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Innovative Solutions for Democratic Processes: A Case Study on Secure JNEC Voting System

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Abstract

In the digital era, there is a need to convert the traditional voting approach. Thus, this paper introduces the JNEC Voting System (JVS), an offline desktop application designed to modernize the voting process. Traditional paper voting systems practiced in Jigme Namgyel Engineering College (JNEC) present challenges such as time-consuming procedures, the potential for invalid votes, and vulnerability to fraud. To address these issues, JVS employs a .NET framework, with C# for frontend and backend development, and MySQL as the database. The development process follows an iterative method, allowing for continuous improvement, flexibility, and adaptability. JVS enables voters to cast their votes by scanning ID cards, while administrators can create events, manage candidates, and manage voter registration. By eliminating the limitations of traditional approaches, JVS aims to enhance the efficiency and simplicity of voting. The primary goal was to replace paper voting systems in college and reduce the time for voting, counting, and result declaration. To tackle these challenges, JVS seeks to boost voter confidence and involvement. Further, it contributes to more transparent, secure, and accountable elections.

Keywords— Desktop application, information System, iterative development, secure Election, voting System, .NET framework

1 Introduction

An election is a formalized democratic process where eligible individuals within a community or organization cast votes to choose representatives or to implement in the decision-making process [1]. The quick development of technology in the era of digitalization has brought about transformative changes in various domains, and the electoral process is no exception. Traditional voting systems are usually dependent on paper-based methodologies, resulting in persistent challenges such as time-consuming procedures, susceptibility to fraud, and inefficiencies in the voting process. In response

to these challenges, this study introduces the JNEC Voting System (JVS)- an offline desktop application developed with a .NET framework, utilizing C# for frontend and backend components, and employing MySQL as the primary database. The inspiration for JVS arises from the need to modernize and optimize voting processes, addressing the limitations of conventional approaches at Jigme Namgyel Engineering College (JNEC). The offline JNEC voting system desktop application can serve as an essential solution to the challenges associated with traditional voting methods. This digital platform enables voters to effortlessly cast their votes using a desktop computer application, eliminating the need for physical ballot boxes and minimizing the potential for fraud or error. A prominent feature of JVS is its adaptability to multiple stations during an election. To ensure secure storage of votes in such scenarios, administrators can create separate databases for each station, enhancing the overall integrity of the electoral process. The study did a detailed examination of the issues and the paper aims to bridge the gap between traditional and modern voting systems. Employing an iterative development approach, the project is broken down into smaller phases, allowing for continuous refinement based on stakeholder feedback and evolving requirements. The successful implementation of the JNEC Voting System (JVS) marks a significant improvement in the efficiency, security, and user-friendliness of the voting process. Voters can now cast their votes securely by scanning identification cards, while administrators can organize events, manage candidates, and oversee voter registration. The integration of a separate database for each station further supports the system's flexibility against potential security threats and ensures the accuracy of the election results. Beyond the technical characteristics, this work holds broader significance in electoral processes. By providing a robust solution to the challenges posed by traditional voting methods, our research contributes to enhancing the integrity and efficiency of democratic processes. The successful implementation of JVS has the potential to strengthen voter confidence, increase participation, and promote transparent, accountable elections. This work highlights the importance of acceptance of technological advancements to safeguard the democratic principles of our electoral systems.

2 Related Work

As per [2], the ancient Greeks were the innovators of democracy, emphasizing citizen involvement in government. However, early democracies, such as Athens, had limitations, excluding certain groups from voting. Voting is a crucial element of democracy as it allows eligible citizens to express their preferences and influence various aspects of governance. According to [1], an election is a formalized democratic process where eligible individuals within a community or organization cast votes to choose representatives or make decisions on specific issues. Traditional paper-based voting systems have been in use for centuries. This system, although straightforward, is susceptible to human error, and fraud and also results in a slow tabulation process. From [3], researchers' pursuit of an innovation for enhancing and simplifying the electoral process, Electronic Voting has emerged as a notable option. Embracing Electronic Voting has gathered interest from technology experts and policymakers. Over time, voting methods have evolved, and the JNEC voting system as a proposed stand-alone desktop application offers numerous advantages. It operates offline, ensuring uninterrupted voting in areas with limited internet access and minimizing vulnerabilities associated with online systems. This Electronic Voting desktop application uses a powerful combination of C#, a versatile programming language, and Microsoft .NET software technology which [4] allows effective and quick development of software applications. In [5], a system/prototype was developed with the fingerprint scanner for security purposes. The development of that system was created in Visual Studio and was interfaced to the server using MySQL and programming was done in C# language. With the initiation of .NET core 5, C# applications now run on multiple platforms. The proposed system uses one of the most popular RDBMS, MySQL. As per [6], MySQL is used with programming languages, including C# due to its performance, dependability, simplicity, and

