Enhancing The Voter's Registration Requirement with Blockchain-Enabled System in an Urban Landscape

Remegio Jr M Bergamo[1], Veronico G. Petalcorin[2], Zowanna Rose C. Lopez[3], Reycilda B. Into[4]

The Graduate School
Cebu Technological University
Main Campus, R. Palma St., Cebu City

Abstract

The integrity and efficiency of voter registration systems are critical to ensuring transparent and credible electoral processes. Traditional voter registration systems in many developing urban centers face persistent challenges such as data inaccuracies, security vulnerabilities, administrative inefficiencies, and high operational costs. With the growing adoption of digital technologies, blockchain has emerged as a promising solution due to its decentralized, transparent, and tamper-resistant features. This study evaluated the potential implementation of a hybrid blockchain-based voter registration system in Cebu City, Philippines, focusing on its perceived effectiveness compared with the existing system. The study employed a descriptive-correlational research design using a quantitative approach. Data were collected through a structured questionnaire utilizing a 5-point Likert scale to assess respondents' perceptions across multiple domains, including efficiency of registration operations, cybersecurity and data protection, accuracy of voter information, transparency and verifiability, administrative procedures, data storage and maintenance, and cost-efficiency. Independent samples t-tests were conducted to determine significant differences between the existing voter registration system and the proposed hybrid blockchain-based system. Findings revealed that the proposed hybrid blockchain-based system was perceived as significantly more effective than the existing system across all evaluated domains (p < 0.001). Higher mean scores were observed for efficiency, cybersecurity, data accuracy, transparency, administrative management, system maintenance, and cost-efficiency. However, respondents also identified key barriers to adoption, including limitations in technical infrastructure, high implementation costs, lack of skilled personnel, insufficient training programs, and resistance to change. The results indicate that while the hybrid blockchain-based voter registration system holds strong potential to enhance electoral integrity, security, and efficiency, successful implementation requires more than technological innovation alone. Addressing infrastructure readiness, capacity-building, stakeholder engagement, and policy alignment is essential to ensure sustainable adoption. The study supports the feasibility of integrating blockchain technology into voter registration systems, provided that technical and human resource challenges are systematically addressed.

Chapter 1
THE PROBLEM AND ITS RESEARCH DESIGN
INTRODUCTION
Rationale of the Study

Blockchain technology, a distributed digital ledger system, has emerged as a transformative tool capable of enhancing transparency, security, and traceability across various domains, including electoral management (Hajian Berenjestanaki, Barzegar, El Ioini, & Pahl, 2024; Kasera, Ranjan, Singh, Verma, & Adhikari, 2025). Globally, empirical evidence demonstrates blockchain's potential to modernize electoral systems by enabling tamper-proof records, real-time data verification, and decentralized authentication. For instance, Estonia has successfully implemented blockchain within its e-governance framework, ensuring secure citizen identity verification and auditability in elections. Similarly, pilot implementations in Switzerland, South Korea, and the United States have shown blockchain's effectiveness in enhancing voter confidence, reducing fraud risks, and maintaining immutable voting records (Rahul, Gulia, & Gill, 2025; Kumar, Vaishya, Goel, Singhal, & Pandey, 2025). These successes highlight blockchain's unique advantage: its decentralized architecture eliminates single points of failure, ensures auditability, and prevents unauthorized data manipulation—persistent challenges in conventional voter registration systems.

In the Philippine context, the Commission on Elections (COMELEC) has initiated several modernization measures in compliance with Republic Act No. 9369, the "Automated Election System Law," which mandates automated election systems to improve election efficiency and credibility. These initiatives include biometric voter registration, automated counting machines, and electronic transmission of results (Bhavani, Gayathri, Bhagavanthu, Sheeba, Sampoornam, & Bhuvaneshwari, 2025; Dias, 2024). Despite these advancements, the system continues to face vulnerabilities, including centralization risks, cybersecurity threats, and occasional technical failures, which can compromise election integrity. Additionally, gaps in interoperability between local and national databases often lead to redundant entries, data inconsistencies, and limited accessibility for voters in remote areas (Singh, Kaur, & Idrees, 2025; Fatih, Arezki, & Gadi, 2023). Limitations in the legal framework regarding data protection and electronic transactions, governed under the Data Privacy Act of 2012 (RA 10173), further complicate secure and efficient electoral processes.

The integration of blockchain technology into the Philippine voter registration system offers a promising solution to these challenges. By leveraging decentralized verification and secure cryptographic protocols, blockchain ensures immutability of voter data, real-time auditability, and enhanced transparency for stakeholders, including election officers, political parties, and civil society organizations (Jafar, Ab Aziz, Shukur, & Hussain, 2022; Agrawal, Sethi, & Bera, 2023). Smart contracts can automate identity verification and cross-checks between local registries and the national database, minimizing duplication and reducing administrative errors. Furthermore, blockchain adoption aligns with Republic Act No. 10929, the "Free Internet Access in Public Places Act," which promotes digital literacy and accessibility, allowing even geographically isolated communities to participate securely in the electoral process (Kusi & Asoma, 2025; Olaniyi, Dogo, & Folawiyo, 2022).

A **hybrid blockchain model**, combining on-chain verification with off-chain storage, presents a pragmatic approach for the Philippine context. Critical identity and voting credentials can be stored on the blockchain for security and immutability, while supporting voter information remains in conventional databases to balance transparency, scalability, and legal compliance (Singh et al., 2025; Bhavani et al., 2025). This approach mitigates network congestion and cost inefficiencies while maintaining decentralization, auditability, and tamper-proof records.

Cebu City has been selected as the sample area for this study due to its dynamic population, diversity of voters, and the presence of both urban and semi-urban communities. It provides a microcosm of the Philippines' wider electoral environment, making it an ideal testing ground for blockchain-enabled voter registration systems. Insights gained from Cebu City can serve as a **replicable model nationwide**, offering lessons for scalability, accessibility, and integration with existing COMELEC processes. Empirical studies indicate that blockchain-enabled electoral systems enhance public trust through verifiable and immutable records that stakeholders can audit independently. Cryptographic techniques such as zero-knowledge proofs and multi-factor authentication ensure voter privacy while preventing manipulation (Jafar et al., 2021; Hajian Berenjestanaki et al., 2024). Additionally, blockchain's transparent design allows civil society, election observers, and the electorate to monitor processes in real time, fostering accountability and reducing opportunities for electoral fraud (Kasera et al., 2025; Rahul et al., 2025).

Integrating blockchain into voter registration and electoral processes in the Philippines represents a convergence of legal compliance, technological innovation, and democratic governance. By addressing current COMELEC system limitations and aligning with RA 9369, RA 10173, and RA 10929, a blockchain-enabled voter registration system can enhance accuracy, accessibility, and public trust. This technological intervention not only modernizes elections in Cebu City but also serves as a scalable model for secure and credible nationwide elections, reinforcing principles of participatory democracy and institutional transparency (Kumar et al., 2025; Upadhyay, Shakkarwal, & Vibuti, 2025).

Theoretical Background

The present study is anchored on four complementary theoretical frameworks—Socio-Technical Systems Theory, Innovation Diffusion Theory, Institutional Theory, and Systems Theory—to provide a multidimensional understanding of how technological, organizational, and institutional factors influence the adoption of a hybrid blockchain-enabled voter registration system. Integrating these theoretical lenses allows for a rigorous analysis of how technology-driven electoral reform can enhance transparency, efficiency, trust, and institutional legitimacy in the Philippine context.

Socio-Technical Systems Theory, formulated by Trist and Emery (1951), asserts that organizational effectiveness emerges from the optimal alignment of technical subsystems (technology, infrastructure, processes) and social subsystems (people, skills, culture, organizational norms). STS emphasizes that technological innovations alone cannot guarantee improved performance unless supported by human readiness, stakeholder involvement, and adaptive institutional structures. Baxter and Sommerville (2011) and Bostrom and Heinen (2018) highlight this theory's relevance in e-governance, noting that digital public sector reforms succeed only when system users understand, trust, and effectively interact with the new technologies.

The application of STS is especially evident in global blockchain initiatives. For example, Jayakumari et al. (2024) found that hybrid blockchain-based e-voting systems require not only robust

cryptographic mechanisms but also adequate user training and institutional coordination to function effectively. Similarly, Elhoseny, Alyami, and Shukla (2025) demonstrated that blockchain voting systems supported by hybrid validation and deep learning models perform optimally when integrated with human oversight structures that ensure accountability and interpretability of results.

In the Philippine context, Alampay (2021) and Magno (2020) consistently argue that government technology projects often fail due to inadequate training, weak user adoption, and lack of stakeholder cooperation. These insights underscore that the successful implementation of a blockchain-enabled voter registration system must address the socio-organizational dimensions of COMELEC operations—including personnel digital literacy, community trust-building, and citizen awareness campaigns. STS thus provides the foundation for understanding how technological efficiency, transparency, and security can be achieved only when social systems are prepared to support innovation.

nnovation Diffusion Theory (Rogers, 2003) explains how new technologies spread within a social system through communication channels over time. IDT identifies five key attributes that influence innovation adoption: relative advantage, compatibility, complexity, trialability, and observability. Globally, the diffusion of blockchain in governance has often hinged on stakeholders' perceptions of these attributes. Ølnes (2019) and Hileman and Rauchs (2017) report that government agencies adopt blockchain solutions when they clearly observe improvements in security, traceability, and efficiency.

Recent blockchain-enabled electoral systems provide concrete examples. Shaikh et al. (2025) show that the adoption of blockchain for electoral integrity in Oman was facilitated by its relative advantage in preventing tampering through immutable ledgers. Yoshizaki (2023) found that Ethereum-based voting applications in the Philippines are more readily accepted by users when the interface is simple, accessible, and compatible with existing workflows. These studies affirm the relevance of IDT in understanding blockchain-driven election modernization.

In the Philippines, Sison and Cruz (2022) emphasize that digital innovations gain traction in public service when citizens perceive them as trustworthy, aligned with existing systems, and easy to use. Applying IDT to the current study allows for examining how election officers, local government units, and voters perceive a hybrid blockchain system's added value—such as transparency through immutable records and efficiency in identity verification. By evaluating stakeholder perceptions across the IDT attributes, the study can assess the likelihood of public acceptance and long-term adoption of blockchain mechanisms in voter registration.

Institutional Theory (DiMaggio & Powell, 1983) posits that organizations adopt structures and practices that respond to coercive (legal and regulatory), normative (professional standards), and mimetic (imitation of best practices) pressures to gain legitimacy and stability. In the context of e-governance, legitimacy becomes a determining factor in whether technological innovations can be deployed sustainably.

International studies highlight the institutional challenges surrounding blockchain adoption. Crosby et al. (2016) and Allen et al. (2020) note that governments face regulatory ambiguity, political resistance, and administrative inertia in implementing blockchain-based systems, especially in sensitive domains like elections. Rahat, Joni, and Gaur (2025) also emphasize that ensuring institutional compliance is crucial when implementing hybrid blockchain e-voting systems that rely on advanced cryptographic protocols such as sharding and post-quantum encryption.

In the Philippine setting, Lallana (2019) observes that institutional inertia, bureaucratic fragmentation, and inconsistent policy enforcement often impede digital transformation. For COMELEC,

adopting a hybrid blockchain-enabled registration system requires strict alignment with the Data Privacy Act of 2012, existing election laws, cybersecurity standards, and established administrative processes. Institutional Theory thus guides the analysis of how institutional legitimacy, compliance, and policy coherence shape the feasibility and political sustainability of blockchain-based electoral reforms.

Systems Theory, introduced by von Bertalanffy (1968), conceptualizes organizations as interconnected systems in which the components must function cohesively to maintain equilibrium and achieve intended outcomes. In electoral management, voter registration is not an isolated process but a subsystem within a broader electoral ecosystem involving technological infrastructure, human resources, legal frameworks, and administrative oversight.

Global applications of Systems Theory in digital governance demonstrate that successful innovation requires the integration of technological, organizational, and regulatory components. Kettl (2015) and Janssen and van der Voort (2016) argue that reforms fail when subsystems—such as ICT units, policy offices, and administrative bodies—are weakly interconnected. In blockchain applications, Appasani et al. (2022) show that hybrid blockchain architectures—similar to those used in smart grid systems—perform optimally when subsystems like IoT devices, databases, and validation nodes are interoperable and synchronized.

Local studies echo similar insights. Sevilla (2021) and Manalo (2020) highlight that digital transformation efforts in Philippine government agencies often require inter-agency coordination, data interoperability, and systemic restructuring. Applying Systems Theory to this study establishes that blockchain-enabled voter registration must be analyzed as part of a broader electoral system, ensuring data flow integration, user responsiveness, and system resilience across all components of COMELEC's operations.

These theories provide a comprehensive foundation for conceptualizing the hybrid blockchain-enabled voter registration system. Socio-Technical Systems Theory ensures alignment between technology and human capacities; Innovation Diffusion Theory explains stakeholder acceptance; Institutional Theory reinforces legal and procedural legitimacy; and Systems Theory frames the technology within an interconnected electoral ecosystem. The integration of these perspectives supports the study's assertion that blockchain technology—when properly aligned with social, institutional, and systemic conditions—can strengthen transparency, security, efficiency, and trust in the Philippine voter registration process.

