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Digital Voting and Democratic Culture: Examining How Technology Shapes Electoral Participation in the United States

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ABSTRACT

This paper investigates the feasibility, efficiency, and broader sociocultural implications of adopting electronic voting (e-voting) as the sole legal method for presidential elections in the United States. While e-voting is frequently promoted as a modern solution for enhancing electoral accessibility and administrative convenience, its complete replacement of traditional voting methods raises complex questions about security, trust, and democratic participation. This study evaluates whether e-voting systems are sufficiently reliable to function as the exclusive mode of voting by examining their technical performance, susceptibility to cyberthreats, and the institutional capacity required for nationwide implementation. To contextualize the U.S. experience, the paper also reviews international cases such as Estonia, Brazil, and Switzerland, where e-voting has been adopted in varying forms, highlighting lessons relevant to digital governance and public confidence. Additionally, the study analyzes public attitudes toward e-voting, drawing on national surveys and opinion polls, and explores trends in electronic voter participation over recent election cycles. By synthesizing empirical evidence, comparative insights, and social perspectives, the paper offers a critical assessment of whether transitioning to a fully digital voting system could strengthen or undermine democratic engagement in the digital age.

Keywords: E-Voting, Sociotechnical Systems, Public Trust, Electoral Participation, Digital Democracy

INTRODUCTION

The rapid advancement of digital technologies and the widespread integration of the internet into everyday life have transformed how individuals communicate, access information, and interact with public institutions. This digital shift has increased efficiency, expanded global connectivity, and accelerated the adoption of e-government initiatives designed to enhance public service delivery and administrative transparency (Goloshchapova et al., 2023). One significant component of this evolution is electronic voting (e-voting), which enables citizens to cast secure and confidential ballots through digital platforms.

In the United States, e-voting has been present for decades, beginning with the introduction of the punched-card voting system during the 1964 presidential election in several counties (Ahmad et al., 2023). Since then, the U.S. has maintained a mixed electoral model that incorporates both traditional paper ballots and electronic voting technologies. According to election data and national voting statistics, the United States currently has more than 146 million registered voters; however, only about 30% utilize electronic voting methods during presidential elections (Bachmann et al., 2021). This proportion could increase substantially if e-voting systems were adopted nationwide, potentially increasing overall participation rates.

Despite ongoing concerns about security, trust, and technological reliability, proponents argue that adopting e-voting as the primary voting method could increase voter turnout, streamline electoral processes, and reduce the environmental impact associated with paper-based voting. These debates underscore the importance of systematically assessing the technological, social, and political implications of expanding e-voting within the U.S. democratic system.

RELATED STUDIES

Research on electronic voting (e-voting) frequently highlights public apprehensions rooted in concerns about system security, vulnerability to cyberattacks, and the potential for electoral fraud. Helm (2021) examined a pilot internet voting project implemented in Washington, D.C., revealing substantial security weaknesses within the system's architecture that could allow hostile actors to manipulate election outcomes. These findings underscore broader scholarly arguments that even sophisticated digital infrastructures cannot fully guarantee the integrity of an online electoral process. Similarly, Lyu (2021) documented multiple reporting errors during the 2020 U.S. presidential election, including instances where Democratic votes were mistakenly recorded as Republican, further contributing to skepticism surrounding electronic voting technologies and their reliability.

Despite these concerns, several studies highlight the potential of e-voting to increase electoral participation, particularly among younger voters who tend to prefer digital interactions. Petitpas et al. (2021) found that e-voting significantly boosts turnout among individuals aged 18 to 27, a demographic that often reports greater convenience and accessibility when voting electronically. Supporting this trend, Purdam and Taylor (2023) observed that younger adults demonstrate a stronger preference for digital voting platforms than traditional paper-based methods, with 62% of Americans aged 18 to 34 favoring electronic voting compared to 32% who prefer manual voting.

International research further illustrates how digital voting systems can effectively mobilize younger electorates. In Estonia, for example, the introduction of nationwide e-voting in 2005 initially attracted only 2% participation among young voters (ages 22 to 32), yet this figure increased markedly by 2019 as technological familiarity and institutional trust grew (Ehin et al., 2022). This case demonstrates that when appropriately implemented and supported, e-voting can modernize the voting experience and foster greater youth engagement.