scalability. An iterative model was adopted for the development of this proposed system. [7] defines the iterative method as "the implementation of the software development life cycle in which the initial development is started based on the initial requirements and more features are added to the base software product with the ongoing iterations until the final system is created." This model provides quick delivery of working software, flexibility for adding new features, cost-effectiveness in changing requirements, fast user feedback incorporation, and early identification of errors. Furthermore, it is suitable for smaller development teams. Based on [8], user-friendly plays a vital role in user experiences. The user-friendly interface and clear instructions of the JNEC Voting System ensure an effective and efficient voting process.

3 Methodology

The utilization of the traditional voting system encompasses various stages, such as voter participation, vote counting, and result announcement. These phases are often characterized by time-consuming procedures and the occurrence of invalid votes. In response to these challenges, the JNEC Voting System was developed, which employs a barcode scanner to register voters' identification by scanning the identity cards and enabling users to securely cast their votes electronically through the system. An iterative methodology was adopted for developing the system as represented in Figure 1. Initially, challenges were studied regarding traditional voting methods, and a project plan was created. The project included defining the system requirements, analysis, and design, and implementing the initial version of the JNEC Voting System.

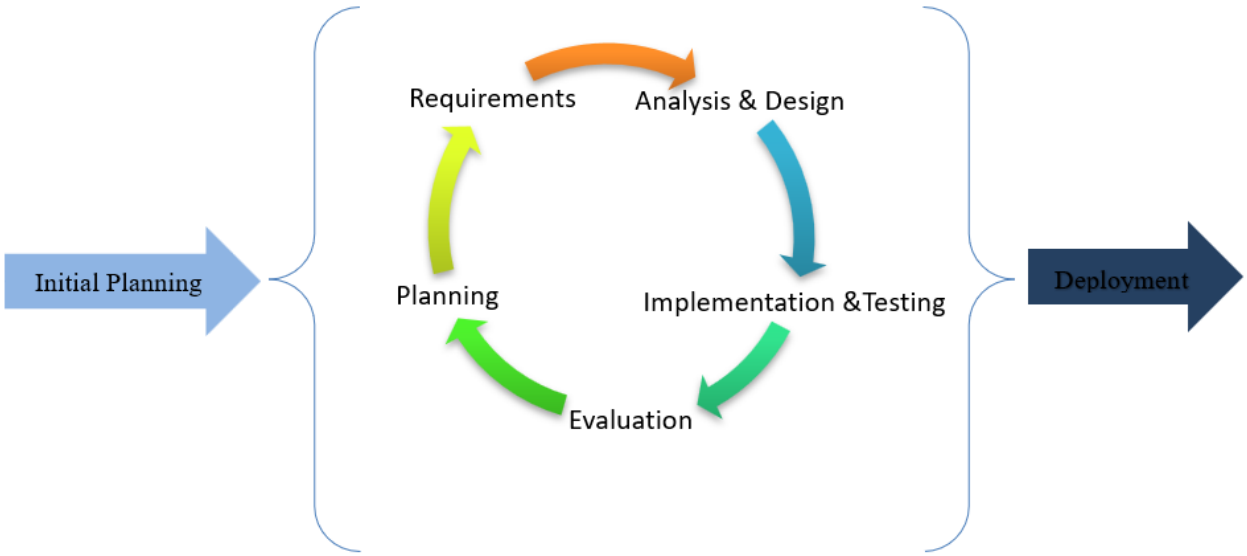


Figure 1: Iterative Method

After analyzing the requirements, the Use Case diagram was designed to show the system's interaction with the users. In this JVS, the Use Case diagram mainly consists of the admin actor and voter actor with many important Use Cases shown in Figure 2.

Through the requirements analysis and Use Case diagram, the database design was completed as represented in Figure 3. Subsequently, iterative cycles of development, testing, and feedback were implemented. The system was implemented and testing was done during leader selection and the system was showing accurate results without any invalid votes. Each iteration involved refining the system based on feedback received from participants during club leader selection.