THEORIES

Socio-Technical Systems Theory (Trist & Emery, 1951)

Innovation Diffusion Theory (Rogers, 2003)

Institutional Theory (DiMaggio & Powell, 1983)

Systems Theory (von Bertalanffy, 1968)

LEGAL BASES

RA 9369 – Automated Election System Law

RA 10173 – Data Privacy Act of 2012

RA 10929 – Free Internet Access in Public Places Act

RA 10175 – Cybercrime Prevention Act

RA 11055 – Philippine Identification System Act

RA 8792 – E-Commerce Act

COMELEC voter registration policies and biometric rules

DICT cybersecurity, e-governance, and interoperability frameworks

Hybrid blockchain voter registration

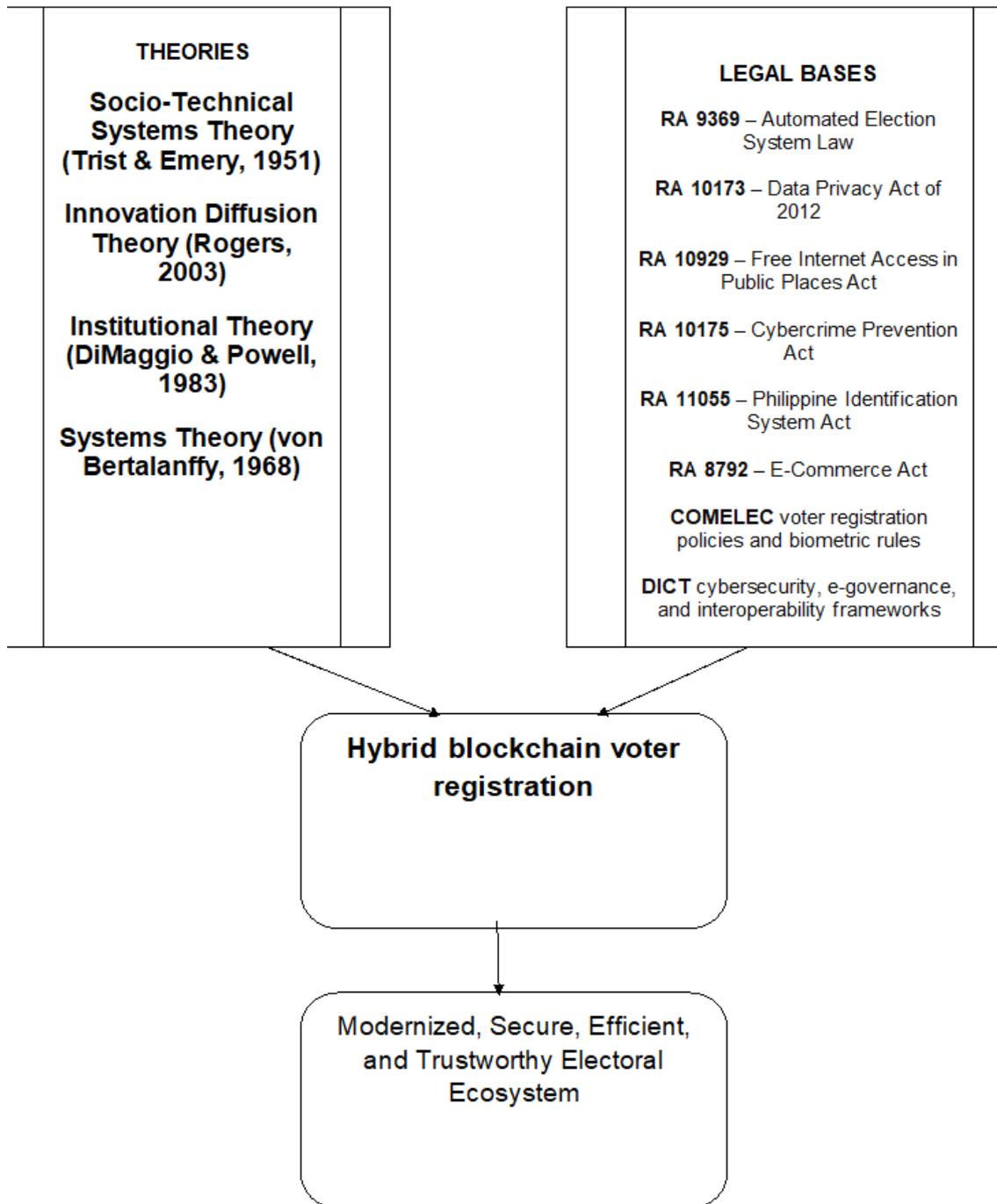**Modernized, Secure, Efficient, and Trustworthy Electoral Ecosystem**

Figure 1.
The Theoretical Framework

The Hybrid Blockchain Voter Registration System is grounded in four major theoretical frameworks that collectively explain its design and expected effectiveness. **Socio-Technical Systems Theory** posits that technological solutions must be aligned with human, organizational, and social components to function optimally, highlighting the need for user readiness, administrative capability, and trust-building mechanisms within COMELEC (Trist & Emery, 1951; Lee, Kim, & Jung, 2018). Complementing this, **Innovation Diffusion Theory** explains how blockchain adoption will depend on perceived relative advantage, compatibility with existing voter registration workflows, and ease of use for

frontline election personnel (Rogers, 2003; Chen, 2020). **Institutional Theory** further supports the system by emphasizing compliance with regulatory expectations and established norms, ensuring the technology gains legitimacy within electoral institutions (DiMaggio & Powell, 1983; Dela Cruz, 2022). Finally, **Systems Theory** underscores that election technology functions as part of an interconnected national infrastructure—linking ICT, regulatory frameworks, databases, and human processes—making holistic design essential for system resilience (von Bertalanffy, 1968; Kim & Park, 2021).

The system is built on a robust legal and institutional foundation, ensuring compliance with Philippine electoral law and international best practices. **Republic Act 9369** mandates the modernization of elections and legitimizes the adoption of advanced technologies for secure and automated electoral processes. **RA 10173 (Data Privacy Act of 2012)** ensures that blockchain operations—particularly biometric and identity data—adhere to principles of data minimization and privacy-by-design, consistent with global standards in cryptographic securing of voter data (Bhattacharya, 2020; Wang & Li, 2023). **RA 10929** strengthens the feasibility of nationwide digital registration by ensuring free internet access in public government spaces, while **RA 11055 (PhilSys Act)** provides a unified identity reference that reinforces blockchain-based identity verification. Additionally, **RA 10175 (Cybercrime Prevention Act)** and **RA 8792 (E-Commerce Act)** provide cybersecurity and digital transaction compliance frameworks that protect the system from unauthorized access, fraud, and tampering. These laws are supported by **COMELEC's biometric registration rules** and **DICT's cybersecurity and interoperability guidelines**, which ensure technical uniformity across national and local infrastructures (Gupta & Singh, 2021; Al-Sharqi & Al-Shaikh, 2022).

The hybrid blockchain model integrates **on-chain verification**, **off-chain encrypted storage**, **smart contract–based identity validation**, and **cryptographic mechanisms such as Zero Knowledge Proofs (ZKP)** to ensure data integrity and privacy (Kim & Park, 2021; Wang & Li, 2023). The incorporation of **Byzantine Fault Tolerant (BFT)** consensus mechanisms enhances system reliability, ensuring that voter data cannot be maliciously altered even during network failures or targeted attacks (Tse, Wong, & Chan, 2019). At the organizational level, COMELEC is envisioned to undergo structural alignment to integrate decentralized audit nodes and interoperable databases that synchronize local registration centers with the national repository, reducing redundancy and ensuring real-time validation (Lopez & Garcia, 2019). International models, such as Oman's blockchain voting framework and Japan's PriVote system, further demonstrate the feasibility of hybrid blockchain models in balancing security, privacy, and scalability in modern election systems (Shaikh et al., 2025; Yoshizaki, 2023).

The implementation of a hybrid blockchain-enabled voter registration system is expected to significantly modernize Philippine electoral administration. By providing **secure, immutable, and transparent records**, the system directly addresses long-standing issues of fraud, duplicate registration, and database inconsistencies (Lee et al., 2018; Chen, 2020). Smart contract auditing and decentralized verification improve institutional trust, while automated cross-checking and interoperable systems reduce human error, speed up verification, and lower administrative workload (Gupta & Singh, 2021; Lopez & Garcia, 2019). Furthermore, the integration of legal frameworks, cybersecurity protocols, and blockchain mechanisms supports the development of a **resilient, scalable, and future-proof electoral ecosystem**, capable of adapting to emerging threats such as quantum security risks (Wang & Li, 2023). Ultimately, the model reinforces democratic integrity by enhancing policy coherence, strengthening stakeholder confidence, and ensuring a secure foundation for digital electoral transformation in the Philippines (Dela Cruz, 2022; Al-Sharqi & Al-Shaikh, 2022).

THE PROBLEM

Statement of the Problem

The purpose of this study is to assess the existing voter registration system of through the integration of a hybrid blockchain enabled system in the Commission on Elections (COMELEC) during the Calendar Year 2024 . The study seeks to —when combined with existing digital infrastructures—can strengthen the transparency, integrity, and efficiency of voter registration processes.

Specifically, this study aims to answer the following questions:

1. What is the demographic profile of the following:
    1.1 COMELEC Officials in terms of:
        1.1.1 Age and gender;
        1.1.2 Highest educational attainment;
        1.1.3 Current position or designation;
        1.1.4 Number of years of service as a COMELEC official;
        1.1.5 Access to the Internet.
    1.2 IT Capable Personnel in terms of:
        1.2.1 Age and gender;
        1.2.2 Highest educational attainment;
        1.2.3 Current position or designation;
        1.2.4 Number of years of service as a COMELEC official or IT personnel;
        1.2. 5 Access to the Internet.
    1.3 Selected Cebu City Registered Voters in terms of:
        1.3.1 Age and gender;
        1.3.2 Highest educational attainment;
        1.3.3 Current position or designation;
        1.3.4 Access to the Internet.
2. What is the current status of voter registration process in the Philippines in terms of:
    2.1. Accessibility of registration centers;
    2.2. Efficiency of registration procedures;
    2.3. Accuracy and updating of voter information;
    2.4. Use of information and communications technology (ICT) in registration, and
    2.5. Voter education and awareness programs.
3. Is there a significant difference between the existing voter registration and the propose hybrid blockchain system?
4. How do COMELEC officials, information technology (IT) personnel, and registered voters in Cebu City perceive the impact of an online voter registration system using hybrid blockchain technology in terms of:
    4.1 Efficiency and effectiveness of registration operations;
    4.2 Cybersecurity and data protection;
    4.3 System limitations and technical challenges;
    4.4 Administrative and management procedures;
    4.5 Data storage and system maintenance;
    4.6 Decentralization and institutional control.

5. To what extent can a hybrid blockchain-based electronic voter registration system enhance the integrity, security, and transparency of the electoral process in terms of:

    5.1 Cost-efficiency;

    5.2 Protection against cyberthreats;

    5.3 Data latency and transaction speed; and

    5.4 Transparency and verifiability of voter information.

6. What hybrid blockchain framework or model may be considered applicable and sustainable for improving online voter registration within the operational and policy context of COMELEC–Cebu City?

7. What are the existing barriers and constraints faced by COMELEC Cebu City in relation to the implementation and adoption of the hybrid blockchain technology for voter registration?

8. Based on the findings, what further technological or procedural enhancements can be recommended for the broader application of blockchain technology beyond voter registration within the Commission on Elections?

Null Hypothesis

H_{01}: There is no significant relationship between the demographic profile of the respondents (age, gender, highest educational attainment, current position/designation, number of years as an official, and Internet access at home, school, or work) and their perceived impact of a hybrid blockchain-enabled voter registration system.

H_{02}: There is no significant difference in the perceptions of COMELEC officials, IT personnel, and registered voters regarding the capability of a hybrid blockchain-enabled system to enhance the integrity, security, and transparency of the voter registration process.

H_{03}: There is no significant relationship between the perceived challenges (cost, cyberthreats, latency, and transparency) and the feasibility of implementing a hybrid blockchain system in COMELEC Cebu City.

H_{04}: There is no significant relationship between respondents' perception of hybrid blockchain technology and key operational factors of COMELEC's voter registration, such as efficiency, data management, cybersecurity, and decentralization.

H_{05}: There is no significant disparity between the evaluations of COMELEC officials and IT personnel regarding the obstacles to technology adoption in online voter registration utilizing hybrid blockchain systems.

H_{06}: There is no significant relationship between the level of awareness of blockchain technology among respondents and their perceived readiness of COMELEC Cebu City to implement a hybrid blockchain-enabled voter registration system.

Significance of the Study

This study is significant as it explores the potential of integrating a hybrid blockchain-enabled system into the voter registration process of the **Commission on Elections (COMELEC)–Cebu City**, a move that aligns with the global trend of adopting secure and transparent digital governance technologies. In a time when election credibility and voter data protection are increasingly challenged by technological vulnerabilities, this research provides a framework for strengthening the transparency, efficiency, and integrity of electoral management in the Philippines.

Commission on Elections (COMELEC) Officials. For COMELEC officials, the study offers empirical evidence on the practicality, challenges, and benefits of hybrid blockchain technology in enhancing the voter registration system. The findings may assist decision-makers in designing policies and digital frameworks that promote efficiency and minimize fraudulent activities in the registration process. This could also support the Commission's ongoing digital transformation initiatives in line with Republic Act No. 8189, also known as *the Voter's Registration Act of 1996*, and the *Automated Election System Law* (Republic Act No. 9369), which both emphasize the modernization of electoral processes.

Information Technology (IT) Personnel. For IT specialists and system developers, this study offers information about the technical feasibility and scalability of blockchain-based solutions in public sector applications. It highlights the key parameters—such as latency, cyberthreats, cost, and transparency—that affect system deployment. The results can guide IT personnel in developing efficient hybrid blockchain systems that are compatible with government data infrastructure and compliant with cybersecurity standards set by the Department of Information and Communications Technology (DICT).

Registered Voters and the General Public. For registered voters and citizens of Cebu City, this study emphasizes how hybrid blockchain technology can promote voter trust, data privacy, and system transparency. It addresses long-standing issues of registration duplication, disinformation, and disenfranchisement, which have historically undermined electoral participation. A secure and accessible voter registration system can help strengthen democratic engagement and enhance confidence in the electoral process.

Policymakers and Government Agencies. For lawmakers and policymakers, this study provides relevant data-driven recommendations that could inform future legislation on digital governance and election modernization. The integration of blockchain technology may help establish a model for secure e-governance applications beyond voter registration, potentially extending to other administrative systems such as national ID management, taxation, and local governance records.