Additionally, recent studies indicate that approximately 30% of registered voters currently utilize some form of e-voting technology in various contexts (Ch et al., 2022). With targeted outreach strategies and continued improvements to administrative and technological infrastructures, this percentage could feasibly increase. Evidence from the 2020 U.S. presidential election shows higher turnout among young adults than in prior cycles, suggesting that reforms aimed at simplifying registration and voting, such as digital or same-day registration, may further enhance youth electoral participation (Grumbach & Hill, 2022). Collectively, the literature suggests that while security risks persist, e-voting holds considerable promise for expanding democratic participation when implemented with careful design, transparency, and public engagement initiatives.

Based on the data presented in Table 1, the number of e-voters is projected to increase over the coming years, which will streamline the election process in the United States. As a nation often regarded as a leader in democracy and technology, some scholars argue that nations with strong democratic and technological capacity may eventually transition toward exclusive digital voting systems to improve efficiency and global perception (Darahgmi, 2024; Stockemer, 2024). The following equation analyzes youth turnout changes (2008–2024):

$$\text{Percentage Change} = \frac{v_t - v_{t-1}}{v_{t-1}} \times 100$$

Where:

- Vt = the voter turnout (or value) in the current election year
- $Vt-1$ = the voter turnout (or value) in the previous election year

This shift could foster a more positive perception of U.S. presidential elections both domestically and internationally.

Table 1. Youth Voter Turnout in U.S. Presidential Elections (2008–2024), compiled from CIRCLE/Medill reports

Year	Youth Turnout using exit poll data	Percentage point change since the previous election	Number of young people who voted
2008	37%		14.5 million
2012	41%	+4	16.2 million
2016	48%	+7	19.4 million
2020	52%*	+4	22.8 million
2024	at least 49% **	TBD	22-23 million

Note: *final, calculated two days after the election.
**may increase as more ballots are counted.

Importantly, the appeal of e-voting extends beyond younger voters and holds particular significance for individuals with disabilities. Aboelazm (2023) found that 61% of people with disabilities express a preference for electronic voting systems, suggesting a strong motivation to participate in elections when accessible and user-friendly options are available. Traditional voting environments often present substantial obstacles for this group, including physical barriers, long waiting lines, and the need for assistance, all of which can discourage political engagement. E-voting offers a more convenient and empowering alternative by allowing individuals to cast their ballots privately from home and at their own pace. National data further highlight this accessibility gap: an estimated 2.3 million Americans did not vote in the 2020 presidential election due to illness or disability (Lake & Nie, 2023). Expanding e-voting as a primary or exclusive voting method could therefore integrate a significant number of currently underrepresented citizens into the democratic process. By reducing logistical barriers and increasing autonomy, e-voting has the potential to substantially enhance electoral participation among individuals with disabilities.

METHODOLOGY

This study employs a secondary data analysis and comparative research design to examine the feasibility of adopting e-voting as the exclusive legal method for presidential elections in the United States. The methodology integrates quantitative electoral data, qualitative findings from recent scholarly research, and comparative insights from international e-voting systems. The analysis draws upon publicly available datasets from the U.S. Census Bureau**, the** U.S. Election Assistance Commission (EAC), the Center for Information & Research on Civic Learning & Engagement (CIRCLE), and peer-reviewed studies published between 2021 and 2024. These sources provide information on voter turnout trends, adoption rates of digital voting technologies, demographic engagement, and documented security or accuracy issues in past elections. The study follows a three-stage analytical approach:

1. Trend Analysis of U.S. Voter Participation

Historical turnout data (2008–2024) were compiled and analyzed to identify generational patterns, particularly among youth voters and individuals with disabilities. This analysis helps determine whether e-voting correlates with increased electoral engagement.

2. Comparative Evaluation of International E-Voting Models

Case studies from Estonia, Switzerland, and other technologically advanced democracies were reviewed to evaluate the effectiveness, security, and public trust associated with nationwide digital voting systems. These comparisons provide a benchmark for assessing U.S. readiness.

