

Literature Review

Existing Online Election Systems Projects

Introduction

The advent of online voting systems has revolutionized the way elections are conducted, offering enhanced convenience, accessibility, and efficiency. However, ensuring the security, anonymity, and integrity of these systems remains a significant challenge. This literature review examines existing projects and technologies across various countries, analyzing their implementations, strengths, and limitations to provide insights for developing a robust online election system.

1. United Kingdom

The United Kingdom has experimented with online voting through local council elections in regions such as Swindon and Sheffield. These trials demonstrated the potential of online voting but were not scaled nationwide due to security concerns.

Key Technologies

- **Encryption:** Secured communication between users and servers.
- **Two-Factor Authentication (2FA):** SMS codes and email verifications ensured voter identity.
- **Audit Trails:** Maintained logs for traceability while preserving anonymity.
- **Centralized Servers:** Voting data was securely stored, though centralization posed a single point of failure.

Strengths - Enhanced accessibility and traceability.

Limitations - Security concerns and centralized architecture reduced scalability.

2. India:

India's online voting experiments have been limited to small-scale and municipal elections, with notable tests in Hyderabad.

Key Technologies:

- **Blockchain:** Provided immutable records of votes.
- **Aadhaar-Based Biometric Verification:** Leveraged India's unique ID system for voter authentication.
- **End-to-End Encryption:** Ensured secure vote transmission.
- **Cryptographic Techniques:** Maintained voter anonymity while allowing verifiability.

Strengths - High-security measures and advanced verification.

Limitations - Challenges in scaling to a diverse and populous electorate.

3. United States

The United States has employed online voting for overseas citizens and military personnel in states like West Virginia.

Key Technologies

- **Blockchain:** Used in West Virginia's pilot to secure vote records.
- **Digital Signatures:** Verified voter identities.
- **Encryption and Tokenization:** Protected votes during transmission and anonymized storage.
- **Audit Mechanisms:** Verified vote integrity post-submission.

Strengths - Focus on absentee voting with secure protocols.

Limitations - Limited scalability and public adoption.

4. South Korea

South Korea's K-Voting system is widely used in local government, corporate, and school elections.

Key Technologies

- **Digital Certificates:** Authenticated voter identities.
- **Encryption:** Secured transmission of votes.
- **Tamper-Proof Records:** Prevented alteration of votes post-submission.
- **Audit Mechanisms:** Ensured transparency and traceability.

Strengths - Comprehensive use in diverse election types.

Limitations - Limited implementation in national government elections.

5. France

France has utilized online voting for citizens living abroad in legislative elections since 2012.

Key Technologies

- **Two-Factor Authentication (2FA):** Verified voter identities via SMS and email codes.
- **Public Key Infrastructure (PKI):** Secured communication.
- **Data Encryption:** Protected votes during transmission and storage.
- **Regular Penetration Testing:** Identified and addressed system vulnerabilities.

Strengths - Reliable system for expatriates.

Limitations - Restricted to specific use cases, with concerns about scalability.

6. Switzerland

Switzerland has been a leader in piloting e-voting systems, particularly for citizens abroad, using solutions like Swiss Post and ScytL.

Key Technologies

- **End-to-End Encryption:** Ensured secure communication.
- **Individual and Universal Verifiability:** Cryptographic proofs verified the integrity of votes.
- **Blockchain Pilots:** Enhanced vote immutability.
- **Penetration Testing:** Ensured robust security against vulnerabilities.

Strengths - Advanced cryptographic measures for verifiability.

Limitations - Pilot projects with limited nationwide implementation.

7. Australia

Australia's iVote system is used for state elections and overseas voters.

Key Technologies

- **Encryption and Decryption Keys:** Maintained vote privacy during submission and counting.
- **End-to-End Verifiability:** Provided voters with verifiable receipts.
- **Authentication Tokens:** Ensured voter identity via email or SMS codes.
- **Tamper-Detection Mechanisms:** Regular audits identified potential alterations.

Strengths - Accessible and transparent voting.

Limitations - System robustness remains under scrutiny.

8. Canada

Canada has implemented online voting in municipal elections, such as those in Markham and Halifax.

Key Technologies:

- **End-to-End Encryption:** Secured voter-system communication.
- **Two-Factor Authentication (2FA):** Ensured secure voter identification.
- **Blockchain Experiments:** Enhanced transparency and immutability.

- **Voter Verification:** Used unique IDs to prevent duplicates.
- **Audit Trails:** Tracked processes for accountability.

Strengths - Effective for smaller elections.

Limitations - Federal-level adoption remains a challenge.

Comparison of Security Technologies

Country	Key Security Features
United Kingdom	Encryption, 2FA, Audit Trails.
India	Blockchain, Biometric Verification, Cryptographic Techniques.
United States	Blockchain, Digital Signatures, Tokenization, Audit Mechanisms.
South Korea	Digital Certificates, Encryption, Audit Mechanisms.
France	2FA, PKI, Regular Penetration Testing.
Switzerland	End-to-End Encryption, Verifiability, Blockchain Pilots.
Australia	Encryption Keys, Verifiability, Tamper-Detection.
Canada	Blockchain, Data Anonymization, Secure Audit Trails.

Conclusion

The review highlights the diversity in approaches to online voting, reflecting varying priorities like accessibility, scalability, and security. While blockchain and end-to-end encryption emerge as common trends, the balance between voter anonymity and verifiability remains a challenge. By addressing these gaps, a more robust and inclusive online election system can be developed, tailored to the unique needs of modern electorates.