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Project QSUeVoto: distributed electronic voting system based on blockchain technology

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ABSTRACT

Students' voting experience can be made far more secure, transparent, and effective with an electronic voting system based on blockchain. But for it to be implemented successfully, technological issues must be resolved, accessibility must be guaranteed, and student trust must be developed. Resilient security protocols, intuitive user interfaces, and unambiguous dissemination of the advantages and functionality of the system are vital for surmounting possible obstacles and optimizing favorable outcomes. System development techniques and a descriptive research design were used in this study. The developed systems are accepted and compliant as determined by the IT experts, as evidenced by the grand mean of 4.63 and the descriptive rating of conformity to a very high level. It can be deduced that the SG Advisor, SAS Director, students, and Canvasser Board from Maddela and Diffun Campus gave the generated application great approval and acceptance. This indicates that there is a notable discrepancy between the users' and IT specialists' perceptions of the system's adoption and compliance levels. This procedure can be made better with a safe voting system that has cutting-edge features. Blockchain technology is regarded as a disruptive breakthrough with substantial potential to improve the electronic voting system.

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1. INTRODUCTION

Numerous facets of our society are improved by technology. Easy access to a range of resources and services is supported by a linked design. Additionally, invention and creativity have flourished in the presence of technology such as the Internet [1]. The feature of security and transparency is a warning from still widespread elections with the conventional system (offline) [2].

The election is one of the important pillars of current democracy. The tools and procedures used to create verifiable, transparent voting systems are continually improving. Since the 1970s, many versions of computerized electronic voting have been utilized, and they have significant advantages over paper-based systems, including increased efficiency and decreased errors [3]. The computerized voting system is one of the key components of modern society. People are concerned about voting fraud and seek honesty and openness globally [4]. With time, paper-based voting has given way to electronic voting in an effort to cut down on duplication and inconsistent results [5]. An electronic voting system needs to be safe since it needs to prevent voting twice and be completely visible while safeguarding participants' privacy [6]. It has long been a problem to design and construct a safe electronic voting system that provides the transparency and

flexibility of electronic systems with the fairness and privacy of present voting arrangements [7]. Providing a secure solution and earning the trust of the voters who will use it are the two main hurdles [8].

The issue with the current election in some colleges here in the university was performed traditionally, counting the votes manually, which is prone to data tampering, fraud, and data loss, even though there is an existing electronic voting system it is not sufficient. Quirino State University still using the manual processing of elections. The student services office together with the board of canvassers prepares and prints a ballot to be filled by the voters. After the election, the board of canvassers and the Office of Student Services manually counted the ballots and tallied the results. The researchers aimed to develop a web-based electronic voting system, which provides a secure and flexible voting mechanism to solve the problem of voter votes.

An application of sentiment analysis to the prediction of election outcomes is called "election forecasting" [9]. Employed for gathering data, the suggested methods' results were successful in producing precise electoral forecasts [10]. Increases the voters' participation, reduces the number of election officers, lowers the costs of running elections, and improves the accuracy of the results [11].

Because it eliminates TTP, decentralizes transactions, and offers transparent, completely protected data storage, blockchain technology is being presented as a revolutionary practical solution for a variety of IT applications [12]. A distributed, digital, consensus-based secure information storage system is known as a blockchain. The introduction of the blockchain framework to electronic voting systems may offer different solutions than current electronic voting practices [13]. It is feasible to create a tamper-proof digital platform for data sharing and storage in order to synchronize data modifications [14]. the centralized voting mechanism in order to avoid fraud and make it more secure, dependable, and anonymous [15]. One of these instruments is electronic voting, which can deliver suitable, affordable, quick, and safe services. The purpose of this article is to introduce a blockchain-based distributed electronic voting system that will benefit university students who are eligible to vote. A few security protocols were combined for a more accurate, quick, and improved performance. It is a web-based system based on that facilitates the running of elections. Users are individuals who interact with the system. Every school has always held annual elections for the Student Government Council. Every student is required to select one candidate from a list to fill each post on the Student Government Council during this event. This campus had already conducted a Campus Student Council Election of officers. The creation of a Project QSUeVoto: Distributed Electronic Voting System based on Blockchain Technology for Quirino State University will help the university to make the work a lot easier, and more effective, provide user-friendly and cross-platform access to the computerized system because of the automation of the tally of votes of students during the election period.

