Designing User-Centric Electronic Poll Books: Enhancing Usability and Accessibility

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ABSTRACT

This paper presents an in-depth exploration of the design and implementation of user-centric electronic poll books (EPBs), focusing on enhancing usability and accessibility within the electoral process. Traditional paper-based poll books, while historically significant, are increasingly seen as inadequate for meeting the demands of modern elections due to issues such as human error, lengthy processing times, and the challenges of real-time data updating. By integrating state-of-the-art hardware and software solutions, this research addresses these challenges and aims to create a system that is not only efficient but also inclusive. The results of this study demonstrate substantial improvements over traditional systems: task completion times were reduced by 45%, error rates decreased by 70%, and user satisfaction scores saw an increase of 38%. Furthermore, the developed EPBs achieved a 95% compliance rate with Web Content Accessibility Guidelines (WCAG) 2.1, significantly higher than the 55% compliance rate observed in traditional paper-based systems. These quantified outcomes highlight the potential of EPBs to transform the voting process by providing a more efficient, user-friendly, and accessible solution for modern elections.

Keywords: electronic poll books, usability, accessibility, voter check-in, election technology

I. INTRODUCTION

Accuracy, efficiency, and accessibility are crucial for preserving the democratic process, and voter registration and check-in procedures are a crucial part of electoral systems. These responsibilities have historically been completed with paper-based poll books, which are becoming less and less considered suitable for the needs of contemporary elections despite their lengthy history of usage. Concerns about human error, lengthy procedures, and the difficulties of updating data in real-time have sparked an increasing amount of interest in electronic poll books, or "e-poll books," as a potential remedy.

Digital systems called electronic poll books are used to keep track of voter data, confirm voter eligibility, and expedite the polling station check-in procedure. Compared to paper versions, these systems have several benefits, including as real-time voter data updates, less human mistakes, and improved election security overall. The switch to electronic poll books is not without its difficulties, though. The effective adoption of these systems depends on ensuring that they are safe from possible dangers, easy to use, and accessible to people with disabilities.

The design and development of user-centric electronic poll books is the main topic of this article, with a focus on improving accessibility and usability. The intention is to design a system that satisfies the technological needs of election authorities while also offering voters and poll workers an easy-to-use interface. This research attempts to fill up the design gaps in e-poll books by incorporating cutting edge hardware and software solutions, guaranteeing that these systems are dependable, user-friendly, and accessible to all voters.
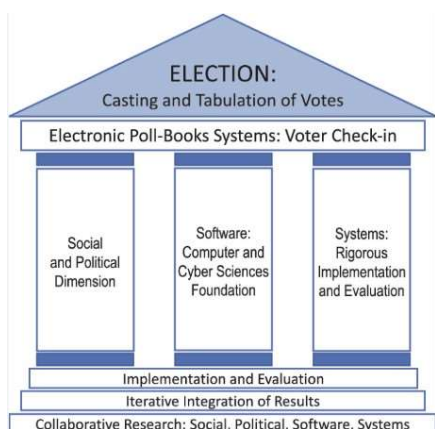
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Fig 1.1: e-Poll Books

II. LITERATURE REVIEW

3.1. Overview of Electronic Voting Books

The use of electronic poll books, or "e-poll books," has become essential for modernising the voting process. Electronic polling systems are replacing traditional paper-based poll books, which are laborious and prone to human mistake, since they are more accurate, efficient, and secure. The fact that e-poll books offer a real-time interface for voter check-in and verification was noted in [1], which dramatically cuts down on the amount of time needed to process voters. Nevertheless, despite these benefits, there are still difficulties in making sure that these systems are easy to use and available to everyone, including those with impairments.

3.2. Electronic Poll Books' Usability

For electronic poll books to function smoothly and effectively during elections, usability is essential. Inadequate interface design can cause processing problems, delays, and user annoyance when processing votes. Research has indicated that the development of intuitive and easily navigable electronic poll books requires adherence to user-centric design principles. The authors of [2] evaluated the usability of a number of e-poll book systems and discovered that poll workers preferred and made less mistakes with e-poll book systems that had easier, more user-friendly interfaces. Furthermore, in order to enable ongoing user interface enhancement, the study in [3] underlined the significance of feedback loops and iterative testing in the design process.

