A case study on Monitoring and Tracking Election Polling Booths Using GIS in Telangana, India

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Abstract

Elections are the foundation of a democratic system because they give people the essential chance to select their representatives and have an active role in national administration. In India, the largest democracy in the world, independent constitutional authorities are tasked with conducting free, fair, and transparent elections. This duty is handled by the State Election Commissions (SECs) in each state, while the Election Commission of India (ECI) is in charge of it at the federal level.

Elections for the Lok Sabha (House of the People), Rajya Sabha (Council of States), and State Legislative Assemblies are supervised by the Election Commission of India, while elections to Panchayati Raj Institutions and Urban Local Bodies, including corporations and municipalities, are handled by the State Election Commissions. The Representation of the People Act and the Constitution's laws and regulations are followed during elections thanks to these commissions.

The election officials collaborate closely with law enforcement organizations, including as the state police, central armed police forces, and paramilitary groups, to uphold order and stop any kind of misconduct. Their combined efforts are essential to preserving the sanctity of the voting process, guaranteeing voter safety, avoiding intimidation, and preserving peace.

In order to guarantee that every citizen's voice is heard and represented in the country's government, India's electoral system uses these procedures to try and exemplify the democratic values of equality, openness, and participation.

The significant challenges toward the conduction of free, fair, and peaceful polling included preventing incidents of sabotage, reporting and managing incidents, countering terror threats, planning traffic movement, ensuring crowd control, enabling public information dissemination, and maintaining social harmony in coordination with all relevant government departments. This case study shows how the Cutting-edge technologies, including Geographic Information Systems (GIS) and Artificial Intelligence (AI), played a key role in achieving the objectives while maintaining law and order.

During the 2024 Lok Sabha elections, the Indian state of Telangana was covered by 35,356 polling booths, with approximately 9,900 being identified as sensitive (28%) for a multitude of reasons. Around 1.88 lakh personnel were deployed: 73,414 ranks of Civil Police, 500 sections of TS Special Police, 164 companies of Central Armed Police Force (CAPF), 3 companies of Tamil Nadu SAP, 2088 ranks from other departments and 7,000 Home Guards sources from other states.

1. Introduction

1.1 Background

Leveraging Telangana's strong reputation as a leader in digital innovation and technological advancement, the Telangana Police Department undertook the development of a Geographic Information System (GIS)-based application under its flagship TSCOP (Telangana State COP) program. This initiative aimed to integrate advanced spatial mapping technologies into election management and law enforcement operations.

The application was initially conceptualized and deployed to assist police and election officials during the 2019 Lok Sabha (General Parliamentary) and Telangana State Legislative Assembly (Vidhan Sabha) elections. Its primary purpose was to enable the initial deployment of GIS-based monitoring during elections was to introduce foundational capabilities such as geotagging of polling booths and real-time identification. It empowered Station House Officers (SHOs) to monitor booths for untoward incidents like booth rigging or unauthorized gatherings. However, the system was limited to displaying only map views during such events. Intelligent reports were generated for stakeholders—including SHOs, field officers, and senior officials, highlighting incidents such as illegal distribution of money, liquor, or other inducements. Despite its utility, the alert mechanism was restricted to notifying only the SHO, which often delayed coordinated responses.

This GIS-based initiative not only reflected the Telangana Police Department's commitment to harnessing digital tools for governance and public safety but also demonstrated how technology-driven policing can strengthen the integrity and effectiveness of the democratic process.

The GIS-based program was upgraded and expanded during the 2023 Telangana State Legislative Assembly and 2024 Lok Sabha elections, drawing on knowledge and experiences gained

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from its previous use. In order to provide more effective monitoring, tracking, and coordination across all polling stations, and therefore, more seamless election management and robust law and order maintenance, the system was redesigned with a number of additional features and performance enhancements.

The enhanced application was intended to develop a robust, multi-layered monitoring tool. Real-time surveillance was extended to the main Control Room, enabling centralized oversight. The application now offered shortest path navigation to incident sites and integrated nearby road junctions and check posts to facilitate rapid response and suspect apprehension. Regarding Situational awareness, this was significantly enhanced by providing GIS Overlay functionality for different thematic maps and or attribute data—for example, resource deployment was optimized based on booth sensitivity, refer figure-3 and voter demographics, such as assigning more female officers to booths with higher female voter turnout. Transparency improved through evidence-linked incident reports, such as photos of cash distribution or video clips of unauthorized campaign activity via mobile app. Sophisticated filters allowed officers to quickly access specific incident types, like reports of intimidation or crowding. Crucially, alerts were now sent not only to SHOs but also to the nearest check post, Control Room and Senior Officers, enabling swift action.