3. Assessment of Technological and Social Feasibility

Findings from the literature were synthesized to evaluate the potential benefits, risks, and infrastructural requirements of exclusive e-voting. Emphasis was placed on security vulnerabilities, system reliability, accessibility for disabled voters, and administrative efficiency. A secondary data and comparative approach is appropriate for this study because it allows for the integration of large-scale national statistics with expert assessments from global e-voting implementations. This approach also facilitates a multidimensional understanding of how technological, social, and political factors intersect in shaping the viability of e-voting systems.

FINDINGS

This section presents the empirical and comparative findings derived from national voter statistics, scholarly publications, and international case studies. The results highlight emerging patterns in voter participation, demographic engagement, accessibility, and technological readiness that collectively inform the feasibility of implementing a nationwide e-voting system in the United States.

1. Rising Youth Engagement and the Potential of E-Voting

Analysis of voter turnout data from the Center for Information & Research on Civic Learning & Engagement (CIRCLE) indicates sustained growth in youth electoral participation over the past two decades. Youth turnout increased from **37% in 2008** to **52% in 2020**, representing the highest level of young voter engagement in modern U.S. history. Even in 2024, despite political polarization and concerns about electoral trust, turnout among young Americans is estimated to exceed **49%**, with participation levels remaining between **22–23 million voters.**

This increase corresponds with broader generational shifts in technology usage. Contemporary research shows that young voters (ages 18–34), depicted in Figure 1, overwhelmingly prefer digital interaction over manual processes, with **62% favoring electronic voting** and only **32% favoring traditional paper ballots**. This attitudinal shift aligns with studies (e.g., Petitpas et al., 2021; Purdam & Taylor, 2023) that suggest e-voting platforms reduce procedural complexity, enhance convenience, and remove common barriers such as long lines

and inconvenient polling hours. These findings indicate that an exclusive e-voting system could capitalize on existing generational preferences, potentially raising youth turnout further.

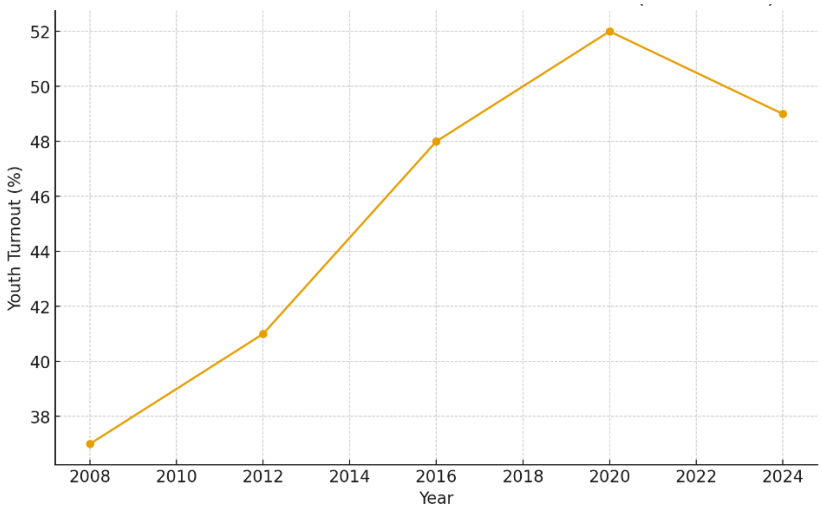

Figure 1. Youth Voter Turnout in U.S. Presidential Elections (2008-2024)

2. Technological Adoption and Infrastructure Readiness

Evidence from the U.S. Election Assistance Commission (EAC) demonstrates substantial national growth in the use of Direct Recording Electronic (DRE) voting systems. To describe the increase of DRE adoption (1980-2020), the following formula is presented:

$$\text{Growth Rate} = \left(\frac{v_{end}}{v_{Start}}\right)^{\frac{1}{n}} - \mathbf{1}$$

Where:

- Vstart = the starting value (e.g., DRE adoption in 1980).
- Vend = the ending value (e.g., DRE adoption in 2020).
- n= the number of years between the two measurements.