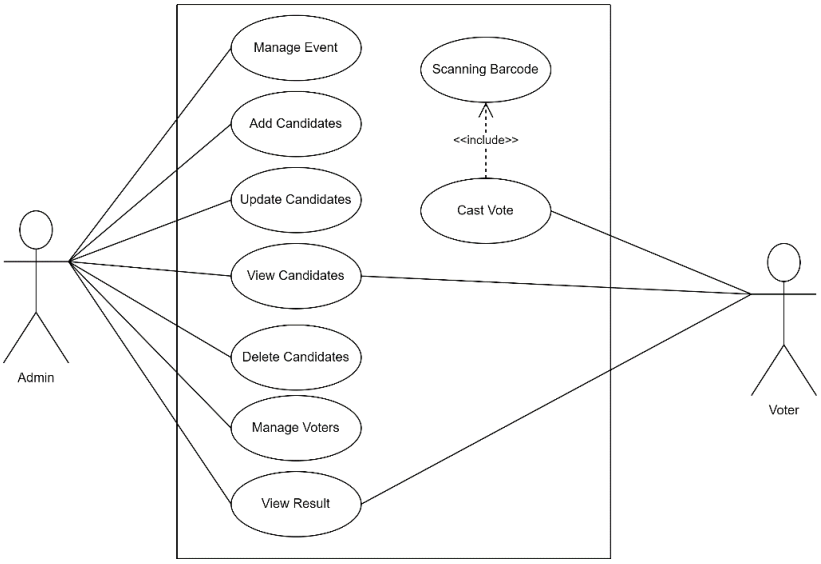


Figure 2: Use Case Diagram

Additionally, concurrency testing was done as discussed in [11]. Since it is a desktop application and process of voting eliminates the concurrency testing and security is revealed as it is a standalone system.

