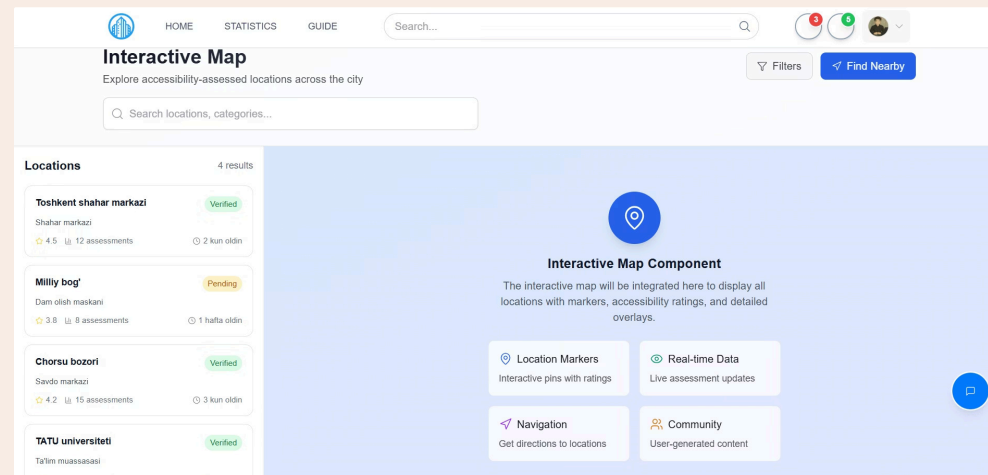
90%
Test Coverage

Comprehensive unit and integration tests guarantee system reliability and stability.

Live Demo Preview

Demo Flow:

- Login as different user roles.

- Browse the interactive map with clustering.

- Create a new accessibility assessment.

- Admin review and publish an assessment.

Future Development Roadmap

Short-term (6 months) — 1

Mobile App: Offline data capture.

2 — **AI Assessments**

Machine learning for image analysis.

Advanced Analytics — 3

Predictive modeling, trend forecasting.

4 — **API Integration**

Connect with government databases.

Medium-term (1-2 years) — 5

IoT Sensor Integration: Real-time monitoring.

6 — **Multilingual Support**

Uzbek, Russian, and English access.

Blockchain Verification — 7

Immutable, transparent record-keeping.

8 — **VR Training Modules**

Immersive training for inspectors.

Long-term (3-5 years) — 9

Regional Expansion: Central Asia.

10 — **Smart City Integration**

Integrate with urban management.

Research Platform — 11

Open data for academic use.

12 — **Policy Impact Tools**

Inform and shape urban policy.

Thank You

Gratitude for your attention. This platform builds inclusive cities for everyone.

Population Impact

Monitoring supports 13.5% of Uzbekistan's population.

Special thanks to my thesis supervisor and the university.

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