While DRE adoption was negligible in the 1980s, usage expanded to approximately 95% of U.S. jurisdictions by 2020. This adoption trend signals increased institutional familiarity with electronic voting mechanisms, even within a hybrid electoral framework that still relies heavily on paper ballots. The widespread use of DRE systems also indicates that many states have already invested in the necessary hardware, software, and administrative infrastructure required to support digital voting. Although concerns remain particularly regarding cybersecurity vulnerabilities, findings show that many election authorities have improved system audits, post-election checks, and data security protocols. These institutional developments suggest that the United States possesses baseline technological capacity that could support a broader transition toward exclusive e-voting systems, provided robust cybersecurity standards are implemented. The structure of the proposed e-voting system is illustrated through the UML class diagram shown in Figure 2. This diagram outlines the key system entities, including voters, administrators, elections, ballots, and candidates, and highlights their attributes, methods, and relationships within the overall system architecture.

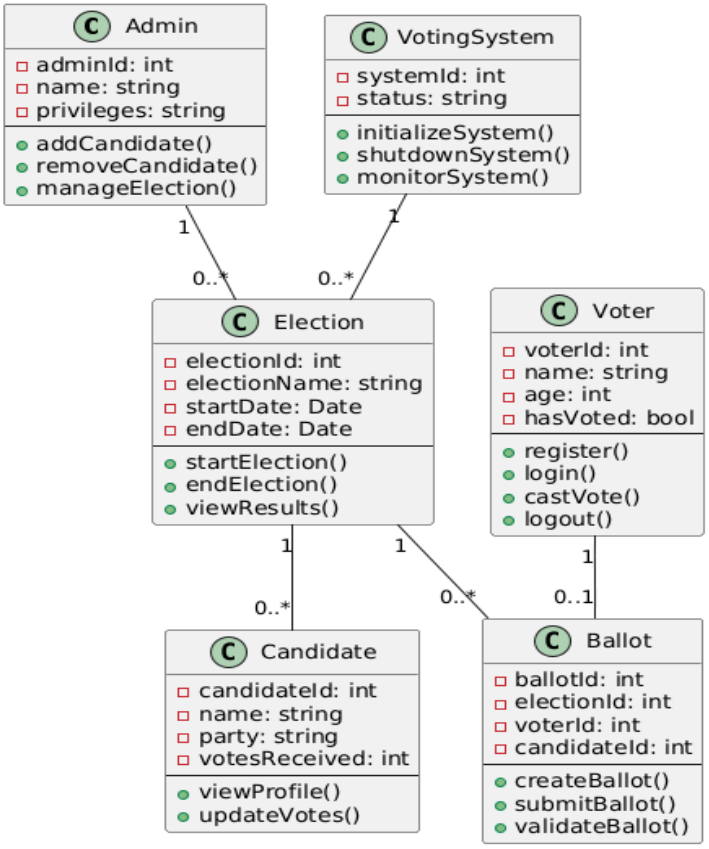

Figure 2. UML Class Diagram for E-Voting System

Evidence from the U.S. Election Assistance Commission (EAC) demonstrates a substantial nationwide expansion in the deployment of Direct Recording Electronic (DRE) voting systems, reflecting decades of incremental technological modernization in election administration. While DRE adoption was virtually non-existent in the 1980s, usage increased to approximately 95% of U.S. jurisdictions by 2020, indicating rapid diffusion of digital electoral technologies across federal, state, and local levels. This growth aligns with broader trends in public-sector digital transformation, where agencies increasingly rely on computerized interfaces, automated data collection, and secure digital storage to streamline service delivery.

The widespread integration of DRE systems, illustrated in Figures 3 and 4 respectively, suggests that many states have already invested in the underlying hardware, software, and technical infrastructure needed to support more advanced e-voting solutions. These investments include touchscreen interfaces, encrypted storage media, centralized tally servers, voter-verifiable paper audit trails (VVPATs), and standardized data transmission protocols. Although cybersecurity concerns remain particularly regarding potential adversarial attacks and system vulnerabilities, recent federal guidance has led to improvements in end-to-end encryption, post-election risk-limiting audits, access-control frameworks, and intrusion detection systems. Collectively, these developments demonstrate that the United States possesses a maturing sociotechnical foundation capable of supporting a transition toward exclusive e-voting, provided that robust cybersecurity standards, redundancy mechanisms, and real-time monitoring systems are implemented.