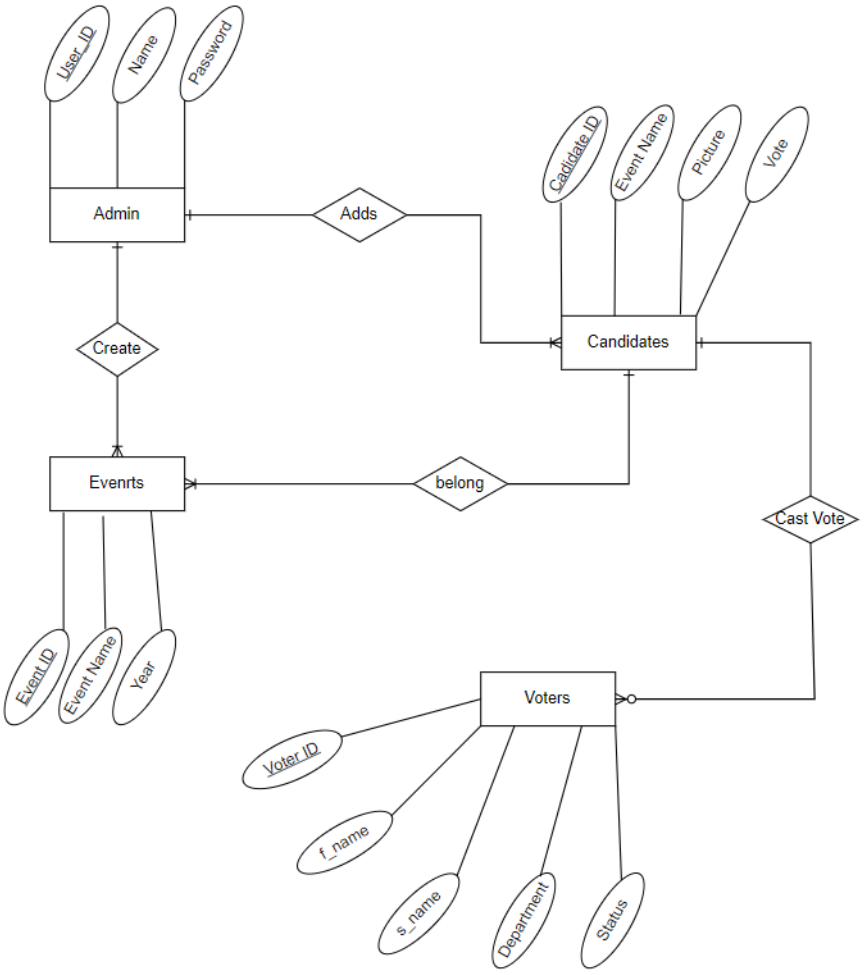


Figure 3: ER Diagram

4 Result

Figure 4 shows the procedures of the JNEC Voting System which is to replace the traditional method of voting. Firstly, the admin creates events for election and manages the candidates and voters in the system. Voters come with their cards for scanning and then vote for their candidates. This system displays the candidates list for the voters and stores the votes for the candidates that were voted by the voters. As soon as the voting is done, the system provides the real-time result declaration at the end of that particular event.

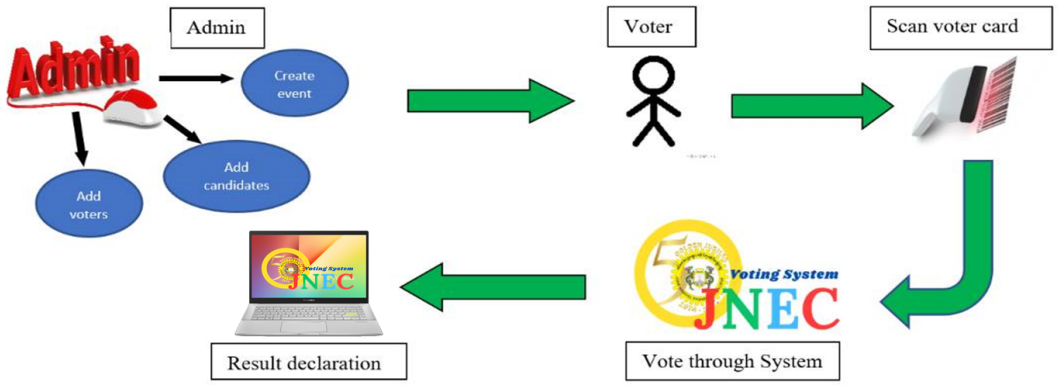


Figure 4: Working model

The JNEC Voting system fully addresses the challenges regarding the traditional method of voting which is characterized by time-consuming procedures and a higher possibility of invalid vote occurrence during the election process. The system is user-friendly which allows the admin to utilize the system easily and efficiently. On running the JNEC voting application, the login page is displayed as shown in Figure 5.



Figure 5: Login Page

After getting into the system, the admin is directed to the home page which consists of two divisions known as the information section and the voting section as shown in Figure 6. The information section is for managing voters' information such as adding and editing the details of voters, whereas the voting section is for creating an event for voting.