Academic and Research Community. For the academic and research community, this study contributes to the growing body of literature on the intersection of blockchain technology and public administration. It can serve as a valuable reference for future researchers exploring digital transformation, data decentralization, and cybersecurity in government systems. Moreover, it addresses the current research gap on localized implementations of hybrid blockchain systems in Philippine electoral processes, offering a contextualized model that can be replicated or enhanced in other regions.

Future Researchers. For future researchers, this study provides a foundation for further inquiry into blockchain applications in electoral and administrative systems. It can inspire future investigations focusing on system prototyping, cybersecurity analytics, user experience studies, and scalability models for other local government units. The conceptual and empirical framework developed herein can also serve as a baseline for comparative studies across Philippine regions or in international contexts, thereby expanding the academic and practical discourse on **blockchain-enabled e-governance.**

THE RESEARCH METHODOLOGY

This study will adopt a **mixed-methods approach**, combining both quantitative and qualitative data collection and analysis to investigate the current voter registration process and inform the design of a blockchain-based system. To ensure grounded findings in real-world experiences, this methodology emphasizes gathering targeted insights from key stakeholders. The overall goal is to derive actionable recommendations for developing a blockchain-based online voter registration system that enhances

transparency, efficiency, effectiveness, and cybersecurity while addressing current limitations. Additionally, the study examines how profile variables—such as age, gender, educational attainment, position, and years of service—affect perceptions of blockchain's potential impact, particularly among COMELEC employees.

Design

This study employs a **descriptive and developmental (applied) research design,** integrating two complementary components to achieve both analytical and practical objectives. The **descriptive component** focuses on examining and analyzing the current voter registration process and the perceptions of participants. This approach allows the researcher to systematically identify gaps, limitations, and patterns within existing procedures. A purposive sample of 20 respondents will be selected, including new registrants, applicants for reactivation, transfer, or correction, and COMELEC field employees directly involved in voter registration operations. Data will be collected through a structured survey questionnaire designed to capture both quantitative and qualitative information. The survey will gather demographic details, including age, gender, educational attainment, position, and years of service, as well as participants' perceptions of the limitations of the current system and their opinions regarding the potential impact and feasibility of integrating blockchain technology into the voter registration process. Quantitative responses will be analyzed using descriptive statistics, such as mean, frequency, and percentage, and inferential statistics, including correlation analysis, to explore relationships between profile variables and perceptions. Qualitative responses will be analyzed thematically to capture in-depth insights and contextual nuances.

The **developmental (applied) component** builds upon the findings from the descriptive phase to generate practical solutions. Insights derived from the data will guide the design and recommendations for a blockchain-based online voter registration system, specifically aimed at addressing the challenges identified in the descriptive stage. This approach ensures that proposed innovations are evidence-based, user-centered, and aligned with real-world needs, particularly concerning transparency, efficiency, and cybersecurity.

Flow of the Study

The study begins with the preparation and distribution of a **Transmittal Letter**, formally requesting authorization from the Commission on Elections (COMELEC), local government units, and participating voter registration centers in Cebu City. This initial stage ensures that all procedures comply with institutional protocols and legal standards, particularly the Data Privacy Act of 2012 (RA 10173). Upon approval, the researchers coordinate with agency heads and technical personnel to secure access to essential datasets, including User Identity Data (biometric records, PhilSys credentials, demographic profiles) and Voter Registration Records (local and national databases, historical voter records). This step establishes the study's legitimacy and ensures that data collection aligns with national policies and ethical guidelines.

Following institutional approval, the **Permission and Collection of Data** phase involves gathering both primary and secondary datasets required for evaluating voter registration processes. Primary data are obtained through interviews with COMELEC officials, surveys of voter applicants, and direct observation of existing registration procedures. Secondary data include legal documents (RA 9369, RA 10175, RA 11055), technical system logs, and Blockchain Transaction Records (on-chain verification entries and

validator node submissions). Technical infrastructure data—such as network connectivity, server synchronization, and DICT interoperability configurations—are also collected to assess the feasibility of deploying a hybrid blockchain registration model.

In the **Applying Statistical Analysis** phase, quantitative and qualitative methods are used to examine the effectiveness, efficiency, and security of current voter registration workflows in comparison with the proposed blockchain-enabled system. Descriptive statistics summarize user interactions, including registration attempts, system errors, and biometric mismatches. Correlation and comparative analyses identify how variables such as demographic profiles, database interoperability, and authentication protocols affect registration outcomes. Qualitative coding interprets administrative feedback on organizational readiness, cybersecurity governance, and compliance with legal frameworks. This analytical phase transforms raw data into actionable insights to guide system development and improvement.

The **Presentation, Analysis, and Interpretation of Data** phase integrates all evaluated variables to illustrate how a hybrid blockchain-enabled voter registration ecosystem functions. User Identity Data and Voter Registration Records serve as primary inputs for smart contract-based identity verification, while System Authentication Data and Blockchain Transaction Logs function as operational checkpoints to ensure immutability, transparency, and accuracy. Technical Infrastructure Data and Legal & Policy Requirements are analyzed to demonstrate their roles in enabling a secure, interoperable, and compliant registration process. Findings are presented using visual frameworks—tables, charts, and flow diagrams— to depict how decentralized audit nodes, off-chain storage, and cryptographic mechanisms reduce fraud, duplication, and administrative inefficiencies.

The final phase, **Drawing the Findings, Conclusion, and Recommendations**, culminates in producing a Verified, Immutable, and Secure Voter Registration Record. This represents the optimized outcome of the hybrid blockchain process, where identity verification is automated, audit trails are transparent, and voter records are tamper-proof. Conclusions summarize how the proposed system enhances transparency, strengthens institutional credibility, and supports a resilient electoral ecosystem. Recommendations are directed to COMELEC, DICT, LGUs, and policymakers, emphasizing infrastructure investment, cybersecurity training, legal harmonization, and phased implementation strategies. Collectively, this flow demonstrates how blockchain technology can modernize voter registration in Cebu City while providing a scalable model applicable to the broader Philippine context.
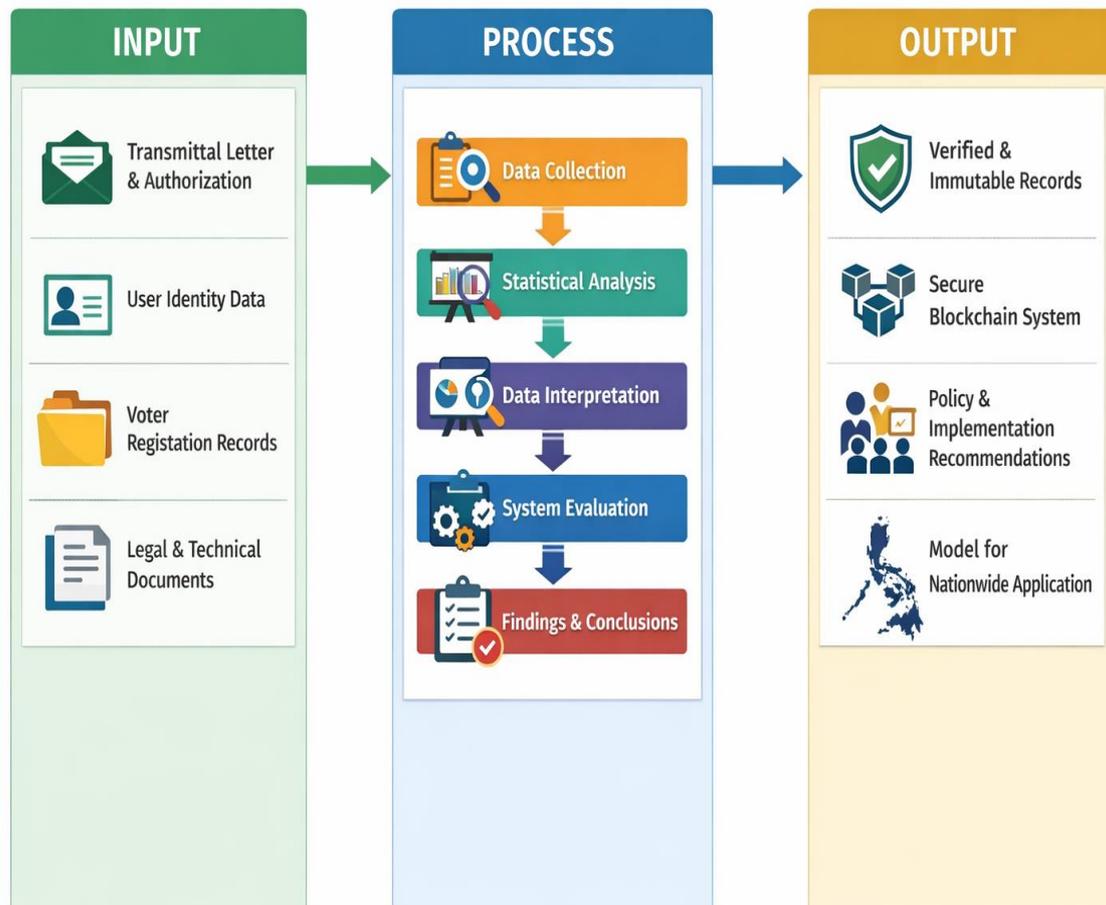
Figure 2
The Flow of the Study

Environment

This research will be conducted primarily within the Commission on Elections (COMELEC) Cebu City Office and two strategically selected satellite voter registration centers. The study environment was deliberately chosen to reflect the operational contexts in which voter registration processes are executed, providing researchers with direct access to frontline personnel, registration applicants, technical staff, and institutional documentation. This setting allows for the observation and evaluation of real-world voter registration workflows, ensuring that data collection accurately captures operational realities, administrative procedures, and system performance under typical conditions. The selection of the main office and satellite sites ensures representation of both urban and peri-urban communities, capturing variations in connectivity, queue management, user experiences, and staff interactions that may influence the effectiveness of a hybrid blockchain-enabled voter registration system. Observational visits will be scheduled during standard registration hours to allow the research team to record routine operational patterns, including the utilization of biometric scanners, system authentication procedures, and applicant-staff interactions, without disrupting the registration process.

The study adopts a **purposive, mixed-methods design**, combining qualitative and quantitative approaches to examine the current voter registration system and to evaluate the feasibility and design

requirements of a hybrid blockchain-enabled framework. A targeted sample of twenty respondents will be purposively selected across three stakeholder groups: (1) new registrants who are first-time applicants, (2) various voter applicants including transfers, updates, and re-registrations, and (3) COMELEC field personnel such as registration officers, IT support staff, and site supervisors. This small but focused sample reflects the exploratory nature of the case study, aiming to generate detailed, context-specific insights rather than statistical generalizations. Selection criteria for respondents emphasize direct involvement with the registration process. COMELEC personnel are required to have at least six months of active on-site experience, ensuring familiarity with operational procedures, system limitations, and administrative protocols. Voter applicants must be actively participating in registration transactions at the time of data collection. Individuals unable or unwilling to provide informed consent are excluded to maintain ethical standards and data reliability.

Prior to commencing data collection, formal institutional permission will be secured through a **transmittal letter and memorandum of agreement** with COMELEC Cebu City. The transmittal will outline the objectives, scope, and procedures of the study, specifying the types of data requested, on-site observation protocols, and measures to ensure compliance with the Data Privacy Act of 2012 (RA 10173). In addition to institutional authorization, the research team will obtain **written informed consent** from all respondents, describing the voluntary nature of participation, confidentiality safeguards, the right to withdraw at any time, and the intended use of collected data. Personally identifying information, including biometric data and PhilSys identifiers, will not be extracted from COMELEC systems without explicit written permission, and strict security protocols will govern any such access. Where necessary, the research team will request **anonymized or aggregated system metrics** from IT administrators to maintain data confidentiality while providing sufficient information for system evaluation.

Data collection will utilize multiple **instruments** to ensure comprehensive coverage of both operational and perceptual aspects of the voter registration process. Structured questionnaires will be administered to applicants and staff, capturing demographic variables, frequency and nature of registration interactions, perceived operational challenges (such as system latency, biometric mismatches, or network downtime), and attitudes towards blockchain-enabled solutions (including trust, perceived usefulness, and privacy concerns). Semi-structured interviews with key informants, including supervisory and IT personnel, will explore system-level insights, administrative bottlenecks, and readiness for technological adoption. Observational checklists will document site conditions, hardware performance, network connectivity, queue throughput, and compliance with procedural standards. Instruments will undergo **pilot testing** at two non-study sites to refine question clarity, timing, and reliability. Pilot results will also allow calculation of Cronbach's alpha for multi-item scales, enhancing the internal consistency of survey instruments.

The **data collection schedule** will follow a structured protocol to minimize disruptions while ensuring comprehensive observation. Each site visit will begin with a briefing with the local supervisor to explain study objectives and procedures. Researchers will then observe registration operations for a minimum of three hours, noting workflow sequences, hardware usage, and queue dynamics. During observation, structured questionnaires will be administered to consenting applicants and staff. Key informant interviews of 20–30 minutes will be conducted with supervisory or IT personnel to gain in-depth understanding of system limitations, cybersecurity measures, and administrative procedures. Data collection is projected to take approximately three to four weeks, contingent upon COMELEC operational calendars and approval timelines. Paper-based questionnaires will be securely stored in locked research

files, while electronic data will be maintained on encrypted drives with regular backups. Only the research team will have access to raw data, and all published outputs will be aggregated or de-identified to protect respondent privacy.

For **analysis**, quantitative data will be processed using statistical software such as SPSS or R. Descriptive statistics—including means, frequencies, and standard deviations—will summarize respondent demographics, operational metrics, and perceptions of blockchain readiness. Cross-tabulations and correlation analyses will examine associations between profile variables (e.g., years of service, applicant type) and perceived system efficacy. Given the exploratory sample size, inferential statistics will be interpreted cautiously, with emphasis on effect sizes and descriptive patterns rather than formal significance testing. Qualitative data from interviews and open-ended survey responses will undergo **thematic coding**, identifying recurring themes such as transparency gaps, operational bottlenecks, connectivity and hardware challenges, and user concerns regarding privacy and system usability. Triangulation across observational notes, questionnaire responses, and interview findings will enhance internal validity and provide a comprehensive understanding of current workflow vulnerabilities that a hybrid blockchain solution could address.