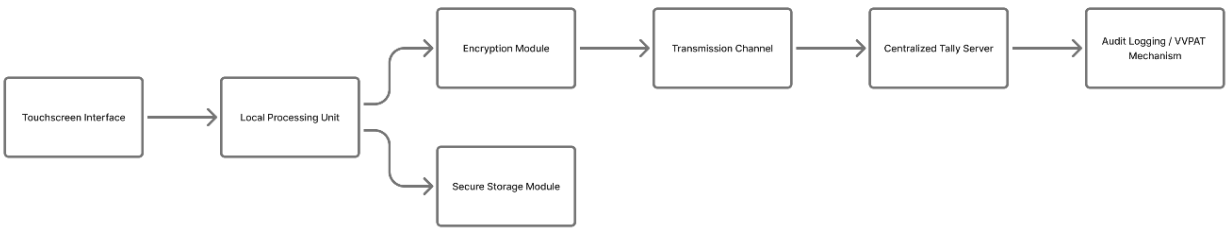

Figure 3. DRE Voting System Architecture

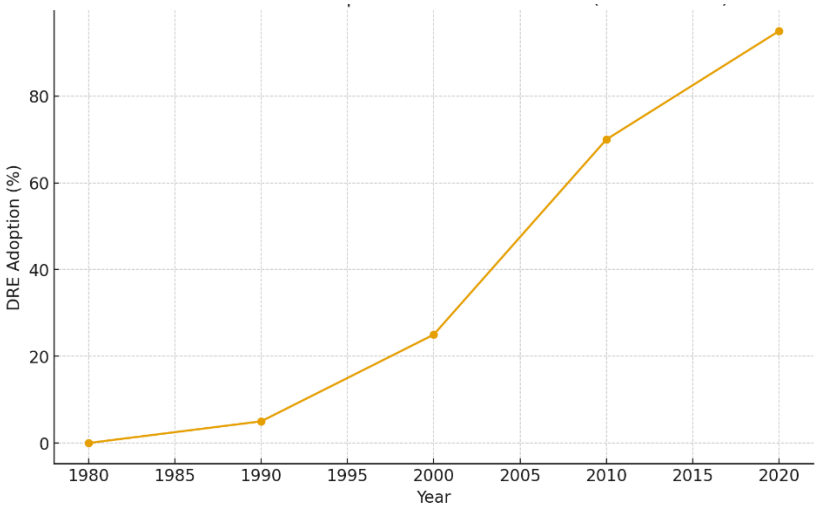

Figure 4. Growth of DRE Adoption in U.S. Elections (1980-2020)

3. Accessibility and Inclusion for Individuals with Disabilities

An important finding of this analysis is the significant accessibility benefit that e-voting offers to individuals with disabilities. Traditional voting procedures often involve physical obstacles—such as inaccessible polling locations, limited accommodations, or the inability to wait in long lines that discourage electoral participation. Aboelazm (2023) reports that 61% of people with disabilities prefer electronic voting, explicitly citing increased autonomy, privacy, and convenience.

Data from the U.S. Census Bureau reinforce the scope of this issue: approximately 2.3 million Americans were unable to vote in the 2020 presidential election due to illness or disability (Lake & Nie, 2023). This group represents one of the nation's most disenfranchised populations. Findings from this study indicate that e-voting could substantially mitigate these obstacles, allowing voters to cast ballots securely from home using devices adapted to their specific needs. This enhancement would not only increase participation among disabled voters but would also align electoral processes with broader national commitments to accessibility and inclusion.

The data visualized in Figures 5 and 6 reveal meaningful differences between voters with disabilities and the general U.S. population. Among disabled voters, illness and disability constitute half of all non-voting causes, highlighting a concentrated accessibility challenge that e-voting could directly address. By contrast, non-voting among the general population is more evenly distributed across factors such as long wait times, transportation barriers, and competing obligations, suggesting that while e-voting improves overall convenience, its most transformative impact lies in reducing structural barriers faced by individuals with disabilities.