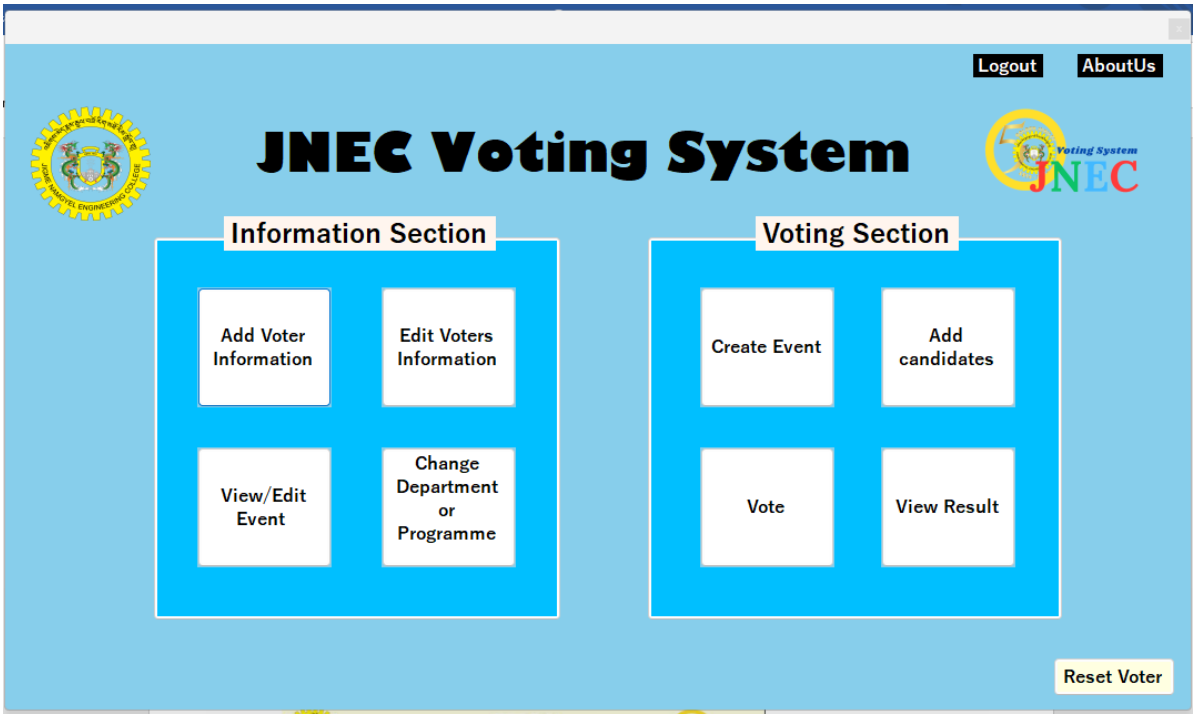


Figure 6: Home Page

After the creation of an event for the vote, the admin can add candidates to a particular event on the 'Add candidate' button. Admin will be asked to enter candidates' details as shown in Figure 7. On adding all the candidate's information, the admin can save it.

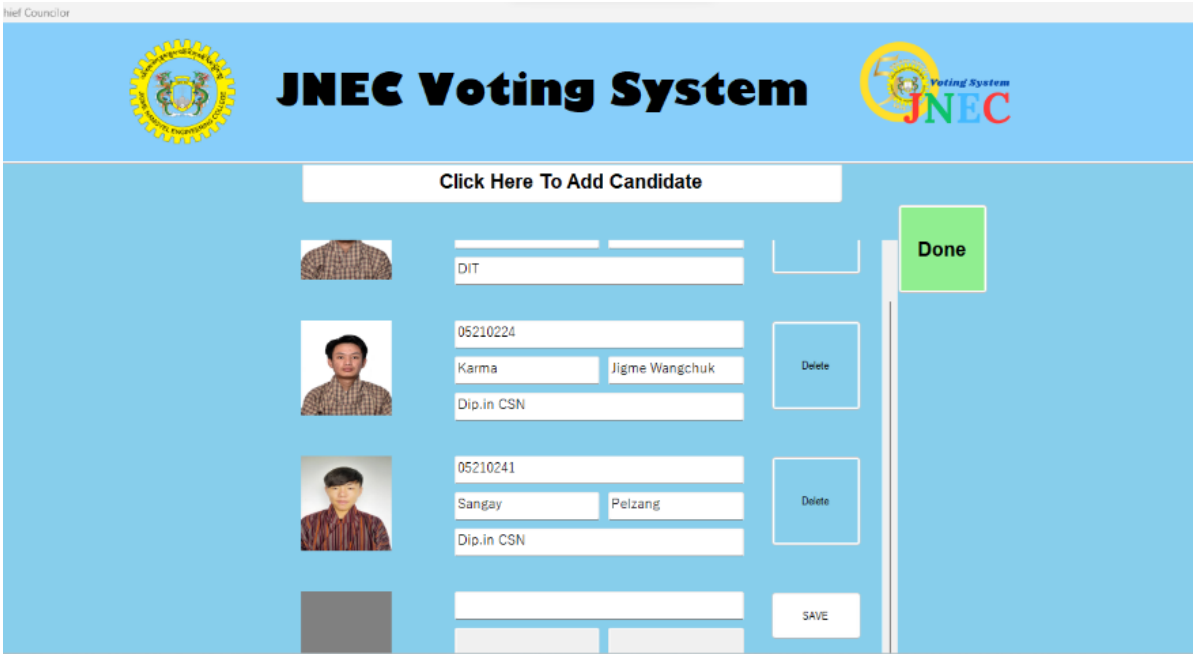


Figure 7: Adding candidates

After the admin creates an event and adds the candidates, the users can proceed to vote for their preferred candidate through the system. All voting counts are generated as shown in Figure 8 and can be viewed by clicking the 'View result' button after the completion of voting.