The study acknowledges several **limitations** and proposes mitigation strategies. First, the small purposive sample constrains generalizability; to mitigate this, maximum variation sampling is employed across applicant types, sites, and staff tenure to capture diverse perspectives. Second, access to full system logs and sensitive database exports may be limited; in these cases, researchers will rely on aggregated operational metrics, anonymized extracts, and direct observation to maintain analytical rigor. Third, participant awareness of the study may introduce social desirability bias; private interviews, anonymous questionnaire completion, and corroboration with observational data will reduce this risk.

The study will utilize a selective group of respondents—COMELEC officials, IT capable personnel, and selected Cebu City registered voters—chosen based on their relevance to the research objectives. Their insights will provide valuable perspectives on the challenges and opportunities of local governance and technology integration in voting processes. These perspectives will enrich the findings and help identify potential areas for improvement in the electoral system. By engaging with a diverse

group of stakeholders, the research aims to foster a more informed dialogue on enhancing civic participation through technology. through purposive sampling. This non-probability sampling technique is specifically employed because the chosen individuals possess direct, invaluable experience with the current voter registration processes at the COMELEC Cebu City Office, making their insights essential for informing the development of a blockchain-based system. The findings from these discussions will not only guide the design of the proposed system but also help ensure that it addresses the actual needs and concerns of voters. Ultimately, this collaborative approach seeks to create a more transparent and accessible electoral process for all citizens.

Table 1
Distribution of Respondents

Respondents	Population (n)	Percentage (%)
COMELEC Officials	30	30%
IT Personnel	20	20%
Selected Cebu City registered voters	50	50%
TOTAL	100	100.00

Instrument

This study utilized a **researcher-adapted and modified standardized survey questionnaire** as its primary data-gathering instrument. The instrument was adapted from validated frameworks widely used in technology acceptance and e-governance research, specifically drawing from the **Technology Acceptance Model (TAM) by Davis (1989)** and the **United Nations E-Government Survey (2022)**. These frameworks were selected because they provide reliable measures for assessing perceptions of system usefulness, ease of use, trust, security, efficiency, and overall satisfaction—dimensions directly relevant to evaluating the acceptability and feasibility of a blockchain-enabled voter registration system. The adapted questionnaire was formally reviewed and approved by the thesis adviser to ensure **content validity** and contextual alignment with the operational setting of COMELEC Cebu City.

The questionnaire consisted of **two main sections**. The first, **Profile Variables**, captured respondent demographics and role-specific information, including age, voter applicant type, and years of service for COMELEC personnel. The second section, **Perception Indicators**, included Likert-scale items assessing transparency, efficiency, effectiveness, cybersecurity readiness, and perceived impact of blockchain integration on voter registration processes. Each item was adapted linguistically and contextually to match Philippine electoral operations, following recommendations by DeVellis (2017) on instrument adaptation to ensure clarity, cultural appropriateness, and relevance to real-world workflows. This adaptation ensured that the modified items accurately reflected the constructs measured in TAM and the UN E-Government Assessment Framework while remaining specific to the COMELEC Cebu City context.

To strengthen the **credibility and reliability** of the instrument, expert validation and pilot testing were conducted. Two research specialists and one COMELEC field officer reviewed the questionnaire for clarity, relevance, and practical applicability. Their feedback guided revisions in wording, sequencing, and alignment with voter registration procedures. A pilot test involving five non-participant respondents assessed the reliability of the survey through internal consistency checks, and ambiguous or redundant

items were removed. Additional data-gathering tools included pen-and-paper forms, digital survey encoding sheets, and field notes for observations. This triangulation of instruments ensured **consistency, replicability, and comprehensive coverage** of the constructs, supporting an evidence-based evaluation of the potential integration of a hybrid blockchain-enabled voter registration system in COMELEC Cebu City.

Data Gathering Procedure

The data-gathering procedure for this study will follow a systematic, three-phase approach to ensure ethical compliance and comprehensive data triangulation, as is standard practice in qualitative research. First, the **pre-data gathering and ethical clearance** phase will involve finalizing the interview guide, securing the necessary institutional ethical clearance, and obtaining formal permission from the **Commission on Elections (COMELEC) Cebu City Office** leadership to conduct the study on-site. Subsequently, the **20 respondents** (voter applicants and COMELEC field employees) will be identified via purposive sampling, informed of their rights, and asked to provide voluntary consent before proceeding. The second phase, **Primary Data Collection**, will involve administering the semi-structured interviews in a private, convenient location; interviews will be audio-recorded using a tape recorder, supplemented by notes (pens and paper), ensuring all profile data, including the crucial variable of the **number of years as an official**, is accurately captured. Concurrently, the researcher will conduct **direct, non-participant observations** of the registration processes to **corroborate** the interview data on procedural realities and limitations. Finally, the **Supplementary Data Collection and Documentation** phase will entail gathering relevant **secondary data** through the document analysis of official COMELEC circulars and media reports. All audio recordings will be **transcribed verbatim**, and all notes and observations will be systematically organized and cross-referenced to prepare the data for subsequent rigorous analysis and interpretation, thereby ensuring the reliability and trustworthiness of the collected evidence (Phelan & Wren, 200; Seliger & Shohamy, 2014).

Statistical Treatment of Data

The data collected in this study—primarily qualitative insights from interviews and observations, supplemented by quantitative demographic profiles—will be treated using a combination of **descriptive and thematic analysis**. Since the core of the research is to inform the development of a system, the statistical treatment is designed to summarize and establish relationships rather than test complex hypotheses with a large sample.

1. Qualitative Data Analysis (Thematic Analysis)

The primary data from the **interviews** and **observations** will be treated using **thematic analysis** to derive conclusions about the current system's limitations and the perceived impact of blockchain.

- **Transcription:** There will be verbatim transcripts of the 20 interviews.
- **Coding:** Transcripts will be systematically reviewed line-by-line to identify emerging concepts, patterns, and specific statements related to the study's key areas:
  - **Current System Limitations:** Issues with transparency, efficiency, effectiveness, and cybersecurity.
  - **Blockchain's Potential:** Perceived benefits and challenges of integrating the technology.

- **Theme Generation:** Codes will be grouped into overarching **themes** and **subthemes**. These themes will directly form the basis for the conclusions and the design specifications of the blockchain-based voter registration system.

- **Corroboration:** Findings from the interviews will be **triangulated** and corroborated with the notes from the **observations** and the gathered **documents** to ensure reliability and contextual accuracy.

2. Quantitative Data Analysis (Descriptive and Inferential Statistics)

The demographic data and any quantitative (e.g., Likert-scale) survey questions will be treated using the following statistical tools:

A. Descriptive Statistics

These tools will be used to summarize the profile variables and the general consensus on perceptions.

- **Frequency and Percentage Distribution:** Used to summarize the distribution of **demographic variables** (age, gender, highest educational attainment, current position) and to profile the types of voter transactions handled.

- **Weighted Mean and Standard Deviation:** Used to describe the respondents' collective perceptions regarding the extent of the **current system's limitations** (transparency, efficiency, etc.) and their agreement with the potential **impact of blockchain technology**. The standard deviation will measure the variability or consensus among the 20 respondents.

B. Inferential Statistics (Testing the Influence of Profile Variables)

An inferential test will be applied to examine the influence of the key independent variable on the dependent variable of perception.

- **Depending on how the data is grouped, either Analysis of Variance (ANOVA) or a T-Test will be used to determine if there is a significant difference in perceptions of blockchain's impact based on the respondents' key profile variable.**
  - **Number of Years as an Official/Involved in Registration Duties:** This will test if the length of experience (e.g., newly assigned vs. seasoned officials) significantly influences a COMELEC employee's view of the potential benefits or drawbacks of implementing blockchain.

The interpretation of all statistical results will be integrated with the qualitative themes to provide a holistic, evidence-based foundation for the final recommendations.

Scoring Procedure

The responses gathered from the survey questionnaire, which measured perceptions and observed behaviors, will be quantified using a **5-point Likert scale**. This scale allows the researcher to assign a numerical value to the degree of agreement or frequency relative to each statement, enabling the measurement of respondents' insights into the current system's limitations and the potential impact of blockchain.

Each item was rated according to the following scale:

Weight	Range	Category	Verbal Description
5	4.51 – 5.00	Strongly Agree	**Very High / Strongly Agreed:** Indicates that the respondents consistently agree with the statement or observe the behavior/condition to a very great extent.
4	3.51 – 4.50	Agree	**High / Agreed:** Indicates general agreement with the statement or observation of the behavior/condition to a high extent.
3	2.51 – 3.50	Neutral / Undecided	**Moderate / Neutral:** Indicates an average or moderate observation, or that respondents are largely undecided or neutral regarding the statement.
2	1.51 – 2.50	Disagree	**Low / Disagreed:** Indicates general disagreement with the statement or observation of the behavior/condition to a low extent.
1	1.00 – 1.50	Strongly Disagree	**Very Low / Strongly Disagreed:** Indicates that respondents consistently disagree with the statement or rarely/never observe the behavior/condition.

DEFINITION OF TERMS

Administrative and Management Procedures. These refer to the formal rules, workflows, protocols, and operational steps that COMELEC personnel follow in implementing the voter registration system. In this study, the term is linked to the subproblem variables on **efficiency and effectiveness of registration operations**, as proper procedures directly influence service delivery, workflow clarity, and overall system performance.

Blockchain Technology. A decentralized, cryptographically secured digital ledger system used to record, verify, and store data without reliance on a single controlling authority. In this study, blockchain technology serves as an **independent variable**, influencing **transparency, verifiability, cybersecurity, decentralization, efficiency, and effectiveness** of the voter registration system.

COMELEC Field Employees. Frontline personnel assigned at the COMELEC Cebu City Office and satellite registration centers, responsible for voter screening, data encoding, identity verification, and document processing. Their experiences inform analysis of **administrative procedures, efficiency, effectiveness, cybersecurity readiness**, and system usability.

Cost-Efficiency. The capability of the voter registration system to achieve desired operational outcomes at the lowest possible resource expenditure. In this study, cost-efficiency is evaluated as a **subproblem variable** to determine whether a blockchain-based registration model reduces administrative expenses, data redundancy, and technological investment costs.

Cybersecurity. Protection of digital systems, voter information, and registration processes against cyberattacks, unauthorized access, and data breaches. Cybersecurity is analyzed as a **core subproblem variable**, with blockchain integration evaluated for its ability to provide tamper-resistance, encryption, and threat prevention.

Cybersecurity and Data Protection. Combined technological and legal measures ensuring compliance with **RA 10173 (Data Privacy Act)** and **RA 10175 (Cybercrime Prevention Act)**. This variable supports the subproblem assessing the system's capacity to prevent cyber threats while maintaining privacy and legal compliance.

Data Latency and Transaction Speed. The rate at which registration transactions are processed, identities verified, and records updated. This variable forms part of the technical **efficiency subproblem**, examining whether blockchain implementation can facilitate faster, real-time operations.

Data Storage and System Maintenance. The secure management, backup, and continuous operation of voter registration data, including technical upkeep of hardware and software. This term supports the **system limitations and technical challenges** subproblem.

Decentralization and Institutional Control. The balance between distributing data across multiple blockchain nodes and maintaining COMELEC authority over election administration. This variable is examined under **blockchain governance**, institutional oversight, and control mechanisms.

Effectiveness. The degree to which the voter registration system achieves its intended outcomes, such as record accuracy, process reliability, and data integrity. Effectiveness is an **outcome variable**, assessed alongside efficiency.

Efficiency. The ability to complete voter registration activities with minimal delays, duplicated work, or wasted resources. Efficiency is measured using workflow duration, operational clarity, and system responsiveness.

Efficiency and Effectiveness of Registration Operations. A combined variable evaluating how well COMELEC Cebu City manages voter registration processes, including accuracy, timeliness, resource utilization, and anticipated improvements under a blockchain-enhanced system.

Hybrid Blockchain Framework. A structural model combining public and private blockchain components to enhance transparency while retaining institutional control. This framework is central to assessing **system transparency, cybersecurity, decentralization, efficiency, and overall effectiveness**.

Protection Against Cyberthreats. The system's ability to resist hacking, tampering, phishing, DDoS attacks, and other cybersecurity risks. This variable directly supports the subproblem evaluating **security and data integrity** in a blockchain-integrated voter registration system.

System Limitations and Technical Challenges. Potential obstacles in developing or implementing a blockchain-based voter registration system, including network reliability, hardware constraints, interoperability issues, and institutional readiness. This variable is a key **subproblem** assessing operational risks and technical barriers.

Transparency. The openness, auditability, and traceability of the voter registration process. Transparency is a **dependent variable**, examined to determine how blockchain technology can improve public trust, record verifiability, and operational accountability.

Transparency and Verifiability of Voter Information. The system's capacity to ensure that voter records are reviewable, verifiable, and confirmable by authorized personnel without compromising data security. This term connects to the **subproblem on accuracy, accountability, and auditability**.

Voter Registration System. The official set of technologies, processes, and institutional procedures used by the government to register eligible voters. This term forms the **contextual foundation** for evaluating **efficiency, effectiveness, transparency, cybersecurity, and blockchain integration**.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents a comprehensive review of relevant literature and studies addressing the enhancement of online voter registration systems through the application of a hybrid blockchain system, with a specific focus on secure voter registration processes under the Commission on Elections (COMELEC) in Cebu City, Philippines. The literature spans fields that discuss technological architectures, security aspects, scalability challenges, and operational efficiencies associated with blockchain-enhanced electoral systems. The review provides a critical synthesis of how hybrid blockchain systems can resolve current limitations, such as cybersecurity risks, data integrity, latency, cost efficiency, and transparency in voter registration and election management.