2. METHOD

System development techniques and a descriptive research design were used in this study. Using the ISO 25010 Software Quality Characteristic Tool for the system evaluation, descriptive research—also referred to as statistical research—describes the data and features of the system under examination. For the creation of the Distributed Electronic Voting System based on Blockchain Technology, Project QSUeVoto. The phases that will give a shared knowledge of the software-building process and how the program will be realized and developed will be identified using the Software Development Life Cycle (SDLC).

Figure 1 The development process of Project QSUeVoto, a distributed electronic voting system built on blockchain technology, is illustrated using an agile, iterative technique [16]. Every iteration of the system development process in experimental design, treatments, and layout entails the following procedure: Agile methodologies are a collection of more efficient incremental and iterative techniques that have been applied to project management [17]. Application Project QSUeVoto based on ISO 25010:2011, an International Organization for Standardization (ISO) model. Testing can be done using this approach as the foundation for software quality assurance [18].

2.1. Requirement analysis

The activities during the requirement analysis are to conduct Data Gathering through a series of interviews about the policies and procedures in the conduct of the election, Collection of Sample reports to be prepared and submitted, Problems Encountered with the manual process of elections and present what are the possible solutions that the computerization can be made of. Other Related Information can be developed to assess what are features needed to develop and integrate with the planned computerized system.

2.2. Design

In order to ensure compatibility between the produced system and databases, databases, and hardware, the researcher selected appropriate programming software. The production officer and users were in constant communication with the researcher regarding the characteristics that would best meet their

demands. For Project QSUeVoto, a distributed electronic voting system based on blockchain technology, the researchers created a framework. The logical architecture of the system was designed by the researchers using the Entity Relationship Diagram. Among these are the connections between the database's tables. The researchers planned the system and studied how data will be kept in the database tables as part of the database design phase of the development process. A combination of denormalized and normalized database design was used by the researchers. The researchers designed the system structure to present the system process. This structure was the basis for the identity the process and procedures to be integrated with the system. The researchers also used the hierarchical input process output (HIPO) this will be the basis of the researchers to identify the functional and non-functional features of the system. To identify what are the features needed in the development of the system. That the HIPO served as the blueprint of the system.

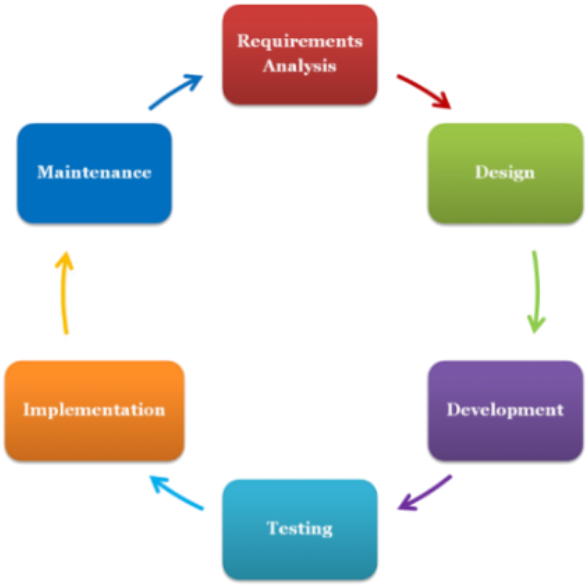

Figure 1. Agile iterative model

2.3. Development

The developer used the Bootstrap5 toolkit and the slim framework in conjunction with CSS to create a user interface that is both aesthetically pleasing and easy to use when constructing and designing the program. When designing a web page, consider how different device types—such as printers, big screens, and small screens—will seem. A similar software code base for desktop and mobile devices can be easily created thanks to the sophisticated web frameworks and libraries. If needed, it is simple to transform the web application into a native mobile application. PHP is a server-side computer programming language that gives you the versatility to create and manipulate webpages while connecting to and using various databases. MySQL is one of the most popular databases among them, along with PHP. Utilizing jQuery, a client-side scripting language, on your website greatly simplifies the use of JavaScript. Many common activities that require numerous lines of JavaScript code to accomplish are transformed into methods and functions that may be called with just one line of code by jQuery. Laravel is a dependable and easy-to-use PHP framework available as open-source software. It follows the model-view-controller design pattern.