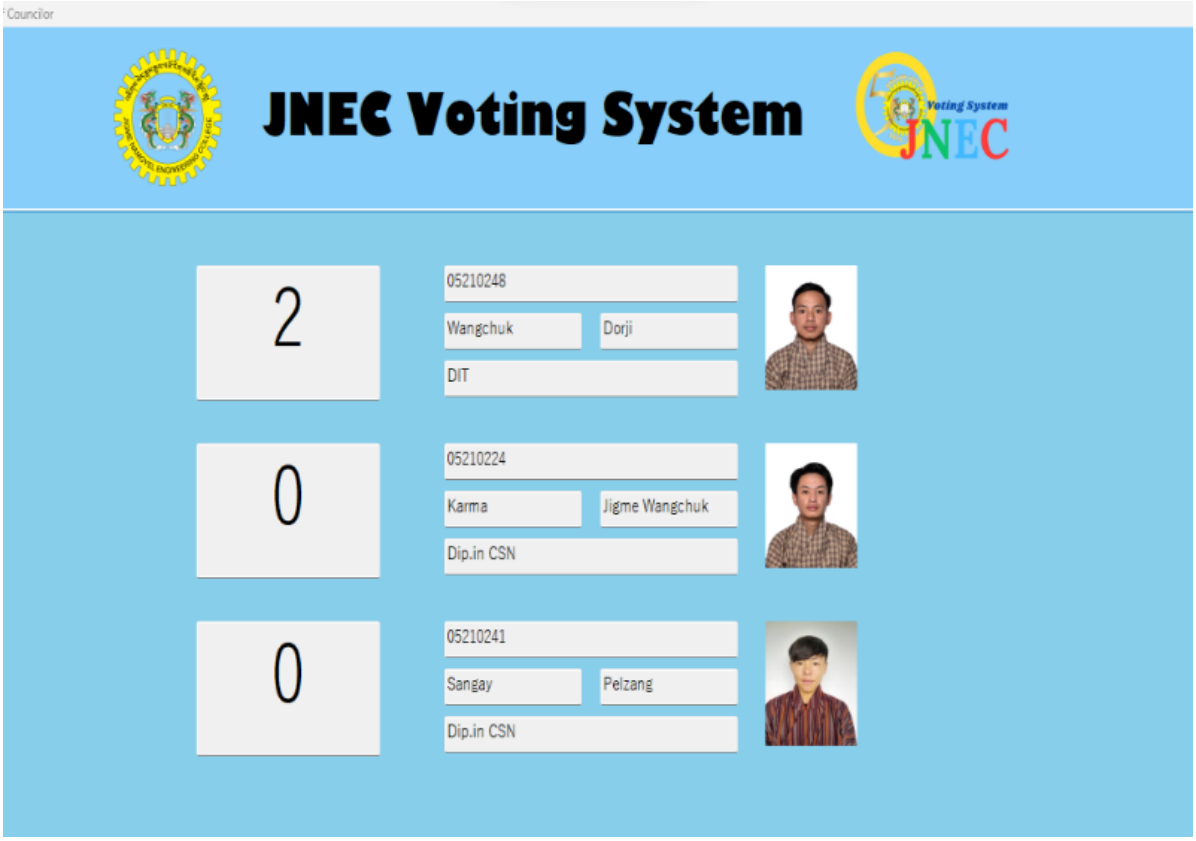


Figure 8: Result declaration page

5 Conclusion

The implementation of the JNEC Voting System eliminates the issues of the traditional method of voting. The existing system for voting had drawbacks such as a time-intensive process, the possibility of resulting in invalid votes, the need for physical ballot boxes, and the potential for error. Therefore, the system was developed using an iterative approach not only to eliminate the drawbacks but also to optimize the voting processes, addressing the limitations of conventional approaches at Jigme Namgyel Engineering College (JNEC). The system has successfully replaced the cumbersome manual procedures, allowing for seamless scanning and auto-generation of user details from the employee ID and student card. The integration of a database has enabled secure storage and accurate vote counting, providing immediate and reliable results. This offline desktop application for voting could be extended to an online voting system. Stand-alone systems have benefits but logistical considerations and limitations in scalability and real-time data management. The visible balance between the advantages of stand-alone systems and incorporating technological advancements is essential for a robust and inclusive democratic process. Overall, it is crucial to continue researching and developing voting systems to address challenges and harness the potential of evolving technologies. Transparency, security, and accessibility should be prioritized to ensure that every eligible voter's voice is heard, and the integrity of the democratic process is maintained.

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