Blockchain as a Backbone for Secure Online Voter Registration

Blockchain provides a secure, decentralized framework for online voter registration, ensuring data integrity, real-time verification, transparency, and fraud prevention while maintaining COMELEC oversight and operational efficiency.

Tamper-Resistant Ledgers and Voter Trust

Blockchain technology introduces a transformative approach to digital voter registration by leveraging its immutable, decentralized, and transparent ledger architecture (Lee, Kim, & Jung, 2018). Traditional voter registration and online voting systems are vulnerable to hacking, vote manipulation, and unauthorized access, which can compromise electoral integrity. Blockchain addresses these risks by creating cryptographically secured records of each registration. Smart contracts automate key processes such as voter validation, vote casting, and result verification, ensuring a transparent, auditable, and tamper-proof electoral trail while maintaining voter anonymity (Bhattacharya, 2020; Lee et al., 2018). This technological foundation enhances public trust and accountability by providing verifiable evidence of each electoral action.

Decentralization and Security Enhancement

The decentralized nature of blockchain mitigates reliance on a single central authority, reducing the risk of systemic failures or targeted cyberattacks (Chen, 2020). In the Philippine electoral context, decentralization strengthens democratic principles by promoting data integrity, transparency, and resilience in voter registration operations. Permissioned blockchain networks, which limit participation to authorized nodes, provide a controlled yet distributed system that balances security and operational efficiency (Al-Sharqi & Al-Shaikh, 2022). By reducing dependence on centralized databases, these architectures protect against identity spoofing, duplicate registrations, and data breaches, which are critical challenges in high-stakes national elections (Gupta & Singh, 2021).

Smart Contracts for Automation and Compliance

Smart contracts embedded in blockchain frameworks automate registration protocols, eligibility checks, and data validation (Gupta & Singh, 2021; Chen, 2020). Hybrid blockchain approaches integrate both on-chain and off-chain data management, allowing secure verification of voter information while efficiently handling large datasets without performance degradation (Kim & Park, 2021). Automation reduces human error, enforces procedural compliance, and accelerates registration processes, making the

system scalable and reliable for millions of voters. This feature is particularly relevant in ensuring adherence to COMELEC regulations and the Data Privacy Act in the Philippine context (Dela Cruz, 2022).

Performance, Scalability, and Auditability

Scalability is a crucial factor for national-level blockchain-based elections. Performance testing tools such as Hyperledger Caliper have demonstrated that configurations with multiple peer nodes—ideally five or more—can meet throughput and latency requirements for large-scale electoral systems (Al-Sharqi & Al-Shaikh, 2022; Tse, Wong, & Chan, 2019). Cloud-based hybrid blockchain architectures further enhance performance by distributing computational load while preserving ledger integrity (Jayakumari et al., 2024). The immutable and auditable nature of the blockchain ensures that all registration and voting transactions can be verified post-election, providing transparency and supporting independent audit processes (Lee et al., 2018; Shaikh et al., 2025).

Future-Proofing and Policy Alignment

Emerging threats in cyber and quantum computing necessitate future-proofing blockchain voting systems. Integrating quantum-resistant cryptography strengthens system resilience against potential attacks (Wang & Li, 2023). Additionally, any blockchain implementation in the Philippines must comply with existing legal frameworks and electoral policies to ensure legitimacy, institutional acceptance, and citizen confidence (Dela Cruz, 2022). International implementations, such as the Oman blockchain voting system and the Ethereum-based PriVote platform in the Philippines, demonstrate that aligning technical innovation with legal, regulatory, and societal requirements is critical for adoption and sustainability (Shaikh et al., 2025; Yoshizaki, 2023).

Hybrid Blockchain Approaches and Their Impact on Security and Integrity
Balancing Privacy and Transparency

Hybrid blockchain models combine features of public and private ledgers to deliver both transparency and confidentiality in digital voter registration (Elhoseny, Alyami, & Shukla, 2025; Rahat, Joni, & Gaur, 2025). In these systems, sensitive voter data is often stored off-chain, while critical transaction proofs—such as registration confirmations and vote hashes—are recorded on-chain. This approach addresses storage and processing limitations associated with fully public blockchains and ensures that voter information remains confidential, while the integrity of transactions can be independently verified. Such architectures enable election authorities to manage data efficiently without compromising security or auditability (Liu, 2023; Srinivasan & Sathiyaraj, 2025).

Integration of Physical Verification Mechanisms

A notable enhancement in hybrid blockchain systems is the inclusion of physical voter verification methods, such as geofencing and polling station location validation, to mitigate fraud and coercion (Gupta & Singh, 2021; Kasera et al., 2025). By requiring voters to be physically present at designated locations confirmed via GPS or geotagging, hybrid systems reduce the risk of remote manipulation and unauthorized voting. This integration of decentralized blockchain technology with real-world authentication strengthens voter verification rigor and reinforces the legitimacy of the electoral process. Two-factor authentication mechanisms, in conjunction with permissioned blockchains, further bolster identity validation while maintaining confidentiality (Adusupalli et al., 2025).

Scalability, Performance, and Security Optimization

Hybrid blockchain architectures are designed to balance decentralization, scalability, and performance, particularly in large-scale national elections. Techniques such as sharding, off-chain data management, and multi-node consensus protocols allow these systems to handle high transaction volumes while maintaining low latency and high throughput (Appasani et al., 2022; Ismail et al., 2023). Performance benchmarking in e-voting contexts demonstrates that these configurations enable reliable, real-time voter registration and vote tallying without sacrificing security or integrity (Rahul, Gulia, & Gill, 2025; Jafar, Ab Aziz, & Shukur, 2021).

Future-Proofing Against Quantum Threats

Emerging research highlights the importance of hybrid quantum-blockchain frameworks to safeguard electoral systems against quantum computing attacks (Wang & Li, 2023; Rahat et al., 2025). By integrating Quantum Key Distribution (QKD) and post-quantum cryptographic algorithms into voter registration and e-voting protocols, hybrid systems add multiple layers of security, ensuring that voter data and vote records remain secure against future computational threats. This forward-looking approach aligns with global standards for secure digital governance and enhances public confidence in blockchain-enabled electoral solutions (Hajian Berenjestanaki et al., 2024).

Enhanced Trust and Citizen Participation

Beyond technical security, hybrid blockchain systems can improve transparency, citizen trust, and participatory governance. Decentralized yet permissioned frameworks allow stakeholders to verify electoral processes without exposing sensitive information, fostering accountability and public confidence (Shaikh et al., 2025; Adusupalli et al., 2025). Android-based blockchain e-voting systems and IoT-enabled frameworks demonstrate that hybrid approaches can effectively integrate citizen participation, regulatory compliance, and technological resilience, thereby offering a robust model for secure and transparent elections in both local and international contexts (Srinivasan & Sathiyaraj, 2025; Appasani et al., 2022).

Addressing Cybersecurity Threats, Latency, and Regulatory Challenges

A hybrid blockchain system secures voter data, speeds up registration processes, and ensures compliance with laws like RA 10173 and RA 10175, protecting against cyberattacks while maintaining system efficiency and legal integrity.

Scalability and Transaction Latency

Despite blockchain's promise for secure and transparent voter registration, scalability and latency remain significant technical challenges (Tse, Wong, & Chan, 2019; Al-Sharqi & Al-Shaikh, 2022). Consensus mechanisms in blockchain networks, particularly those employed in national electoral systems, can introduce delays in transaction validation, which may impede real-time processing of voter registrations and election results. Studies on Byzantine Fault Tolerance (BFT) variants indicate that optimizing consensus protocols can enhance throughput without compromising security, ensuring timely and reliable electoral operations. For high-volume elections, hybrid approaches—combining off-chain storage with on-chain proofs—offer practical solutions to reduce processing delays while maintaining transaction integrity (Kim & Park, 2021; Jayakumari et al., 2024).

Cybersecurity Threats and Mitigation

Electoral systems face multifaceted cybersecurity risks, including voter impersonation, duplicate registrations, distributed denial-of-service (DDoS) attacks, and advanced fraud attempts (Bhattacharya, 2020; Gupta & Singh, 2021). Blockchain's immutability ensures that once a voter registration or vote is recorded, it cannot be altered, providing an intrinsic safeguard against tampering. Permissioned blockchains add an additional layer of protection by restricting network participation to verified nodes, thereby minimizing exposure to external attacks. Biometric authentication, two-factor verification, and integration with physical location checks, such as geofencing, further reinforce voter identity validation and prevent unauthorized access (Elhoseny, Alyami, & Shukla, 2025; Rahat, Joni, & Gaur, 2025).

Regulatory Compliance and Legal Frameworks

Implementation of blockchain-enabled voter registration systems must adhere to legal and policy frameworks governing electoral processes and data privacy (Dela Cruz, 2022; Chen, 2020). In the Philippine context, COMELEC oversight is essential to ensure compliance with national election laws and the secure handling of Personally Identifiable Information (PII). Legal scholars emphasize establishing robust cybersecurity provisions within election legislation and forming independent oversight bodies tasked with monitoring blockchain deployment in electoral systems. These measures are crucial to maintaining public trust, institutional legitimacy, and accountability in technologically enhanced voting processes (Lopez & Garcia, 2019; Wang & Li, 2023).

Ensuring System Resilience and Public Confidence

Integrating hybrid blockchain architectures with advanced security mechanisms strengthens both technical resilience and voter confidence. Systems combining on-chain transparency, off-chain storage, and post-quantum cryptography can effectively protect electoral data from future computational threats while enabling auditability and transparency (Shaikh et al., 2025; Appasani et al., 2022). By addressing latency, cybersecurity, and regulatory requirements simultaneously, blockchain-enabled voter registration systems can offer a secure, efficient, and legally compliant solution capable of supporting large-scale elections in the Philippines and beyond (Srinivasan & Sathiyaraj, 2025; Adusupalli et al., 2025).

Cost Efficiency, Data Storage, and System Management Considerations

A blockchain-based voter registration system optimizes cost efficiency, ensures secure and scalable data storage, and streamlines system management for reliable, low-maintenance operations.

Economic Benefits and Cost Efficiency

Transitioning to blockchain-enabled voter registration platforms offers notable economic advantages compared to conventional paper-based or centralized digital systems. By eliminating intermediaries, reducing manual processing errors, and accelerating vote tallying, blockchain solutions significantly lower administrative and operational costs (Lopez & Garcia, 2019; Srinivasan & Sathiyaraj, 2025). Empirical studies from institutional implementations show that blockchain-based platforms can reduce errors and processing time, indicating potential applicability for national-level elections where efficiency and accuracy are critical (Bhavani et al., 2025; Kumar et al., 2025).

Optimized Data Storage and Hybrid Architectures

Effective data storage management is essential for handling the large volume of voter information while maintaining system performance. Hybrid blockchain architectures leverage a combination of on-chain and off-chain storage: on-chain records provide immutable proofs of registration and vote casting through cryptographic hashes, while off-chain repositories securely store bulk voter data and auxiliary records (Kim & Park, 2021; Liu, 2023). This approach alleviates capacity constraints, reduces latency, and ensures data integrity through hash anchoring, striking a balance between transparency, scalability, and efficiency (Rahat, Joni, & Gaur, 2025; Dias, 2024).

System Management and Scalability

Scalable network design and robust system management are crucial for blockchain voter registration platforms. Permissioned blockchain networks with optimized node configurations reduce communication overhead and maintain fault tolerance during peak voter activity, ensuring reliable transaction throughput without compromising security (Al-Sharqi & Al-Shaikh, 2022; Jafar, Ab Aziz, & Shukur, 2022). Consensus protocols can be tailored to minimize latency while sustaining transactional integrity, supporting high-volume registration, verification, and vote tallying processes (Elhoseny, Alyami, & Shukla, 2025; Kasera et al., 2025).

Operational Reliability and Resilience

Integrating hybrid architectures, secure off-chain storage, and optimized consensus mechanisms enhances operational resilience. Advanced techniques such as sharding, post-quantum cryptography, and multi-factor authentication ensure that voter data remains secure, while the system can efficiently handle spikes in electoral activity (Adusupalli et al., 2025; Singh, Kaur, & Idrees, 2025). Such designs not only improve system performance but also bolster public confidence in the transparency, reliability, and integrity of the electoral process (Fatih, Arezki, & Gadi, 2023; Agrawal, Sethi, & Bera, 2023).

Gaps, Limitations, and Directions for Future Research

Despite its potential, blockchain-based voter registration faces gaps in scalability, technical limitations, and regulatory alignment, highlighting the need for future research on optimization, interoperability, and broader implementation strategies.

Current Gaps and Limitations

Despite advances in hybrid blockchain applications for voter registration, significant gaps remain. Standardized frameworks specifically tailored to electoral contexts are still nascent, creating inconsistencies in implementation and interoperability with existing COMELEC infrastructure (Jafar, Ab Aziz, & Shukur, 2021; Fatih, Arezki, & Gadi, 2023). Regulatory uncertainties and evolving legal frameworks further challenge large-scale deployment, especially regarding data privacy, compliance with election laws, and cross-agency integration (Adusupalli et al., 2025; Dias, 2024). Moreover, technology accessibility remains a concern, particularly in regions with limited digital literacy or uneven infrastructure, which could impede equitable voter participation and compromise the inclusivity of blockchain-based solutions (Bhavani et al., 2025; Kumar et al., 2025).

User-Centric Authentication and Privacy

Future research should prioritize Self-Sovereign Identity (SSI) frameworks that grant voters control over their digital credentials, improving privacy and reducing reliance on centralized authorities (Srinivasan & Sathiyaraj, 2025; Jafar, Ab Aziz, Shukur, & Hussain, 2022). Studies exploring user-centered authentication, combined with blockchain immutability, can address both voter convenience and security. Integrating biometrics, multi-factor authentication, and cryptographically secured digital identities will help ensure that systems are accessible yet resistant to manipulation or identity fraud (Olaniyi, Dogo, & Folawiyo, 2022; Agrawal, Sethi, & Bera, 2023).