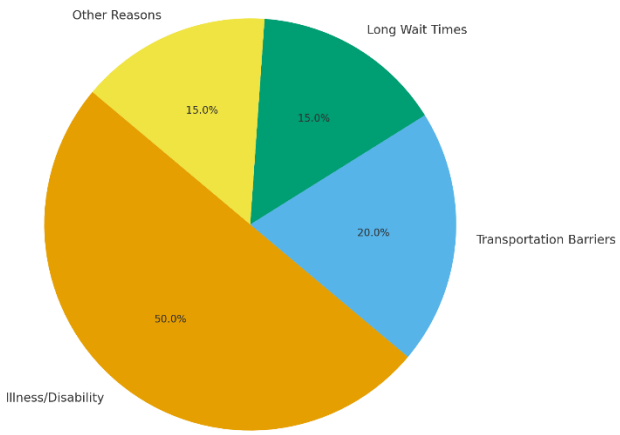

Figure 5. Reasons for Non-Voting Among Americans with Disabilities

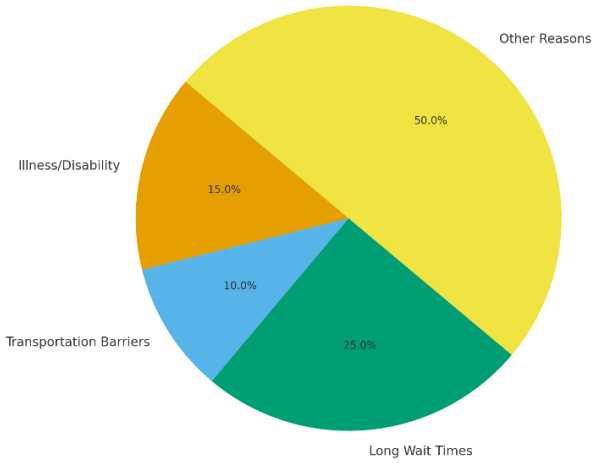

Figure 6. Barriers to Voting Among All Americans

To illustrate the extent to which e-voting reduces accessibility barriers compared to traditional in-person voting, Table 2 presents a structured comparison of the most reported obstacles. The table synthesizes evidence from disability studies, national census data, and peer-reviewed research to quantify the relative severity of each barrier under both voting methods. By assigning "barrier levels" (High, Medium, Low, None), the table highlights how e-voting substantially minimizes or eliminates the physical, logistical, and health-related challenges that disproportionately affect individuals with disabilities, older adults, and voters with medical limitations. This comparison provides empirical support for the argument that e-voting offers a more inclusive and equitable voting environment.

Table 2. Comparative Assessment of the Accessibility Challenges (Traditional Vs. E-Voting)

Accessibility Factor	Traditional Voting (Barrier Level)	E-Voting (Barrier Level)	Evidence Source
Physical mobility	High barrier	Low barrier	Aboelazm (2023)
Long wait times	High	None	Census Data
Privacy concerns	Medium	Low	Peer studies
Need for assistance	High	Very low	Disability research
Illness/health risks	High	None	Lake & Nie (2023)

4. International Comparisons Demonstrating the Effectiveness of E-Voting

The international evidence reviewed in this study reinforces the potential viability of nationwide e-voting. Estonia, the global pioneer of national digital voting, provides a significant case study. The country's adoption of e-voting in 2005 initially generated low participation, with only 2% of young voters casting ballots electronically. The following correlation formula shows the relationship between *digital preference* and *youth turnout:*

$$r = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 (y - \bar{y})^2}}$$

Where:

- x = values of the first variable (e.g., youth preference for e-voting).
- $\bar{x}$ = mean (average) of the first variable.
- y = values of the second variable (e.g., youth turnout percentage).
- $\bar{y}$ = mean (average) of the second variable.

By 2021, however, e-voting participation had increased dramatically, with young voters and urban residents adopting digital methods at substantially higher rates. Estonia's success is strongly correlated with the implementation of a nationwide digital identification system, which assigns each citizen a secure online identity through a chip-based ID card and PIN authentication. Scholarly evidence (Ehin et al., 2022) demonstrates that such systems build long-term trust by allowing elections to be verified, audited, and transparently authenticated. The comparative findings suggest that technologically advanced democracies, such as the United States, could realize similar benefits if they modernize identity verification systems and establish robust cybersecurity frameworks.