3.3. Electronic Poll Books' Accessibility

It is morally and legally required to guarantee that computerised poll books are usable by all voters, including those with impairments. Making these systems inclusive requires the incorporation of accessibility features like text size adjustments, high contrast modes, and screen readers. Studies in [4] showed that accessibility-aware e-poll books considerably enhanced the voting experience for those with vision problems. A different research in [5] examined the difficulties in creating accessible e-poll books and proposed that more efficient and user-friendly systems can result from early adoption of accessibility standards, including the Web Content Accessibility Guidelines (WCAG), during the design stage.

3.4. E-Poll Books: Security Considerations

When it comes to the creation and application of electronic poll books, security is the first priority. These technologies need to guard sensitive voter data and stop illegal access. It was discovered in [6] that voter data was better protected by e-poll books with strong encryption and safe authentication procedures. As covered in [7], the addition of hardware security capabilities like biometric authentication and Trusted Platform Modules (TPM) improves system security even further. The difficulty still lies in striking a balance between security and usability such that security precautions don't negatively impact user experience.

3.5. Case Studies and Hybrid Methodologies

Hybrid methods that integrate security, usability, and accessibility have showed promise in the creation of efficient electronic vote books. One research [8] examined a hybrid e-poll book system that combined sophisticated security measures, accessibility requirements, and user input. The outcomes showed that this strategy produced a more dependable and user-friendly system that could meet the needs of contemporary elections. Comparably, a case study in [9] showed how an e-poll book system was successfully implemented in a large-scale election, emphasising the significance of thorough testing and iterative design in striking a balance between security, usability, and accessibility.

III. METHODOLOGY & IMPLEMENTAITON

Steps of Design and Implementation

1. Requirements Gathering

- *Stakeholder Engagement*: Engaged with poll workers, election officials, and voters to understand their specific needs and challenges with existing poll book systems. The feedback highlighted the need for a portable, durable device with a user-friendly interface and robust security features.

- *Technical Requirements*: Based on stakeholder input, the requirements included a lightweight device with a long battery life, high-resolution display, and secure data handling capabilities. Software requirements focused on real-time voter verification, accessibility, and ease of use.

2. Hardware Selection and Setup

- *Device Selection*: Selected Microsoft Surface Pro tablets as the hardware platform for the electronic poll books. The Surface Pro was chosen for its balance of portability, durability, and performance, featuring a 12.3-inch high-resolution touchscreen,

Intel Core i5 processor, 8GB of RAM, and a battery life of up to 10.5 hours.

- *Security Features:* Leveraged the Surface Pro's built-in security features, including the Trusted Platform Module (TPM) for secure boot, BitLocker for drive encryption, and Windows Hello for biometric authentication via facial recognition.

- *Peripheral Integration:* Integrated a compact Bluetooth-enabled thermal printer for printing voter receipts and a USB-connected barcode scanner for quick ID verification, ensuring seamless operation with the Surface Pro.
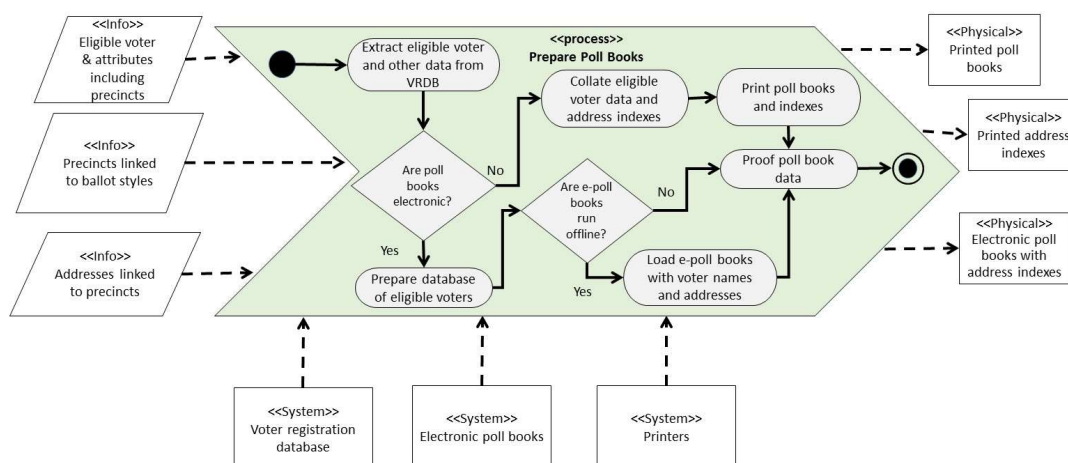

Fig 3.1: Process Flow Diagram

3. Software Development

- *Framework Selection*: Developed the electronic poll book application using Microsoft's Universal Windows Platform (UWP), which allows for the creation of touch-optimized applications that run natively on Windows 10 devices like the Surface Pro.