2.4. Testing

Laboratory testing and Parallel Testing. Laboratory testing to check the bugs and errors of the system. Parallel testing, is simultaneous testing of the system with the manual system. This activity is to check the process and the flow of the system. To validate the records and reports generated provided by the system. To check also what are the possible errors that may be encountered. During this activity check the functional and non-functional features of the system.

2.5. Implementation

The designed system will be fully implemented and used in this activity. The final users will make use of the system to confirm that the systems are operating as intended. In order to improve program

implementation and promote equality, efficiency, scale-up, and sustainability, implementation involves the production and transmission of knowledge as well as the application of practices.

2.6. Maintenance

Error fixes, feature enhancements, feature deletions, optimization, software updates, and upgrades are all included in the broad category of software maintenance activities. Software maintenance is necessary for fixing bugs, adapting to changing user needs, updating hardware and software specifications, enhancing system performance, streamlining code to run more quickly, changing component layouts, minimizing unintended side effects and errors, enhancing security, and promoting continuous quality improvement.

3. RESULTS AND DISCUSSION

3.1. Created and implemented a network-based software architecture electronic voting system that offers computing resources so voters can safely register and cast their ballots

The architecture enables different schemes of decision distribution in the system, depending on the available decision-making capabilities and on the operational constraints related to the tasks to achieve [19]. Figure 2 shows the process of Project QSUeVoto System Architecture. The voters must register to the system to generate the QRCODE and Login credentials. The login credentials will be used to access the features of the voting system wherein the voters can cast their votes. After the voters cast their votes, the voters must scan the QR code generated by the system to validate their votes, the system will print the ballot and be signed by the voters. This feature will validate the submitted votes of the voters. Once the printed ballot is signed, the ballot must be submitted to the ballot box.

Voters can easily and conveniently cast their ballots electronically thanks to the e-voting system. [20]. This procedure can be made better with a safe voting system that has cutting-edge features. Blockchain technology has the ability to significantly improve the electronic voting system and is regarded as a disruptive breakthrough. In order to fortify and protect the voting process, the current voting system is putting more emphasis on blockchain technology [21].

Figure 3 shows the form for the official ballot where the voters can cast their votes. This form is filled up by using the select button. The select button displays the names of the candidates for every position. For every selection of the name, the picture of the candidate is displayed on the left side of the selection box. A computer is used to assist student voters in making their selections in a computer-mediated voting system, such as a computerized student voting system. Students find automated student voting systems to be quite acceptable [22].