Telangana comprises 17 Parliamentary Constituencies and 119 Assembly Constituencies spread across 33 districts, with a population of approximately 39.64 million and a population density of 307 persons per square kilometre. To ensure the smooth and secure conduct of elections, the Election Authority requisitioned nearly 1.88 lakh personnel for polling duties, supported by around 63,000 police personnel and 160 companies of central armed forces, refer figure-1

To maintain vigilance and curb electoral malpractices, a robust surveillance framework was deployed across the state. This included 4,661 Flying Squads, 4,438 Static Surveillance Teams, 1,710 Video Surveillance Teams, and 934 Video Viewing Teams, all operating round the clock to swiftly detect an act upon any instances of voter inducement or code violations.

In addition, the Telangana State Police established a centralized Control Room at the Director General of Police (DGP) Office, serving as the command hub for real-time monitoring, coordination, and communication during the election period, refer figure-2, displaying the map of polling stations within a designated jurisdiction.

Section II outlines the key challenges encountered during the monitoring process, including maintaining social harmony, preventing sabotage, and managing logistics and coordination. Section III discusses the mitigation methodology adopted by Telangana Police, specifically focusing on the development and implementation of a GIS-based application for real-time election monitoring. Section IV elaborates on the purposeful and agile innovation introduced through LTTS' & Departments value-driven solution, highlighting its user-centric design and operational impact. Section V details the core functionalities enabled by the system, such as data input and management, monitoring and oversight, and reporting and alert mechanisms. Section VI presents the underlying technology stack, while Section VII suggests directions for future improvements, including the integration of advanced AI and real-time analytics. Finally, Section VIII concludes the paper by

reflecting on the outcomes and proposing broader applications of the system for large public gatherings beyond elections.
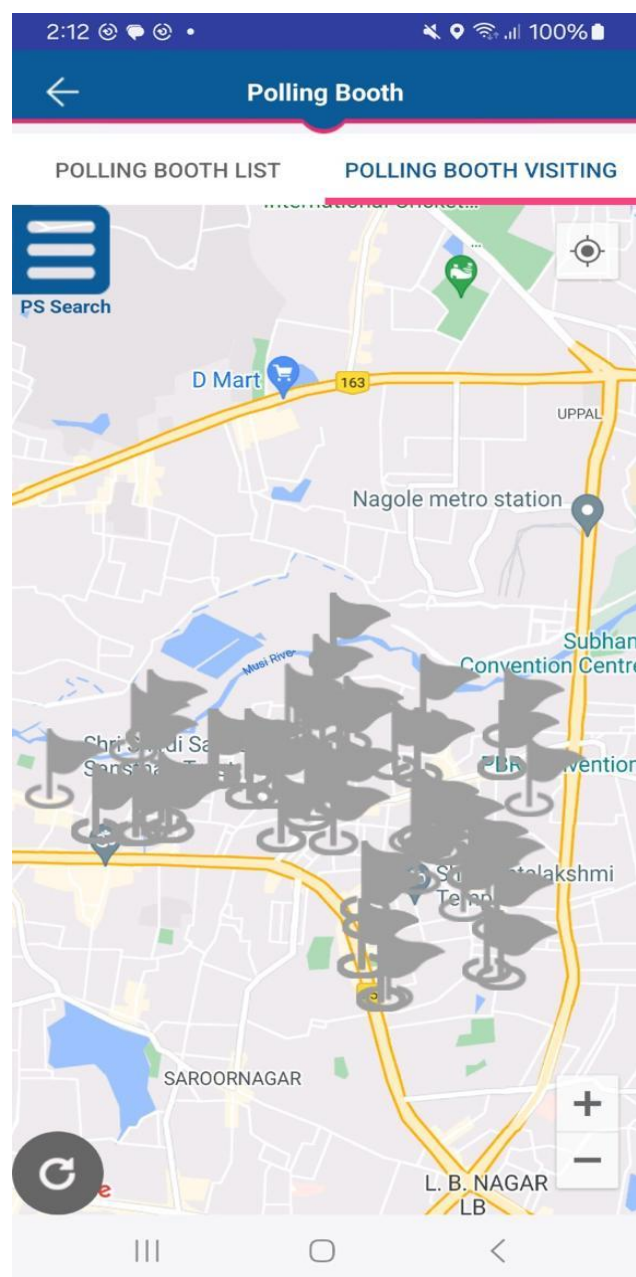

Figure 1: Mobile application interface displaying the map of polling stations within a designated jurisdiction during Telangana Elections 2024.