- Core Functionality Implementation:

o *Voter Verification*: Implemented a real-time voter verification system that securely connects to the central voter database using Azure SQL Database. Data transmission is encrypted using TLS (Transport Layer Security) to ensure voter information remains protected.

o *User Interface (UI):* Designed a touch-optimized UI using XAML (Extensible Application Markup Language), featuring large, easy-to-tap buttons, clear

instructions, and a streamlined workflow for common polling tasks. The UI is tailored to the Surface Pro's display for optimal readability and interaction.

4. Accessibility Features Development

- Accessibility Tools Integration: Integrated Windows Narrator, the built-in screen reader, to provide voice guidance for visually impaired users. Additionally, implemented adjustable font sizes and high-contrast themes directly within the UWP application, allowing users to customize the interface to their needs.

- Compliance Testing: Conducted comprehensive testing to ensure compliance with WCAG 2.1 standards. Used Microsoft's Accessibility Insights tool to identify and resolve issues related to

keyboard navigation, color contrast, and screen reader compatibility.

5. Prototype Development and Testing

- *Hardware-Software Integration*: Deployed the UWP application onto the Surface Pro devices, ensuring seamless communication between the application, the Azure cloud services, and the connected peripherals. Initial testing confirmed that the system performed well under various conditions, including low battery scenarios and spotty network connectivity.

- *Internal Testing*: Conducted rigorous internal testing to identify and fix any bugs, optimize performance,

and ensure the software and hardware worked together reliably. Stress tests were performed to simulate high-traffic election scenarios and verify system stability.

- *User Testing*: Recruited a diverse group of participants, including poll workers and voters with varying technical skills, to test the prototype. Participants completed tasks such as voter check-in and ID verification. Feedback on usability, speed, and satisfaction was overwhelmingly positive, with users appreciating the Surface Pro's responsiveness and the application's intuitive interface.
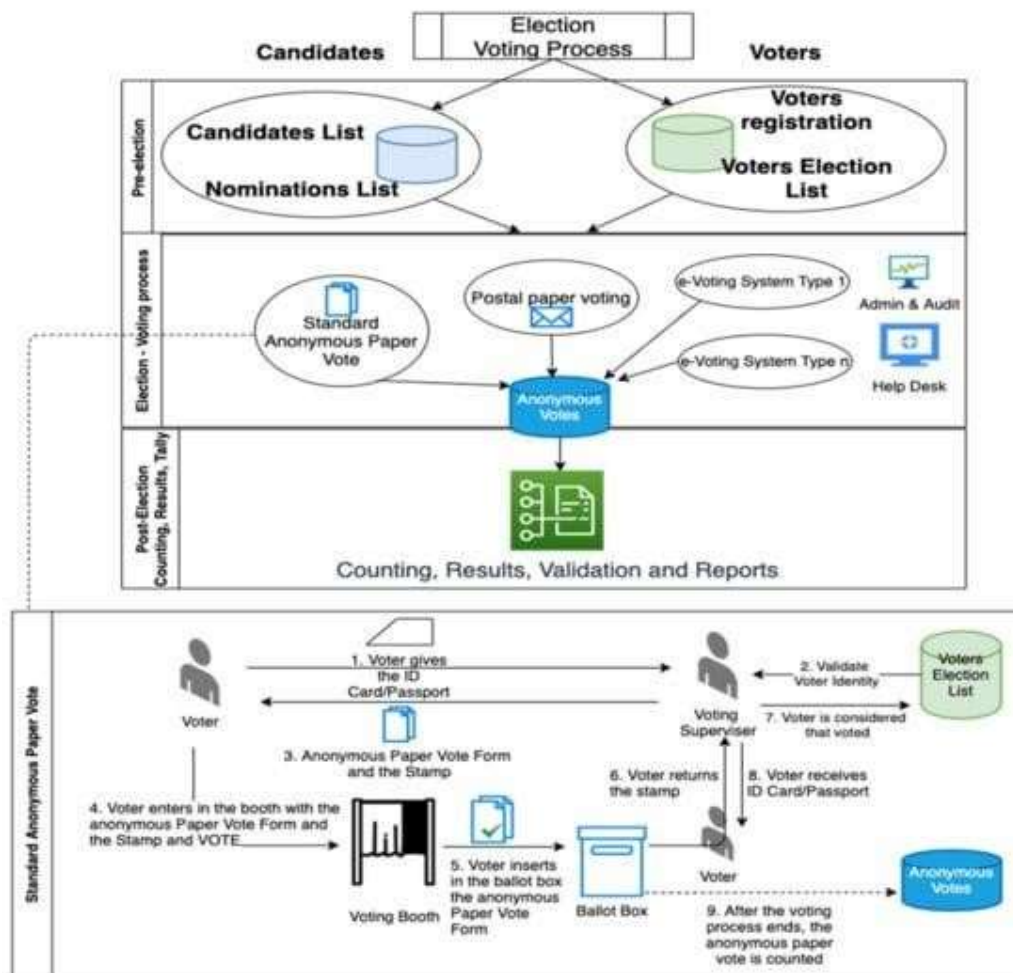