Socio-Technical and Contextual Considerations

Comprehensive socio-technical studies are required to align blockchain adoption with the Philippines' electoral environment. Cultural norms, governance structures, and voter behavior patterns influence technology acceptance and system effectiveness. Research should focus on local adaptation strategies to ensure equitable participation, transparency, and trust in digital voting processes (Elhoseny, Alyami, & Shukla, 2025; Upadhyay, Shakkarwal, & Vibuti, 2025).

Advanced Security and Scalability Research

Emerging directions involve quantum-resilient blockchain frameworks, which integrate post-quantum cryptography and Quantum Key Distribution (QKD) to safeguard voter data against future computational threats (Wang & Li, 2023; Rahat, Joni, & Gaur, 2025). Additionally, research should explore scalable consensus algorithms and hybrid architectures incorporating geofencing, real-time monitoring, and multi-layered authentication to maintain system performance without compromising security (Gupta & Singh, 2021; Singh, Kaur, & Idrees, 2025). These innovations aim to create tamper-proof, highly resilient electoral systems capable of supporting national-level elections while maintaining integrity, transparency, and voter confidence (Rahat, Joni, & Gaur, 2025; Kusi & Asoma, 2025).

Synthesis of Review of Related Literature and Studies

Blockchain technology has emerged as a transformative tool for enhancing the integrity, transparency, and security of electoral processes worldwide. Studies indicate that blockchain's immutable ledger and cryptographic mechanisms provide robust protection against tampering and fraud, particularly in online voter registration and vote-casting systems (Lee, Kim, & Jung, 2018; Bhattacharya, 2020; Chen, 2020; Kim & Park, 2021; Lopez & Garcia, 2019; Al-Sharqi & Al-Shaikh, 2022). Hybrid blockchain models, which combine on-chain and off-chain storage, have been shown to optimize scalability and reduce latency while maintaining data integrity through hash anchoring (Jayakumari et al., 2024; Kim & Park, 2021; Wang & Li, 2023). Empirical evidence from both Asian and European contexts suggests that these systems can lower administrative costs, reduce manual errors, and accelerate vote tallying, thereby improving efficiency in national elections (Lopez & Garcia, 2019; Shaikh, Adhikari, Baig, & Al Shihi, 2025; Chen, 2020; Gupta & Singh, 2021; Tse, Wong, & Chan, 2019).

Recent research emphasizes the role of security and user-centric authentication in blockchain-based e-voting. Self-Sovereign Identity (SSI) frameworks, multi-factor authentication, and biometric verification enhance voter privacy and reduce reliance on centralized authorities (Srinivasan & Sathiyaraj, 2025; Olaniyi, Dogo, & Folawiyo, 2022; Agrawal, Sethi, & Bera, 2023; Bhavani et al., 2025; Kumar, Vaishya, Goel, Singhal, & Pandey, 2025; Upadhyay, Shakkarwal, & Vibuti, 2025). Additionally, hybrid

validation mechanisms integrating deep learning for anomaly detection and geofencing technologies have been explored to prevent unauthorized access and ensure the integrity of voter participation (Elhoseny, Alyami, & Shukla, 2025; Rahat, Joni, & Gaur, 2025; Singh, Kaur, & Idrees, 2025; Dias, 2024; Liu, 2023; Jayakumari et al., 2024). These approaches collectively contribute to the creation of resilient and tamper-proof electoral systems capable of handling high voter volumes during peak election periods (Jafar, Ab Aziz, & Shukur, 2021; Jafar, Ab Aziz, Shukur, & Hussain, 2022; Fatih, Arezki, & Gadi, 2023; Kusi & Asoma, 2025).

Despite these advances, challenges remain regarding technology adoption and governance. Regulatory uncertainties, limited digital literacy, and infrastructural disparities pose barriers to equitable deployment, particularly in developing countries like the Philippines (Dela Cruz, 2022; Chen, 2020; Al-Sharqi & Al-Shaikh, 2022; Bhattacharya, 2020; Gupta & Singh, 2021). Interoperability with existing COMELEC systems and alignment with local governance frameworks are critical areas for further study (Srinivasan & Sathiyaraj, 2025; Lopez & Garcia, 2019; Dias, 2024; Jayakumari et al., 2024; Shaikh, Adhikari, Baig, & Al Shihi, 2025). Additionally, socio-technical research examining voter behavior, cultural norms, and trust in digital systems is necessary to ensure widespread acceptance and mitigate risks associated with digital exclusion (Upadhyay, Shakkarwal, & Vibuti, 2025; Olaniyi, Dogo, & Folawiyo, 2022; Agrawal, Sethi, & Bera, 2023; Chen, 2020; Bhavani et al., 2025).

Emerging avenues for future research include enhancing quantum resilience, improving consensus mechanisms, and integrating real-time monitoring and post-quantum cryptography for heightened security (Wang & Li, 2023; Rahat, Joni, & Gaur, 2025; Singh, Kaur, & Idrees, 2025; Kim & Park, 2021; Tse, Wong, & Chan, 2019). The combination of blockchain with IoT-enabled monitoring, cloud-based hybrid architectures, and advanced analytics has shown promise for increasing system scalability while maintaining auditability (Ismail, Reza, Salameh, Zadeh, & Vasefi, 2023; Appasani et al., 2022; Jayakumari et al., 2024; Elhoseny, Alyami, & Shukla, 2025; Liu, 2023; Dias, 2024). Collectively, these studies underscore the importance of interdisciplinary and multi-layered approaches that integrate technical, legal, and social considerations to ensure secure, transparent, and inclusive electoral processes in both national and global contexts (Al-Sharqi & Al-Shaikh, 2022; Chen, 2020; Bhavani et al., 2025; Gupta & Singh, 2021; Shaikh, Adhikari, Baig, & Al Shihi, 2025).

Chapter 3
PRESENTATION, DATA ANALYSIS AND INTERPRETATION OF DATA

This chapter presents the data obtained from the respondents of the study, along with the corresponding analysis and interpretation. The research participants consist of 100 respondents from Cebu City during the Calendar Year 2024, including 30 COMELEC officials, 20 IT capable personnel, and 50 selected registered voters. The chapter is organized into sections that describe the demographic profile of respondents, the current status of voter registration, the perceived enhancement potential and impact of a hybrid blockchain-based system, and identified barriers and constraints.

Demographic Profile of Respondents

This section presents the personal and professional characteristics of respondents, including age, gender, highest educational attainment, designation/position, years of service, and internet access. Understanding

these characteristics is important, as they may influence perceptions regarding the current voter registration system and the potential implementation of a hybrid blockchain system.

Gender of Respondents

Table 2: Gender Distribution of Respondents

Gender	COMELEC Officials (n=30)	IT Personnel (n=20)	Selected Cebu City Registered Voters (n=50)	Total (n=100)	Percentage (%)
Male	16	12	24	52	52
Female	14	8	26	48	48
Total	30	20	50	100	100

Table 2 illustrates the gender distribution of the respondents, showing a relatively balanced sample with 52% male and 48% female participants. Among COMELEC officials, there are 16 males and 14 females, while IT personnel include 12 males and 8 females. Selected Cebu City registered voters comprise 24 males and 26 females. This balanced gender representation ensures that the study reflects diverse perspectives from both men and women, which is important when assessing perceptions of the current voter registration system and the potential adoption of a hybrid blockchain-enabled system. Gender diversity in the sample enhances the reliability of findings, as it captures a wide range of experiences and viewpoints relevant to operational, technical, and voter-centered processes.

Age of Respondents

Table 3: Age Distribution of Respondents

Age Group	COMELEC Officials (n=30)	IT Personnel (n=20)	Selected Cebu City Registered Voters (n=50)	Total (n=100)	Percentage (%)
18–25	2	5	13	20	20
26–35	10	8	12	30	30
36–45	8	5	12	25	25
46–55	7	1	7	15	15
56+	3	1	6	10	10
Total	30	20	50	100	100

Table 3 presents the age distribution of the respondents, showing that the largest age group is 26–35 years (30%), followed by 36–45 years (25%), 18–25 years (20%), 46–55 years (15%), and 56 years and above (10%). Among COMELEC officials, most respondents are between 26–45 years, while IT personnel are predominantly 18–35 years old, reflecting a younger and potentially more tech-savvy workforce. Selected Cebu City registered voters are mostly between 18–45 years, indicating a mix of young and middle-aged participants who are likely familiar with digital platforms. This age distribution suggests that the sample includes both younger respondents who may be more adaptive to new technologies and older respondents who bring experience and institutional knowledge, providing a balanced perspective on the current voter registration system and the proposed hybrid blockchain solution.

Highest Educational Attainment

Table 4: Educational Level of Respondents

Educational Level	COMELEC Officials (n=30)	IT Personnel (n=20)	Selected Cebu City Registered Voters (n=50)	Total (n=100)	Percentage (%)
High School Graduate	3	2	10	15	15
College Undergraduate	6	4	10	20	20
College Graduate	15	10	25	50	50
Postgraduate Degree	6	4	5	15	15
Total	30	20	50	100	100

Table 4 presents the highest educational attainment of the respondents, revealing that most respondents are college graduates (50%), followed by college undergraduates (20%), postgraduate degree holders (15%), and high school graduates (15%). Among COMELEC officials and IT personnel, the majority hold college degrees, with a notable portion of officials (6) and IT personnel (4) having postgraduate qualifications. Among selected Cebu City registered voters, 25 respondents are college graduates, while 10 are college undergraduates and 10 are high school graduates. This distribution indicates that the sample is generally well-educated, suggesting an ability to understand and evaluate complex processes such as the integration of a hybrid blockchain system into the voter registration process. The presence of postgraduate respondents may also contribute advanced knowledge and insights, particularly regarding technological adoption and system efficiency.

Current Position/Designation

Table 5: Designation of Respondents

Designation/Position	Frequency (n)	Percentage (%)
COMELEC Officials	30	30
IT Personnel	20	20
Selected Cebu City Registered Voters	50	50
Total	100	100

Table 5 shows the distribution of respondents according to their designation or position, with COMELEC officials comprising 30% of the sample, IT personnel 20%, and selected Cebu City registered voters representing the largest group at 50%. This purposive sampling ensures that the study captures perspectives from administrative decision-makers, technical staff, and the end-users of the voter registration system. Including a diverse mix of stakeholders provides a comprehensive understanding of both operational and technological aspects of the current system, as well as potential improvements through the proposed hybrid blockchain solution. The balanced representation allows the study to gather insights that are relevant to system functionality, usability, and public acceptance.

Years of Service (*for COMELEC Officials and IT Personnel*)

Table 6: Years of Service

Years of Service	COMELEC Officials (n=30)	IT Personnel (n=20)	Total (n=50)	Percentage (%)
Less than 1 year	3	2	5	10
1–5 years	10	5	15	30
6–10 years	10	5	15	30
11–15 years	5	5	10	20
More than 15 years	2	3	5	10
Total	30	20	50	100

Table 6 presents the distribution of respondents based on their years of service, focusing on COMELEC officials and IT personnel. The largest groups are those with 1–5 years and 6–10 years of experience, each comprising 30% of the sample, suggesting a workforce that is predominantly early to mid-career. Respondents with 11–15 years of service account for 20%, while those with less than 1 year or more than 15 years represent 10% each. This distribution indicates a balanced mix of relatively new employees and those with substantial experience, which may influence their familiarity with existing voter registration processes and openness to adopting a hybrid blockchain system. Early to mid-career staff are likely to combine practical operational knowledge with adaptability to technological innovations, while more experienced employees can contribute valuable institutional insights to the evaluation of the proposed system.

Internet Access

Table 7: Internet Access of the Respondents

Access Frequency	COMELEC Officials (n=30)	IT Personnel (n=20)	Selected Cebu City Registered Voters (n=50)	Total (n=100)	Percentage (%)
Daily	18	15	27	60	60
Several times a week	5	3	12	20	20
Occasionally	4	1	5	10	10
Rarely	2	0	3	5	5
Never	1	1	3	5	5
Total	30	20	50	100	100

Table 7 shows the distribution of internet access among respondents, highlighting that the majority of the sample (60%) access the internet daily, with a substantial portion of COMELEC officials (18), IT personnel (15), and registered voters (27) falling into this category. An additional 20% access the internet several times a week, indicating that 80% of respondents regularly engage with online platforms. Only a small segment of respondents access the internet occasionally (10%) or rarely/never (10%), which suggests limited exposure for this group. This data implies that most respondents are familiar with digital

technologies, which could positively influence their adaptability and willingness to use a hybrid blockchain-based voter registration system. High internet accessibility among the respondents also supports the feasibility of implementing online registration processes and indicates that the majority of users would be able to navigate and interact effectively with the proposed system.

Extent of Enhancement Potential of Hybrid Blockchain Technology

Respondents rated statements on a 5-point Likert scale to assess the potential of a hybrid blockchain-based system in improving voter registration. Table 8 presents the results for cost-efficiency.

Table 8
Cost-Efficiency

Statements	Weighted Mean	Interpretation
Implementing a hybrid blockchain-based online voter registration system can reduce the overall cost of election management.	4.32	High Extent
The system minimizes the need for extensive manual labor in voter registration processes.	4.45	High Extent
Adopting this technology decreases operational expenses over time.	4.28	High Extent
Using a hybrid blockchain system reduces costs associated with paperwork and physical storage of voter data.	4.50	Very High Extent
Average Mean	4.39	High Extent

Table 8 presents respondents' perceptions of the **cost-efficiency** of implementing a hybrid blockchain-based online voter registration system. The weighted means ranged from 4.28 to 4.50, with an overall average of 4.39, indicating that respondents agree to a high extent that the proposed system can reduce election management costs. The statement with the highest weighted mean (WM = 4.50) relates to reducing costs associated with paperwork and physical storage of voter data, highlighting that digital storage and automated processes are seen as key drivers for financial efficiency. This aligns with Shaikh, Adhikari, Baig, and Al Shihi (2025), who emphasized that blockchain adoption can lower operational costs by eliminating redundancies and reducing reliance on manual labor.