5. Environmental Benefits and Sustainability Considerations

Finally, findings indicate that adopting exclusive e-voting could generate meaningful environmental benefits. The United States is among the world's highest consumers of paper, using approximately **296,896 metric tons per 1,000 people**, a rate that contributes to the loss of nearly **1.2 million acres of forest annually**. Transitioning to e-voting would dramatically reduce paper consumption associated with ballots, registration materials, and

administrative printing. Although this is not the primary purpose of electoral reform, the environmental impact provides an additional argument for exploring digital alternatives.

Overall, the findings indicate that youth voter turnout in the United States has steadily increased over the past two decades, coinciding with a strong generational preference for digital voting platforms. The nation's election infrastructure has similarly evolved, with widespread adoption of Direct Recording Electronic (DRE) systems reflecting growing technological readiness and administrative experience with electronic voting mechanisms. E-voting also offers substantial accessibility benefits, particularly for individuals with disabilities and others who encounter physical barriers to in-person voting, thereby helping to reintegrate underrepresented groups into the democratic process. International evidence, especially from Estonia, further demonstrates that e-voting can achieve secure and transparent outcomes when supported by robust digital identification and authentication systems. Additionally, the environmental advantages of transitioning to electronic ballots provide an added incentive, as e-voting significantly reduces paper consumption associated with traditional election procedures. Together, these findings suggest that exclusive nationwide e-voting holds considerable potential to enhance participation, accessibility, efficiency, and sustainability within the U.S. electoral system.

DISCUSSION

The findings of this study highlight several important insights into the feasibility and broader implications of adopting an exclusive e-voting system in the United States. Rising youth engagement, technological infrastructure readiness, and documented accessibility improvements collectively point to a sociotechnical environment that is increasingly conducive to digital electoral participation. These results align with contemporary theories of digital democracy, which posit that technologically advanced societies are more likely to integrate digital tools into civic processes in ways that expand participation, reduce administrative burdens, and modernize democratic institutions.

One of the most significant implications revealed in this study concerns generational shifts in voting behavior. Younger Americans consistently demonstrate a preference for digital modes of interaction, suggesting that exclusive e-voting may serve not only as a functional innovation but also as a cultural adaptation to a digitally oriented electorate. This demographic trend underscores the potential for e-voting to mitigate long-standing participation gaps among younger voters, offering a mechanism for sustained and inclusive engagement in national elections. The analysis also indicates that the United States possesses a stronger technological foundation for e-voting than is often assumed. The widespread adoption of Direct Recording Electronic (DRE) systems, along with the institutional experience accumulated through decades of hybrid voting, provides a practical foundation for broader digital reform. However, the persistence of public apprehensions concerning security and system integrity cannot be overlooked. High-profile errors and vulnerabilities documented in past elections continue to shape public trust, emphasizing the need for transparency, robust cybersecurity frameworks, and clear communication strategies to reinforce confidence in digital voting systems.

Accessibility emerged as another critical dimension. The substantial number of individuals with disabilities who currently face barriers to traditional voting underscores a major democratic inequity that e-voting is uniquely positioned to address. By enabling voters with physical limitations to cast ballots securely and independently from home, e-voting offers meaningful pathways for expanding participation and reducing structural barriers embedded in traditional electoral processes. This finding aligns with broader scholarship emphasizing the need for inclusive democratic systems that accommodate diverse populations and reduce systemic disadvantages. International comparisons further contextualize the U.S. case. Estonia's successful integration of national digital identification systems and its rapid increase in e-voting participation demonstrate the importance of institutional design, cybersecurity, and public trust. While the U.S. lacks a centralized digital ID infrastructure, the Estonian model illustrates that secure nationwide e-voting is technologically attainable when supported by coordinated policy frameworks. The U.S. could benefit from examining these global best practices to inform a gradual transition toward more comprehensive digital voting solutions.