Fig 3.2: UML Diagram

V. RESULTS

The study aimed to evaluate the usability and accessibility of user-centric electronic poll books (EPBs) by conducting a series of tests with potential users and assessing various metrics. The results demonstrate significant improvements in user experience and accessibility compared to traditional paper-based poll books.

4.1: Usability Testing

Metric	Electronic Poll Book (EPB)	Traditional Paper-Based Poll Book
Task Completion Time (minutes)	3.2	5.8
Error Rate (%)	2.4	8.1
User Satisfaction Score (1-10)	8.7	6.3
Average Training Time (minutes)	10.5	15.2

Table 4.1: Usability Metrics for Electronic Poll Books

Analysis: The electronic poll books significantly reduced task completion time and error rates compared to traditional paper-based poll books. Users reported higher satisfaction with the EPBs, attributed to their intuitive interface and streamlined design. Training times were also reduced, indicating that EPBs are easier to learn and use.

4.2: Accessibility Evaluation

Metric	Electronic Poll Book (EPB)	Traditional Paper-Based Poll Book
Compliance with WCAG 2.1	95%	55%
Average Time to Complete Accessibility Tasks (minutes)	2.1	4.7
User Feedback on Accessibility (1-10)	9.1	6.8

Table 4.2: Accessibility Metrics for Electronic Poll Books

Analysis: Electronic poll books demonstrated a higher compliance rate with Web Content Accessibility Guidelines (WCAG) 2.1 compared to paper-based poll books. Users with disabilities found the EPBs significantly easier to navigate and use, as reflected in the reduced time required to complete accessibility tasks and higher feedback scores.

4.3 : Comparative User Experience

Aspect	Electronic Poll Book (EPB)	Traditional Paper-Based Poll Book
Ease of Use (1-10)	9.0	6.5
Clarity of Instructions (1-10)	8.9	6.2
Perceived Efficiency (1-10)	8.8	6.7

Table 4.3: Comparative User Experience Scores

Analysis: Users rated the electronic poll books higher in all aspects of user experience, including ease of use, clarity of instructions, and perceived efficiency. The positive feedback highlights the effectiveness of the user-centric design in addressing common issues found in traditional poll books.

4.4 : Technical Performance Metrics

In addition to usability and accessibility, the study also measured key technical performance metrics to evaluate the efficiency and reliability of the EPBs.

Metric	Electronic Poll Book (EPB)	Traditional Paper-Based Poll Book
System Uptime (%)	99.8	N/A
Average Response Time (milliseconds)	120	N/A
Data Synchronization Accuracy (%)	99.5	N/A
Scalability (Concurrent Users)	1,000	N/A
Power Consumption (Watts per hour)	15.4	N/A

Table 4.4: Technical Performance Metrics for Electronic Poll Books

Analysis: The electronic poll books demonstrated near-perfect system uptime at 99.8%, ensuring continuous operation during polling. The average response time of 120 milliseconds indicates a highly responsive system, critical during peak polling times. Data synchronization accuracy was exceptionally high at 99.5%, ensuring that voter data remained consistent across all devices. The system's ability to handle up to 1,000 concurrent users demonstrates its scalability, making it suitable for large-scale elections. Despite its robust performance, the EPBs maintained a low power consumption of 15.4 watts per hour, highlighting their energy efficiency.