1.2 Challenges

The monitoring process during elections posed several complex challenges that demanded strategic planning and close coordination among multiple agencies. A key priority was maintaining social harmony, ensuring that the electoral process proceeded peacefully without disturbing the communal balance. Equally important was the protection of polling stations from potential acts of sabotage or violence, requiring adequate security deployment and rapid response mechanisms.

Given the sensitive nature of elections, preventing and addressing terror threats remained a major focus, supported by

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intelligence-based surveillance and quick response teams. Simultaneously, effective traffic management and crowd control were essential to ensure smooth voter movement and access to polling stations.

Efficient communication and collaboration across departments, including the police, election officials, and local administration, played a crucial role in timely decision-making and maintaining order. Through these concerted efforts, the law enforcement and administrative machinery worked together to ensure elections were conducted in a secure, transparent, and peaceful manner.

2. Methodology

2.1 Mitigation Methodology Adopted

The Telangana Police developed a GIS-based application to accurately locate polling booths and capture real-time activities during the election process. The system integrates polling booth details and employs a mobile application to geotag all locations with precise attribute information and administrative boundaries, including ward limits, delineated blocks, individual buildings, and designated voting booths.

The application enables field officers to update visit details, upload reports, retrieve the polling details and Police station details and document incidents directly from their mobile devices, refer to figure- 4, 5 & 6. It also provides real-time alerts and notifications related to Model Code of Conduct (MCC) violations, allowing for swift action and improved accountability.

Figure 2: Centralized Command and Control Centre located in Hyderabad used during Telangana Elections 2024

All field-level data and updates are continuously monitored through a centralized Command and Control Centre located in Hyderabad, refer figure-2, ensuring efficient supervision, rapid response to incidents, and enhanced coordination across different enforcement units.

3. Solution

3.1 Purposeful Agile Innovation: LTTS' Value-Driven Solution

The joint solution developed by L&T Technology Services (LTTS) in collaboration with the Telangana Police Department leveraged GIS technology to create an efficient and user-friendly digital ecosystem for election monitoring. The system featured intuitive interfaces designed for Presiding and Polling Officers, Law Enforcement Agencies, and Revenue Officers,

ensuring seamless coordination and ease of use across all operational levels.

The integrated geotagging functionality enabled precise mapping of polling booths, while the mobile application facilitated real-time status updates and communication from field personnel, refer figure: 1. This digital integration greatly enhanced the ability of the Telangana Police Department to track, monitor, and respond effectively during the election period.

As a result of these technological and operational advancements, the entire election process was conducted peacefully, with no major incidents reported, underscoring the success of the GIS-enabled monitoring system in promoting efficiency, transparency, and security throughout the electoral exercise.

Year	Registered Voters	Total Polling Booths	Polling %	Amount Seizures	No, of FIR Registered
2014 (United AP)	64,934,138	71,223	74.20 %	Rs 1,480,700,000.00	2,472
2018 (TSLA)	28,075,912	34,603	73.37 %	Rs 1,038,922,753.00	984
2023 (TSLA)	26,118,257	35,356	71.32 %	Rs 4,710,045,611	12,586

Table 1: Electoral Overview and Law Enforcement Metrics in Telangana (2014–2024)

The implementation of GIS-based system has delivered measurable results, reinforcing security and reliability across the state by enabling:

a) Immediate Reporting:

Officers could immediately report violations, /incidents allowing for prompt handling of situations via the mobile app, refer figure- 5 & 6

b) Efficient Tracking and Real-time Updates:

Patrolling was planned based on the criticality of polling booths to ensure law and order was maintained during the elections, refer to figure-3.