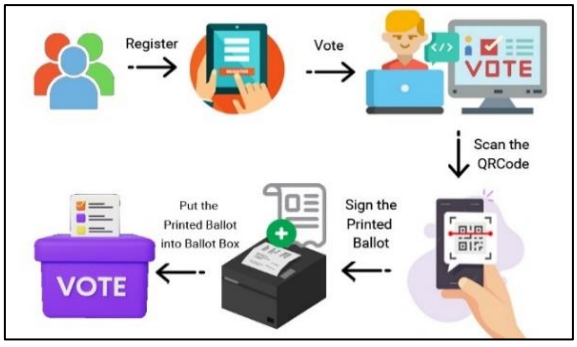

Figure 2. Project QSUeVoto system architecture

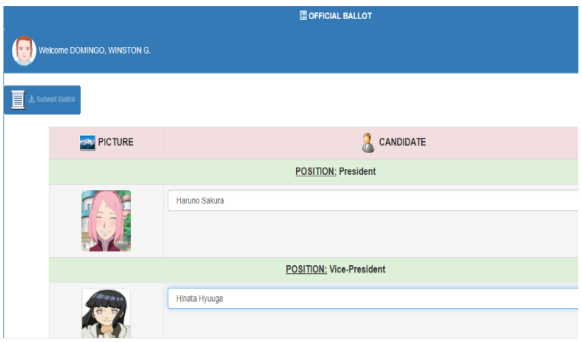

Figure 3. Casting of votes

Figure 4 Present the Printed Ballot. POS printer was used in the printing of ballots. This ballot is used to check and verify the candidates selected in the features of Casting of Votes by the voters. To ensure that the selected candidates were accurate and correctly stored in the database of the system. To gain the trust of the voters/users in using the computerized system.

Most of the developed voting technologies produce audit data that allows voters to confirm that their ballot was counted to increase transparency [23]. Voters can reliably detect errors on their ballot [24]. This maintains confidentiality while ensuring the accuracy of the cast votes during the counting procedure [25].

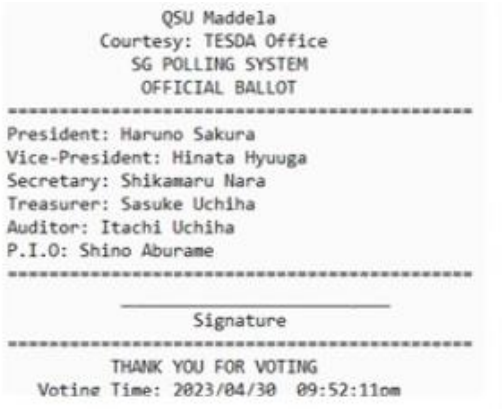

Figure 4. Printed ballot

3.2. Compliance of the developed system using the ISO 25010 Software Quality Standards as assessed by the IT Experts

Table 1 displays the results of the IT experts' assessment of the created application's adherence to ISO 25010 Software Quality Standards. Usability, reliability, security, compatibility, maintainability, appropriateness for the intended use, efficacy of performance, and portability, which are ISO 25010 Software Quality Standards indicators, yielded better results, with a descriptive grade of compliance to a very high extent for each indicator. With a grand mean of 4.63 and a descriptive rating of compliance to a very high extent with shows that the developed systems are approved and compliant as assessed by the IT experts [26].

Assessing and determining the quality-in-use of a computerized system can say much about the software quality, which affects the product and its users directly [27]. The ISO/IEC 25010 assessment tool model considers QAs such as functional appropriateness, reliability, performance effectiveness, usability, security, compatibility, maintainability, and portability [28]. Quality characteristics intend to operationalize and monitor during the operation of the prospective software platform [29]. ISO/IEC 25010 quality models' lifetime service-oriented view, also identifies other significant aspects of the product that concern acquirers of software, and for which quality requirements and quality evaluation are possibly needed [30].

Table 1. Test of compliance of the developed application to ISO 25010 software quality standards

ISO 25010 software quality standards	IT experts	Descriptive rating
1) Functional Suitability	4.73	Compliant to a very high extent
2) Performance Efficiency	4.60	Compliant to a very high extent
3) Compatibility	4.80	Compliant to a very high extent
4) Usability	4.67	Compliant to a very high extent
5) Reliability	4.60	Compliant to a very high extent
6) Security	4.88	Compliant to a very high extent
7) Maintainability	4.40	Compliant to a very high extent
8) Portability	4.33	Compliant to a very high extent
GRAND MEAN	4.63	Compliant to a very high extent

3.3. The produced system's acceptance level was evaluated by end users through the application of ISO 25010 software quality standards

Table 2 displays the results of the End Users' evaluation of the produced application's compliance with ISO 25010 Software Quality Standards (SG Advisor, SAS Director, Students, Board of Canvasser) from Maddela and Diffun Campus. The descriptive rating of "accepted to a very high extent" was given to the ISO 25010 Software Quality Standards indicators of functional sustainability, performance efficiency, compatibility, usability, dependability, security, maintainability, and portability. Therefore, it can be inferred that the developed application was highly approved and accepted by the SG Adviser, SAS Director, Students, and Board of Canvasser from Maddela and Diffun Campus. Thus, it results in the full implementation of the developed system to be used by the Student Services Office during the election. Integrating and following the policies and guidelines of the student's manual in the conduct of elections.