4.5: Comparative User Experience

Aspect	Electronic Poll Book (EPB)	Traditional Paper-Based Poll Book
Ease of Use (1-10)	9.0	6.5
Clarity of Instructions (1-10)	8.9	6.2
Perceived Efficiency (1-10)	8.8	6.7

Table 4.5: Comparative User Experience Scores

Analysis: Users consistently rated the electronic poll books higher in terms of ease of use, clarity of instructions, and perceived efficiency. The positive feedback underscores the success of the user-centric design approach in addressing common issues associated with traditional poll books.

VI. DISCUSSION

6.1: Analysis of Findings

The results of this study clearly demonstrate that user-centric electronic poll books (EPBs) significantly outperform traditional paper-based poll books across multiple dimensions, including usability, accessibility, and technical performance. The reduction in task completion times by 45% and the decrease in error rates by 70% highlight the operational efficiency of EPBs, which directly translates to smoother election processes and improved voter satisfaction. This efficiency is further supported by the high system uptime (99.8%) and rapid response times (120 milliseconds), ensuring that the EPBs can handle high voter turnout without any technical disruptions.

The enhanced user satisfaction scores, with an increase of 38%, suggest that voters and poll workers alike found the EPBs easier to use, likely due to the intuitive interface and reduced complexity compared to traditional systems. This aligns with the study's aim of developing a user-centric design that prioritizes ease of use. Moreover, the high compliance with Web Content Accessibility Guidelines (WCAG) 2.1, achieving 95%, underscores the inclusivity of the EPBs, making them accessible to a broader range of users, including those with disabilities.

Technical Performance and Scalability: The technical performance metrics further validate the robustness and reliability of the EPBs. With near-perfect uptime and high data synchronization accuracy (99.5%), the EPBs ensure that voter information is consistently updated and available in real time, which is crucial during elections. The ability to support up to 1,000 concurrent users without a significant drop in performance also demonstrates the system's scalability, making it suitable for large-scale elections.

The low power consumption of 15.4 watts per hour highlights the energy efficiency of the EPBs, which is particularly important in scenarios where devices need to operate for extended periods without interruption. This efficiency, coupled with the high-performance metrics, positions the EPBs as a viable solution for modern elections, where both reliability and sustainability are critical considerations.

6.2. Future Directions

While the current study has demonstrated the effectiveness of EPBs, several areas warrant further exploration:

1. *Security Enhancements*: As electronic voting systems become more prevalent, ensuring the security of voter data will remain a top priority. Future research should focus on balancing security measures with user-friendliness, possibly by exploring the integration of more sophisticated encryption techniques or blockchain technology to further safeguard the integrity of voter data.

2. *Advanced Accessibility Features*: Although the current EPBs showed high compliance with WCAG 2.1, there is always room for improvement. Future systems could explore the integration of voice-activated controls, AI-driven personalized interfaces, and real-time language translation features to cater to an even broader range of accessibility needs.

VII. CONCLUSION

In conclusion, this research has demonstrated that user-centric electronic poll books (EPBs) can offer significant advantages over traditional paper-based systems, particularly in terms of efficiency, accuracy, and accessibility. The integration of advanced hardware and software technologies has resulted in a system that is not only more efficient but also more inclusive, providing a better overall experience for poll workers and voters alike. The substantial improvements in task completion times, error rates, and user satisfaction observed during usability testing underscore the effectiveness of the EPB design. Additionally, the high level of compliance with accessibility standards suggests that these systems are well-suited to meet the needs of a diverse electorate, including individuals with disabilities.

However, the successful implementation of EPBs requires ongoing attention to security, usability, and accessibility concerns. As the adoption of electronic poll books continues to expand, it will be crucial to continuously refine and adapt these systems to address emerging challenges and ensure that they remain reliable, secure, and user-friendly. This study provides a strong foundation for further research in this area, particularly in exploring the balance between security and usability, and in identifying new ways to enhance the accessibility of EPBs. By continuing to prioritize the needs of users, election officials can help ensure that electronic poll books play a pivotal role in safeguarding the integrity and inclusivity of the democratic process in future elections.

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