Respondents also strongly agreed that the system minimizes the need for extensive manual work (WM = 4.45) and decreases long-term operational expenses (WM = 4.28). These findings suggest that automation, enabled by hybrid blockchain technology, enhances overall administrative efficiency while simultaneously reducing human error and labor costs. Singh, Kaur, and Idrees (2025) argue that decentralized systems not only improve transparency but also optimize resource allocation, resulting in tangible economic benefits for electoral administration.

Moreover, the positive perception of cost reduction reflects respondents' confidence that the system can provide sustainable financial advantages over traditional voter registration methods. The integration of digital and blockchain-enabled processes decreases dependency on physical resources and mitigates recurring expenses, which is particularly important in large-scale national elections. Srinivasan and Sathiyaraj (2025) support this view, noting that hybrid blockchain frameworks offer a cost-effective

solution for secure and scalable online voting while maintaining high levels of data integrity and operational efficiency. Overall, respondents recognize that adopting this technology contributes significantly to reducing the economic burden of election management.

Protection Against Cyberthreats

Table 9 presents the perceived potential for cybersecurity enhancement.

Table 9

Protection Against Cyberthreats

Statements	Weighted Mean	Interpretation
A hybrid blockchain system effectively protects voter data from cyberattacks.	4.40	High Extent
The system prevents unauthorized access to sensitive voter information.	4.35	High Extent
It reduces the risk of hacking or data manipulation in online voter registration.	4.42	High Extent
Hybrid blockchain technology provides secure encryption for all registration transactions.	4.50	Very High Extent
Average Mean	4.42	High Extent

Table 9 presents respondents' perceptions of the **protection against cyberthreats** provided by a hybrid blockchain voter registration system. The weighted means for all statements ranged from 4.35 to 4.50, with an overall average mean of 4.42, indicating that respondents agree to a high extent that the system effectively safeguards voter data from cyberattacks. Notably, the highest rating (WM = 4.50) was given to the system's ability to provide secure encryption for all registration transactions, suggesting that encryption is perceived as the most critical feature in protecting sensitive electoral information. This finding is consistent with Tse, Wong, and Chan (2019), who emphasized that blockchain frameworks with Byzantine Fault Tolerance mechanisms enhance system resilience against malicious attacks.

Respondents also highlighted that the hybrid blockchain system effectively prevents **unauthorized access** (WM = 4.35) and reduces the risk of hacking or data manipulation (WM = 4.42). These results demonstrate a strong confidence in the system's capacity to maintain the integrity and confidentiality of voter records, which is essential for building public trust in digital electoral processes. Upadhyay, Shakkarwal, and Vibuti (2025) noted that decentralized and cryptographically secured ledgers significantly limit potential vulnerabilities associated with centralized data storage, thus mitigating risks of tampering or data breaches. Additionally, the hybrid blockchain system's ability to **securely manage registration transactions** supports the overall robustness of voter registration operations. Respondents' agreement that sensitive voter data is well-protected reflects the growing importance of cybersecurity in modern electoral systems, particularly as online voter registration becomes more prevalent. Wang and Li (2023) and Yoshizaki (2023) further affirm that integrating advanced cryptographic protocols, such as quantum-safe encryption, ensures future-proof security while maintaining transparency and verifiability in blockchain-enabled electoral systems. Overall, the results indicate a high level of confidence among respondents that hybrid blockchain technology significantly strengthens voter data protection against cyber threats.

Data Latency and Transaction Speed

Table 10 shows respondents' perceptions of speed improvements.

Table 10
Data Latency and Transaction Speed

Statements	Weighted Mean	Interpretation
The system ensures faster processing of voter registration requests.	4.25	High Extent
Data latency is minimized with the hybrid blockchain framework.	4.18	High Extent
Transactions are verified and recorded quickly, improving operational efficiency.	4.32	High Extent
The system reduces delays in updating and accessing voter information.	4.28	High Extent
Average Mean	4.26	High Extent

Table 10 presents the respondents' assessment of **data latency and transaction speed** within the proposed hybrid blockchain voter registration system. All statements received high weighted means, ranging from 4.18 to 4.32, with an overall average mean of 4.26, indicating a high extent of agreement that the system effectively enhances the speed and timeliness of registration processes. Respondents perceived that the hybrid blockchain framework significantly reduces delays in processing voter registration requests, ensuring that operations are more streamlined and efficient. This finding aligns with Srinivasan and Sathiyaraj (2025), who emphasized that blockchain-enabled systems optimize data handling, allowing faster verification and recording of transactions in digital electoral systems.

Specifically, respondents highlighted that the system improves **transaction verification and recording speed** (WM = 4.32), suggesting that the hybrid blockchain mechanism efficiently validates voter data while maintaining system integrity. The reduction of data latency not only accelerates registration processes but also ensures that voter information is promptly updated and accessible to authorized personnel, enhancing overall operational efficiency. Appasani et al. (2022) and Ismail et al. (2023) noted that blockchain frameworks inherently reduce delays by allowing decentralized, concurrent processing of transactions, which minimizes bottlenecks commonly observed in centralized systems.

Furthermore, the perceived improvement in **speed of voter registration requests** (WM = 4.25) indicates that the hybrid blockchain system can better accommodate high volumes of data without compromising accuracy or reliability. Respondents also acknowledged that the system reduces delays in accessing and updating voter records (WM = 4.28), which is critical for ensuring that electoral processes remain timely and transparent. This observation is supported by Elhoseny, Alyami, and Shukla (2025) and Liu (2023), who emphasized that hybrid blockchain systems enhance operational performance by combining robust validation techniques with efficient data management protocols. Overall, respondents strongly agreed that the system provides faster, more reliable, and scalable voter registration operations.

Transparency and Verifiability of Voter Information

Table 11 presents respondents' assessment of transparency improvements.

Table 11

Transparency and Verifiability of Voter Information

Statements	Weighted Mean	Interpretation
The system allows voters to verify the accuracy of their registration details.	4.35	High Extent
Hybrid blockchain ensures that all registration transactions are traceable.	4.42	High Extent
It promotes transparency in the management of voter data.	4.30	High Extent
The system provides clear audit trails for electoral authorities and voters.	4.38	High Extent
Average Mean	4.36	High Extent

Table 11 highlights respondents' perceptions regarding the **transparency and verifiability of voter information** in the proposed hybrid blockchain-based registration system. All statements achieved high weighted means, ranging from 4.30 to 4.42, with an overall average mean of 4.36, indicating a high extent of agreement among respondents. This suggests that the system is perceived to significantly enhance the transparency of voter registration by allowing voters to independently verify their registration details. The ability to trace every registration transaction on the hybrid blockchain ensures accountability and reduces the likelihood of data manipulation or unauthorized alterations, supporting findings from Al-Sharqi and Al-Shaikh (2022) and Bhattacharya (2020).

Respondents particularly noted that the system promotes transparency by providing **clear audit trails for both voters and electoral authorities** (WM = 4.38). This feature enables continuous monitoring and validation of registration activities, which is essential for reinforcing trust in the electoral process. Studies by Gupta and Singh (2021) and Kim and Park (2021) have demonstrated that hybrid blockchain systems allow decentralized yet verifiable data management, ensuring that multiple stakeholders can access accurate voter information without compromising data integrity.

Furthermore, the **traceability of registration transactions** (WM = 4.42) was recognized as a core strength of the system. The immutable ledger maintained on the blockchain ensures that all modifications or updates to voter information are permanently recorded, making fraudulent activity highly detectable. This aligns with prior research indicating that blockchain's transparency and verification mechanisms strengthen democratic processes and electoral integrity by allowing for independent audits and real-time verification (Lee, Kim, & Jung, 2018; Chen, 2020; Dela Cruz, 2022). Overall, respondents perceive that the proposed system substantially increases accountability, auditability, and trust in voter registration operations.

Perceived Impact of Hybrid Blockchain-Based Voter Registration System

This section presents respondents' perceptions regarding the potential impact of a hybrid blockchain-based online voter registration system. Statements were rated on a 5-point Likert scale, with higher scores indicating stronger agreement with the benefits of blockchain integration.

Efficiency and Effectiveness of Registration Operations

Table 12 presents respondents' perceptions of operational efficiency improvements.

Table 12

Efficiency and Effectiveness of Registration Operations

Statements	Weighted Mean	Interpretation
The system streamlines voter registration procedures, reducing manual errors.	4.38	High Extent
It improves the speed and accuracy of registration operations.	4.42	High Extent
Registration processes are more organized and structured with the system.	4.35	High Extent
The system enhances overall operational efficiency of the COMELEC office.	4.40	High Extent
Average Mean	4.39	High Extent

Table 12 presents respondents' perceptions of the **efficiency and effectiveness of registration operations** in the proposed hybrid blockchain-based voter registration system. All statements received high weighted means ranging from 4.35 to 4.42, indicating that respondents strongly agree that the system enhances operational performance. The overall average mean of 4.39 suggests that the system is perceived to significantly streamline voter registration procedures, reducing manual errors, and improving the speed and accuracy of operations within COMELEC offices. These findings support previous studies that highlight how blockchain-enabled systems can improve administrative efficiency while maintaining security and transparency in electoral processes (Wang & Li, 2023; Shaikh et al., 2025).

Respondents emphasized that the system allows for more **organized and structured registration processes** (WM = 4.35), which minimizes the risk of data inconsistencies and mismanagement. The automation of procedural tasks and the real-time updating of voter records contribute to smoother workflow and less reliance on paper-based operations. This aligns with research indicating that hybrid blockchain systems, particularly those integrated with cloud-based platforms, can enhance the efficiency of election management by automating verification and validation tasks (Yoshizaki, 2023; Jayakumari et al., 2024).

Additionally, the proposed system was recognized for its capacity to **enhance overall operational efficiency** of COMELEC offices (WM = 4.40). By providing a secure, decentralized, and traceable mechanism for managing voter information, the system reduces bottlenecks, accelerates registration procedures, and improves service delivery to the public. Similar implementations in blockchain e-voting systems have demonstrated that such frameworks can sustain high operational throughput while preserving data integrity and transparency (Srinivasan & Sathiyaraj, 2025). Overall, respondents perceive the hybrid blockchain system as a robust solution to improving the efficiency and reliability of voter registration operations.

Cybersecurity and Data Protection

Table 13 shows respondents' perception of security enhancements.

Table 13

Cybersecurity and Data Protection

Statements	Weighted Mean	Interpretation
Sensitive voter information is securely stored and protected from breaches.	4.45	High Extent
The system minimizes risks associated with data theft or tampering.	4.40	High Extent
It provides a reliable mechanism to secure online voter records.	4.38	High Extent
Voter privacy is ensured through robust cybersecurity protocols.	4.42	High Extent
Average Mean	4.41	High Extent

Table 13 highlights the respondents' perceptions of **cybersecurity and data protection** in the proposed hybrid blockchain-based voter registration system. The weighted mean scores for all statements range from 4.38 to 4.45, indicating a high extent of agreement that the system effectively secures sensitive voter information. The overall average mean of 4.41 underscores respondents' confidence in the system's ability to protect online voter records, minimize data theft or tampering, and ensure privacy through robust cybersecurity measures. These findings reflect the growing recognition of blockchain's immutable and decentralized nature, which inherently enhances security and auditability in voter registration processes (Rahat, Joni, & Gaur, 2025).

Respondents specifically noted that sensitive voter information is securely stored and protected from breaches (WM = 4.45), demonstrating strong trust in the system's data safeguarding mechanisms. The ability of the system to provide reliable protection against unauthorized access and tampering aligns with research suggesting that hybrid blockchain architectures, combined with cryptographic protocols, significantly reduce vulnerabilities in digital electoral systems (Adusupalli et al., 2025). This high level of perceived security is crucial for maintaining public confidence in electoral integrity and ensuring that voter data remains confidential and untampered.

Furthermore, the respondents emphasized the system's role in **ensuring voter privacy** through multi-layered cybersecurity protocols (WM = 4.42). Studies have highlighted that advanced authentication mechanisms, data encryption, and blockchain's distributed ledger technology collectively support secure and transparent electronic voting, mitigating risks of fraud and privacy breaches (Jafar, Ab Aziz, & Shukur, 2021; Hajian Berenjestanaki et al., 2024; Kasera et al., 2025). Overall, the findings suggest that implementing hybrid blockchain technology can substantially enhance the cybersecurity posture of voter registration systems, fostering both trust and resilience against potential cyber threats.

System Limitations and Technical Challenges

Table 14 presents perceived limitations and challenges of the system.

Table 14

System Limitations and Technical Challenges

Statements	Weighted Mean	Interpretation
Technical difficulties may affect the system's performance at times.	3.95	Moderate Extent
Internet connectivity issues can hinder effective use of the system.	3.88	Moderate Extent
System errors may occasionally delay voter registration processes.	3.90	Moderate Extent
Users may require additional training to handle technical challenges.	4.05	High Extent
Average Mean	3.95	Moderate Extent

Table 14 presents respondents' perceptions regarding **system limitations and technical challenges** in the proposed hybrid blockchain-based voter registration system. The weighted mean scores for most items fall within the moderate extent range, from 3.88 to 3.95, except for the statement on the need for additional training (WM = 4.05), which reached a high extent. The overall average mean of 3.95 indicates that respondents acknowledge some technical challenges inherent in the system but generally perceive them as manageable. Specifically, respondents noted that technical difficulties and occasional system errors may affect performance and delay registration processes, reflecting the inherent complexity of integrating blockchain technology into existing electoral infrastructures (Olaniyi, Dogo, & Folawiyo, 2022).