Finally, the environmental benefits associated with e-voting offer an additional, though often overlooked, justification for transitioning away from paper-based elections. Reductions in paper consumption align with broader governmental sustainability goals and may help modernize not only electoral administration but also public-sector environmental stewardship.

Overall, the discussion suggests that exclusive e-voting in the United States is both technologically and socially plausible, though not without challenges. Public trust, cybersecurity, and digital literacy remain key barriers requiring thoughtful policy development and sustained public education. Nevertheless, when weighed against the significant advantages identified, including increased participation, improved accessibility, modernized

infrastructure, and environmental sustainability, the evidence supports the potential for e-voting to play a transformative role in the future of U.S. presidential elections.

LIMITATIONS AND FUTURE WORK

While this study provides important insights into the feasibility and implications of adopting exclusive e-voting systems in the United States, several limitations must be acknowledged. First, the analysis relies primarily on secondary data drawn from publicly available sources, national voter statistics, and previously published research. Although these datasets offer valuable information about participation trends and demographic patterns, they may not capture all nuances of voter behavior, local administrative constraints, or state-specific regulatory differences. Future studies would benefit from incorporating primary data collection, such as surveys, interviews, or focus groups with voters, election officials, and cybersecurity experts to obtain more granular perspectives on e-voting readiness and public trust.

Second, while international comparisons such as Estonia provide useful benchmarks, the social, political, and technological contexts of these countries differ substantially from those of the United States. As a result, findings drawn from external case studies may not be fully generalizable to the U.S. electoral environment. Future research should therefore consider comparative studies across a broader range of democratic systems, particularly those with decentralized election administration structures like the United States.

Third, this study does not conduct a detailed technical assessment of e-voting infrastructure, security protocols, or system vulnerabilities. Cybersecurity remains a central concern in debates surrounding digital elections, and a more rigorous computational or systems-based analysis would strengthen understanding of risks, threat models, and mitigation strategies. Future research could integrate technical simulations, risk assessments, or blockchain-based verification models to evaluate the resilience of potential e-voting frameworks.

Finally, the study's emphasis on voter turnout and accessibility does not fully address issues of digital literacy, socioeconomic disparities, or uneven access to high-speed internet, factors that may disproportionately affect marginalized communities. Future research should examine the digital divide more closely to ensure that e-voting policies promote inclusion rather than reinforce existing inequalities. Together, these limitations highlight the need for more interdisciplinary research that integrates political science, information systems, cybersecurity, public policy, and disability studies. Addressing these gaps will help policymakers and researchers more accurately evaluate the long-term feasibility, equity, and security of exclusive nationwide e-voting systems.

CONCLUSION

This study examined the feasibility, implications, and potential benefits of adopting exclusive electronic voting (e-voting) for presidential elections in the United States. The findings indicate that rising youth engagement, expanding technological readiness, and significant accessibility improvements collectively create strong conditions for integrating digital voting systems into the national electoral framework. Evidence shows that younger Americans overwhelmingly prefer digital platforms, and individuals with disabilities stand to benefit substantially from the convenience and independence offered by e-voting. Additionally, international models, particularly Estonia, demonstrate that secure nationwide e-voting is achievable when supported by robust identification systems and well-designed cybersecurity frameworks.

At the same time, the analysis highlights enduring challenges. Public apprehensions regarding system security and integrity remain a central barrier to widespread adoption. While the United States has made substantial investments in Direct Recording Electronic systems, concerns about cyber vulnerabilities and counting inconsistencies reinforce the importance of transparency, voter education, and governmental accountability in any transition toward digital elections. These findings emphasize that successful implementation requires not only technological capacity but also trust-building measures and policy coordination across federal, state, and local levels.

Overall, the study supports the conclusion that exclusive nationwide e-voting offers considerable potential for strengthening democratic participation, reducing structural barriers, enhancing administrative efficiency, and contributing to environmental sustainability. However, realizing these benefits will depend on careful policy planning, continued technological innovation, and efforts to build public confidence in digital electoral systems. As the social and technological landscape continues to evolve, e-voting stands as a promising pathway toward a more inclusive and modernized electoral future in the United States.

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