Red Dots represent Sensitive booth, Blue dots represent non-sensitive booth

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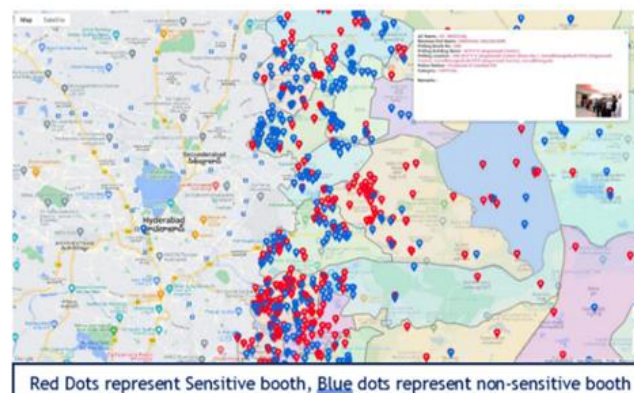1–3 September 2025, Symbiosis International University, Pune, India

Figure 3: Web application interface displaying sensitive, critical, and non-critical polling stations within a designated jurisdiction during Telangana Elections 2024.

Apart from this, officers could track polling booth visit details with filters for efficient data access. This proactive approach led to a significant reduction in election-related incidents compared to previous elections and increase registration of FIR cases. Refer to Table -1.
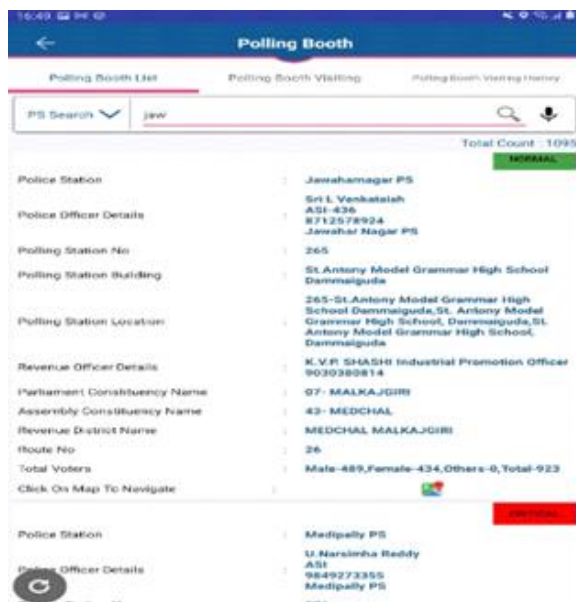
Figure 4: User interface of the election mobile app designed to retrieve polling booth details during Telangana General Elections 2024.
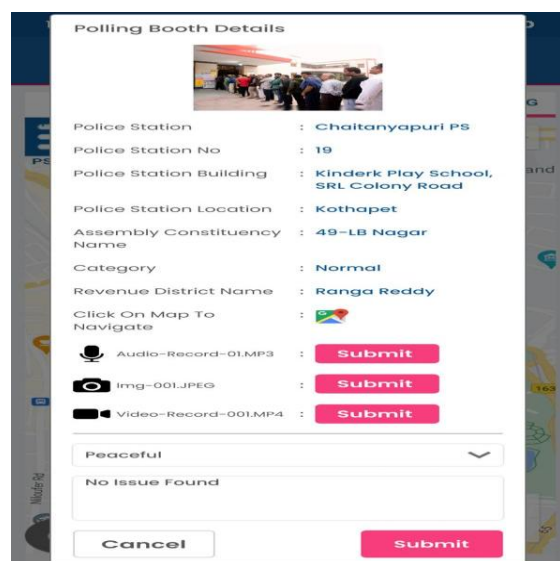
Figure 5: Mobile application interface for recording incident details during Telangana Elections 2024.

c) **Enhanced Monitoring and Reporting:**

Senior officers were provided with enhanced visibility into voting progress and field activities through real-time dashboards and monitoring tools. This enabled assigned police officers to verify polling booth statuses, track visit updates, and report unlawful activities instantly from the ground.