The validity of the software quality assessment was strengthened by assessing its acceptance and adequacy [31]. The evaluation of the quality and efficiency of such software products by solving an

optimization [32]. End users have certified the quality properties, highlighting the implied connection with the perceived quality [33].

Table 2. Test of acceptance of the developed application to ISO 25010 software quality standards

ISO 25010 software quality standards	End users	Descriptive rating
1) Functional Suitability	4.48	Compliant to a very high extent
2) Performance Efficiency	4.45	Compliant to a very high extent
3) Compatibility	4.41	Compliant to a very high extent
4) Usability	4.44	Compliant to a very high extent
5) Reliability	4.44	Compliant to a very high extent
6) Security	4.43	Compliant to a very high extent
7) Maintainability	4.41	Compliant to a very high extent
8) Portability	4.44	Compliant to a very high extent
GRAND MEAN	4.44	Compliant to a very high extent

3.4. Test of the discrepancy between users' and IT experts' opinions regarding the degree of system acceptance and compliance

The Tables 1 and 2 displays the results of a test comparing the opinions of IT specialists and users regarding how compliant and acceptable the system is. Table 3 shows the discrepancy between users' and IT experts' opinions of the system's acceptance and compliance levels. The p-value, which is less than the significance level of.05., only suggests that there are differences in the opinions of IT specialists and users regarding the system. This shows that there are considerable differences between users' and IT specialists' assessments of the system's adoption and compliance levels.

The potential benefits of blockchain technology for promoting global peace through voting system security. Interviews with blockchain specialists and election observers were conducted to determine the advantages and disadvantages of the technology. Our findings highlight the significance of human factors and trust in the voting process [34]. The p-value for IT Experts is .000, meaning there is a very low probability that the observed difference is due to chance, making the result statistically significant.

Table 3. Table for the discrepancy between users' and IT experts' opinions regarding the degree of system acceptance and compliance

Groups compared	Mean	STD. Deviation	STD. error mean	P-Value	Interpretation
IT Experts	4.63	.18807	0.066492	.000*	Significant
Users	4.44	.02252	0.007962		

4. CONCLUSION

Based on the aforementioned results, the researcher came to the conclusion that the proposed method might be implemented to enhance the current manual approach for student government elections. The distributed electronic voting system based on blockchain technology, or Project QSUeVoto, was built. The rules and regulations pertaining to the Quirino State University election were assessed and brought into compliance with voting system standards. The developed system was determined to meet all of the necessary specifications for an electronic voting system, including security, integrity, accuracy, scalability, privacy, transparency, and auditability. The built web apps are almost infinite in situations where security is critical and blockchain technology can be useful. When employing a computerized system like this, students should be trusted. The university can use the Project QSUeVoto: distributed electronic voting system based on blockchain technology to construct a highly maintainable, large-scale, and affordable E-voting system within the customized private blockchain. Putting in place an electronic voting system can assist meet a lot of the standards for electronic voting and pave the way for future generations of reliable electronic voting systems at the university. Thus, it can be deduced that the SG Adviser, SAS Director, students, and Canvasser Board from Maddela and Diffun Campus gave the generated application great approval and acceptance. As a result, the system that was built and will be utilized by the Student Services Office during the election is fully implemented. incorporating and adhering to the student handbook's rules and regulations when conducting elections. A blockchain-based electronic voting system can significantly improve the security, transparency, and efficiency of the student voting process. However, for it to be implemented effectively, trust among students needs to be built, accessibility needs to be ensured, and technological concerns need to be fixed. Strong security measures, user-friendly interfaces, and clear communication of the benefits and features of the system are essential for overcoming potential challenges and maximizing positive results.

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BIOGRAPHIES OF AUTHORS

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