The impact of these technological improvements is clearly reflected in Table 1, which shows a significant rise in enforcement actions — 12,586 cases were registered in 2024, compared to 984 in 2018 and 2,472 in 2014. Additionally, the value of seized materials was nearly four times higher than in previous election years, indicating a more effective crackdown on violations and electoral malpractices.
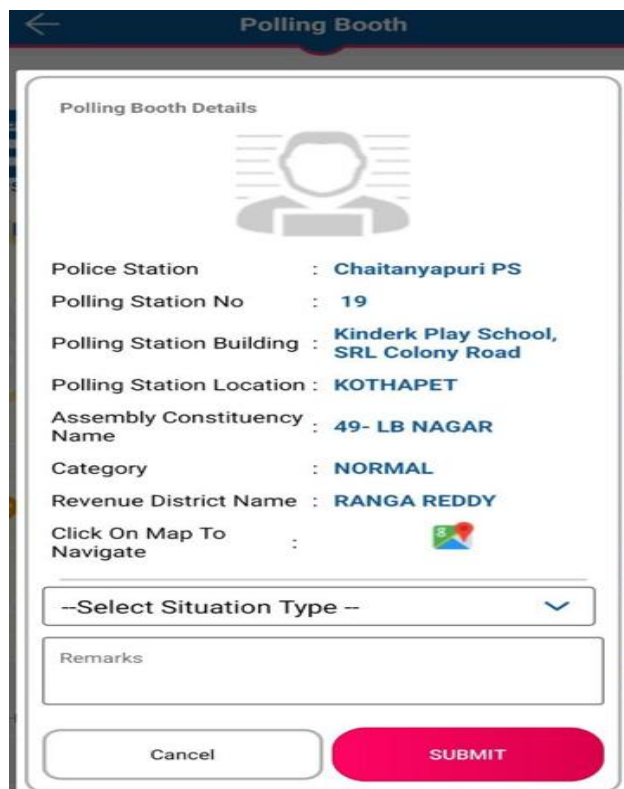

Figure 6: Mobile application interface for closing reported incidents during Telangana Elections 2024

This improvement can be largely attributed to the centralized monitoring framework, comprising 4,438 Static Surveillance Teams, 1,710 Video Surveillance Teams, and 934 Video Viewing Teams equipped with AI-enabled cameras. These teams provided round-the-clock surveillance, serving both as a deterrent to illegal activities and a source of direct, verifiable evidence. All surveillance data was continuously monitored at the Central Command and Control Centre (CCC), enabling prompt investigation and the filing of FIRs against offenders, refer figure-2.

d) **Efficient Resource Allocation:**

The system facilitated the effective allocation of police resources based on the sensitivity and risk level of each area, ensuring the deployment of adequate security measures to maintain law and order throughout the election process.

e) **Strategic Planning and Navigation:**

The system utilized interactive map views to assist in patrol route planning and ensure comprehensive coverage of all

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critical polling booths, refer figure-3. It enabled field officers to visualize the shortest routes to polling booths, refer figure-8, nearby police stations, and relevant administrative or ward boundaries, optimizing time and resource utilization. Additionally, the platform allowed officers to demarcate and save heat maps highlighting areas of concern or incidents, which could be referenced for future planning and analysis. This feature not only enhanced situational awareness during the elections but also contributed to data-driven decision-making for subsequent operations.

Figure 7: Mobile application interface highlighting incident occurrences on a GIS map during Telangana Elections 2024
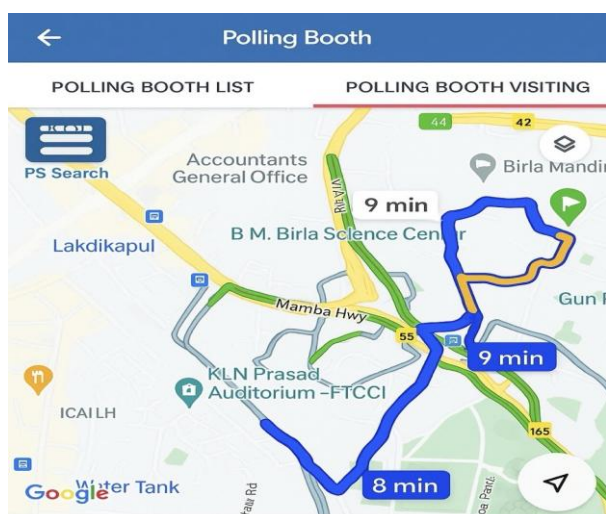
Figure 8: Mobile application interface highlighting shortest path to reach the incident site on a GIS map during Telangana Elections 2024

3.2 Functionalities Enabled by the System

a) Data Input and Management:

The system provides comprehensive geo-tagging capabilities, enabling the capture and integration of detailed information about each election polling station, including the associated police station, sector, revenue officer, and police officer assigned to that location, refer to figure-1. This ensures precise mapping and accountability across all administrative levels. In addition, the application incorporates an overlay feature that allows users to superimpose election polling station maps onto various spatial and non-spatial datasets, such as sensitivity maps, road network maps, and other relevant geographic layers. This functionality enhances situational awareness, facilitates better planning, and supports data-driven decision-making. Furthermore, the system enables assigned police officers to record and update voter turnout figures as reported by revenue officers, ensuring the timely availability of accurate and consolidated election data.

b) Monitoring and Oversight:

The system incorporates role-based access control to ensure secure and efficient monitoring by various levels of law enforcement personnel, including Station House Officers (SHOs), Sub-Inspectors, Blue Colts teams, and patrol units. Each user is granted access according to their operational role and jurisdiction, enabling focused oversight and accountability.

A detailed map or spatial interface provides a visual representation of polling booths, along with nearby police stations, road networks, and check posts, facilitating quick navigation and situational awareness, refer to figure-7. The platform further supports real-time status updates and visits reporting by assigned officers, ensuring timely information flow and coordinated field operations across all election monitoring teams.

c) Reporting and Alerts:

The system enables comprehensive reporting and monitoring through both mobile-based and web-based applications, ensuring accessibility and responsiveness across all levels of law enforcement. These platforms empower officers to make prompt and informed decisions using GIS-based visualization tools such as Point Maps, Choropleth Maps, Heat Maps, and Proportional Symbol Maps, which provide real-time spatial insights and activity patterns, refer to figure-9. In addition, the system generates role-based summary reports customized to specific jurisdictions and operational hierarchies, allowing officers and command staff to monitor performance and incidents relevant to their areas of responsibility. The platform further supports incident reporting and real-time status updates for polling booths, with automated notification alerts sent to the central control room and the nearest police station in the event of any irregularity or emergency. This integrated reporting framework enhances situational awareness, accountability, and coordination across all units involved in election monitoring.

3.3 Technology Stack

The system has been developed using .NET technology for the web-based platform and Android technology implemented with Java and Kotlin—for the mobile application. It integrates the MapmyIndia base map to provide accurate and high-resolution geospatial visualization for real-time monitoring and analysis. For backend data handling, the system utilizes an SQL database, ensuring secure, reliable, and structured storage and management of operational and spatial data.

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Figure 9: Comprehensive web interface showing polling station details alongside incident summaries

4. Future Work

4.1 Next Phase Objectives and Action Plan

To further strengthen monitoring and tracking during elections, several strategic enhancements can be implemented. These include:

a) Enhanced AI Integration:

Leveraging advanced artificial intelligence algorithms for predictive analysis, enabling proactive responses to potential issues and improved situational awareness.

b) Real-Time Data Analytics:

Implementing near real-time analytics to provide instant insights and facilitate timely decision-making at all operational levels.

c) Improved Data Transparency:

Adopting best practices in election data management to ensure integrity, accountability, and public trust in the electoral process.

d) Expanded Use of Technology:

Integrating digital tools and automation across all stages of the election cycle—from planning and monitoring to reporting and analysis.

e) Increased Inter-Agency Collaboration:
Strengthening coordination between government departments, law enforcement, and election authorities to ensure a unified and efficient response mechanism.

f) Public Engagement:

Enhancing voter awareness and participation through digital outreach, education, and transparency initiatives.
Collectively, these measures would enhance the efficiency, accuracy, and credibility of the election monitoring process while reinforcing public confidence in democratic governance.

5. Conclusion

The integration of GIS technology significantly enhanced the efficiency of election monitoring by enabling precise tracking of polling booths and facilitating the strategic deployment of police forces. This data-driven approach supported effective traffic management, improved resource allocation, and strengthened law and order maintenance throughout the electoral process.

Building upon this success, the system can be expanded to monitor public religious events and large gatherings, ensuring seamless coordination and enhanced public safety. By extending GIS-based tracking and situational monitoring to such events, authorities can manage crowd movement, emergency responses, and overall security more effectively, thereby promoting order, transparency, and citizen safety across diverse public occasions.

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