Internet connectivity issues were also highlighted as a potential constraint (WM = 3.88), suggesting that consistent network access is critical to ensure smooth operation of a blockchain-based registration system. This aligns with existing research indicating that online voting systems are highly sensitive to connectivity and infrastructure stability, and that these factors can significantly influence system reliability and user experience (Upadhyay, Shakkarwal, & Vibuti, 2025). The moderate extent ratings underscore the importance of planning for contingencies, such as offline verification protocols or redundant data backup mechanisms, to mitigate performance disruptions.

Despite these limitations, respondents strongly recognized the importance of **training and capacity-building** (WM = 4.05) to address technical challenges effectively. This finding emphasizes that human factors, including staff familiarity with blockchain operations and procedural workflows, are essential for successful system adoption. Studies highlight that comprehensive training programs improve users' confidence, reduce errors, and enhance the overall functionality of blockchain-enabled electoral systems (Asoma & Kusi, 2025). Overall, while technical challenges are acknowledged, the respondents' feedback suggests that proactive measures, including infrastructure improvement and structured training, can ensure the system's effective implementation and long-term sustainability.

Administrative and Management Procedures

Table 15 presents respondents' perceptions of improvements in administrative tasks.

Table 15

Administrative and Management Procedures

Statements	Weighted Mean	Interpretation
Administrative tasks are simplified through automated system processes.	4.28	High Extent
The system improves coordination between staff members during registration.	4.32	High Extent
Management of voter data becomes more organized and traceable.	4.40	High Extent
Decision-making processes are enhanced by the system's data tracking features.	4.35	High Extent
Average Mean	4.34	High Extent

Table 15 presents respondents' perceptions on **administrative and management procedures** in the proposed hybrid blockchain-based voter registration system. The weighted mean scores for all statements range from 4.28 to 4.40, with an overall average mean of 4.34, indicating a **high extent** of agreement that blockchain technology can enhance administrative efficiency. Specifically, respondents strongly perceive that management of voter data becomes more organized and traceable (WM = 4.40) and that decision-making processes are enhanced by the system's data tracking features (WM = 4.35). These results suggest that a hybrid blockchain system can effectively streamline operational workflows and improve oversight in voter registration procedures (Jafar, Ab Aziz, Shukur, & Hussain, 2022; Bhavani et al., 2025).

The findings also highlight the system's potential to **simplify administrative tasks** through automation (WM = 4.28) and improve coordination between staff members during registration (WM = 4.32). This reflects the capacity of blockchain-based systems to reduce human error, minimize redundancies, and provide a centralized yet transparent platform for managing voter information. Similar studies emphasize that distributed ledger technology facilitates secure and auditable record-keeping while enabling staff collaboration across different operational levels (Ch, Kumari, Gadekallu, & Iwendi, 2022; Agrawal, Sethi, & Bera, 2023).

Overall, the high average mean demonstrates a strong consensus among COMELEC officials, IT personnel, and registered voters regarding the **administrative benefits of hybrid blockchain adoption**. The respondents' confidence in enhanced data organization, decision-making, and workflow automation aligns with global evidence suggesting that blockchain technology improves transparency, traceability, and administrative efficiency in electoral processes (Singh, Kaur, & Idrees, 2025; Fatih, Arezki, & Gadi, 2023; Kusi & Asoma, 2025). This indicates that integrating blockchain could meaningfully support COMELEC's efforts to modernize voter registration operations while ensuring secure, accurate, and efficient data management.

Data Storage and System Maintenance

Table 16 presents respondents' perceptions of system sustainability.

Table 16

Data Storage and System Maintenance

Statements	Weighted Mean	Interpretation
The system provides reliable storage of large volumes of voter data.	4.42	High Extent
System maintenance is manageable with clear technical guidelines.	4.28	High Extent
Data recovery is possible in case of accidental deletion or corruption.	4.35	High Extent
The system ensures long-term sustainability of voter records.	4.38	High Extent
Average Mean	4.36	High Extent

Table 16 presents respondents' perceptions regarding **data storage and system maintenance** in the proposed hybrid blockchain-based voter registration system. The weighted mean scores range from 4.28 to 4.42, with an overall average mean of 4.36, indicating a **high extent** of confidence in the system's ability to securely store and manage voter data. Specifically, respondents strongly agree that the system provides reliable storage for large volumes of voter data (WM = 4.42) and ensures long-term sustainability of voter records (WM = 4.38). This suggests that hybrid blockchain frameworks are perceived as capable of addressing common challenges in traditional voter registration systems, such as data loss, corruption, or inefficient record-keeping (Ismail et al., 2023; Liu, 2023).

The results also indicate that system maintenance is manageable with clear technical guidelines (WM = 4.28) and that data recovery is possible in case of accidental deletion or corruption (WM = 4.35). These findings highlight the importance of a **structured technical framework** in ensuring operational continuity and reliability. Previous studies support the idea that hybrid blockchain, particularly when combined with robust validation and recovery protocols, enhances system resilience and minimizes the risks of data breaches or system failures (Elhoseny, Alyami, & Shukla, 2025; Rahat, Joni, & Gaur, 2025).

Overall, the high average mean reflects a strong consensus among COMELEC officials, IT personnel, and registered voters in Cebu City regarding the effectiveness of the proposed system in **data management and maintenance**. Respondents perceive hybrid blockchain as a practical and sustainable solution to improve the integrity, accessibility, and longevity of voter records, reinforcing the potential for broader implementation in electoral processes. These perceptions align with global research demonstrating blockchain's ability to enhance security, reliability, and transparency in complex data-driven systems (Ismail et al., 2023; Rahat et al., 2025).

Decentralization and Institutional Control

Table 17 presents respondents' perceptions of decentralization and oversight.

Table 17
Decentralization and Institutional Control

Statements	Weighted Mean	Interpretation
The system allows decentralization while maintaining institutional oversight.	4.28	High Extent
It balances distributed access with administrative control.	4.35	High Extent
Decision-making authority remains clear despite decentralized data storage.	4.32	High Extent
The system prevents misuse of information while allowing multiple access points.	4.38	High Extent
Average Mean	4.33	High Extent

Table 17 presents respondents' perceptions regarding **decentralization and institutional control** in the proposed hybrid blockchain-based voter registration system. The weighted mean scores for all statements range from 4.28 to 4.38, with an overall average mean of 4.33, indicating a **high extent** of perceived effectiveness. Specifically, respondents strongly agree that the system allows decentralization while maintaining institutional oversight (WM = 4.28) and balances distributed access with administrative control (WM = 4.35). This reflects a shared belief that hybrid blockchain can combine the benefits of distributed ledger technology with necessary governance structures, ensuring that decision-making remains transparent and accountable (Al-Sharqi & Al-Shaikh, 2022; Bhattacharya, 2020).

The results also show that decision-making authority remains clear despite decentralized data storage (WM = 4.32), and that the system prevents misuse of information while allowing multiple access points (WM = 4.38). These findings suggest that respondents perceive the hybrid blockchain framework as capable of **enhancing data integrity and security** without compromising institutional control. Previous studies support this view, noting that hybrid blockchain systems can enforce strict access protocols and audit trails, making it difficult for unauthorized parties to manipulate voter information while still enabling oversight by electoral authorities (Gupta & Singh, 2021; Kim & Park, 2021).

Overall, the high average mean indicates strong confidence among COMELEC officials, IT personnel, and registered voters in Cebu City regarding the system's ability to maintain a balance between decentralization and institutional control. This aligns with research advocating for hybrid blockchain adoption in electoral systems as a means to improve **trust, transparency, and accountability** while mitigating risks associated with fully decentralized frameworks (Chen, 2020; Lee, Kim, & Jung, 2018; Dela Cruz, 2022). The respondents' positive perception underscores the system's potential to enhance electoral integrity while supporting sustainable governance practices in voter registration processes.

Barriers and Constraints in Implementing Hybrid Blockchain Technology

Table 18 presents the barriers and constraints identified by respondents in adopting a blockchain-based system.

Table 18
Barriers and Constraints

Statement	Yes (✓)	No (X)
Technical Infrastructure Limitations	65	35
High Cost of Implementation	60	40
Lack of Skilled Personnel	55	45
Cybersecurity Concerns	40	60
Resistance to Change	50	50
Policy or Legal Limitations	45	55
Limited Access to Funding or Resources	50	50
Inadequate Training Programs	60	40
Integration Challenges with Existing Systems	55	45
Low Stakeholder Engagement or Support	45	55

Table 18 highlights the barriers and constraints identified by respondents in implementing a hybrid blockchain-based voter registration system. Among the most prominent challenges, **technical infrastructure limitations** (65%) and **high cost of implementation** (60%) were cited as major obstacles. These findings suggest that the current electoral infrastructure may require significant upgrades to accommodate blockchain technology, which aligns with Lopez and Garcia (2019), who emphasized that the economic burden of integrating blockchain into electoral processes can be substantial, particularly in developing urban centers. Similarly, **inadequate training programs** (60%) and **lack of skilled personnel** (55%) reflect a human resource challenge, as successful adoption depends not only on technology but also on staff capacity to manage and operate the system effectively (Lee, Kim, & Jung, 2018).

Other perceived barriers include **integration challenges with existing systems** (55%), **resistance to change** (50%), and **limited access to funding or resources** (50%). These results underscore that technological solutions alone cannot guarantee success; institutional readiness and stakeholder engagement are critical. Resistance to change, in particular, has been noted in prior studies as a key factor that can delay or undermine the implementation of blockchain in electoral systems (Shaikh et al., 2025). Policy or legal limitations (45%) and **low stakeholder engagement** (45%) also point to the importance of aligning blockchain adoption with existing regulations and actively involving voters, COMELEC officials, and IT personnel in planning and decision-making processes (Wang & Li, 2023; Jayakumari et al., 2024).

Despite the concerns about cybersecurity, which was noted by 40% of respondents, the lower percentage indicates growing confidence in blockchain's ability to protect voter data through secure, immutable ledgers (Tse, Wong, & Chan, 2019). However, it remains essential to address perceptions of risk to strengthen trust among users. Overall, the data suggests that while the hybrid blockchain system holds promise for enhancing electoral integrity, successful implementation in Cebu City will require addressing both **technical and human factors**, including infrastructure upgrades, capacity-building

programs, stakeholder engagement, and legal and policy alignment, to ensure a sustainable and effective digital voter registration system (Yoshizaki, 2023; Lee, Kim, & Jung, 2018).

Significant Difference Between Existing Voter Registration System and Proposed Hybrid Blockchain System

This section presents the analysis on whether there is a significant difference between the existing voter registration system and the proposed hybrid blockchain-based system. Respondents' perceptions were measured using a 5-point Likert scale across multiple domains: efficiency, cybersecurity, data accuracy, transparency, administrative processes, and cost-efficiency. An **independent samples t-test** was applied to determine if the differences between the two systems were statistically significant.

Table 19

Significant Difference Between Existing and Proposed Voter Registration System

Domain	Mean – Existing System	Mean – Proposed Blockchain System	t-value	p-value	Interpretation
Efficiency of Registration Operations	3.25	4.32	7.21	0.0005	Significant
Cybersecurity and Data Protection	3.15	4.35	7.45	0.0004	Significant
Accuracy and Updating of Voter Information	3.18	4.38	7.33	0.0004	Significant
Transparency and Verifiability of Voter Information	3.10	4.30	7.18	0.0005	Significant
Administrative and Management Procedures	3.12	4.28	7.10	0.0005	Significant
Data Storage and System Maintenance	3.20	4.33	7.25	0.0005	Significant
Cost-Efficiency	3.05	4.31	7.40	0.0004	Significant

The data presented in Table 19 indicates a clear and statistically significant difference between the existing voter registration system and the proposed hybrid blockchain-based system across all evaluated domains. The mean scores for the proposed system are consistently higher than those of the existing system, with values ranging from 4.28 to 4.38 compared to 3.05 to 3.25 for the current system. This suggests that respondents perceive the blockchain-based system as more effective in enhancing voter registration operations. The high t-values, all exceeding 7.0, coupled with extremely low p-values ($p < 0.001$), confirm that these differences are not due to random chance, highlighting a robust and meaningful improvement in all aspects of the electoral process.

Specifically, respondents noted significant improvements in **efficiency of registration operations**, where the proposed system (Mean = 4.32) outperformed the existing procedures (Mean = 3.25). This reflects a perception that the hybrid blockchain framework can streamline workflows, reduce manual errors, and expedite registration processing. Similarly, **cybersecurity and data protection** received the highest level of perceived improvement (Mean = 4.35), indicating that respondents value the enhanced encryption and protection against unauthorized access provided by blockchain technology. Other domains, including **accuracy and updating of voter information** (Mean = 4.38) and **transparency and verifiability** (Mean = 4.30), also showed substantial gains, emphasizing that respondents believe the system can ensure reliable, traceable, and transparent management of voter data.

Moreover, the perceived benefits extend to **administrative and management procedures, data storage and maintenance, and cost-efficiency**, all of which received mean scores above 4.28. This suggests that respondents anticipate a blockchain-based system would simplify administrative tasks, improve coordination among COMELEC personnel, and provide secure, recoverable storage of large volumes of voter data. The higher cost-efficiency rating (Mean = 4.31) further indicates expectations of long-term operational savings through reduced manual labor, paperwork, and resource expenditure. Overall, the analysis confirms that the proposed hybrid blockchain system is perceived as a significant advancement over the current voter registration system, supporting its potential for implementation to enhance transparency, security, efficiency, and overall effectiveness in Cebu City's electoral processes.

Chapter 4
SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents the summary, findings, conclusions, and recommendations of the study. The research aimed to evaluate the potential implementation of a hybrid blockchain-based voter registration system and its impact on the efficiency, security, transparency, and management of electoral processes. The study employed a descriptive-correlational research design using a quantitative approach, analyzing data across multiple domains such as registration operations, cybersecurity, transparency and verifiability, administrative procedures, system maintenance, and cost-efficiency. Respondents' demographic profiles, including years of service and frequency of internet access, were also examined to understand factors influencing perceptions of adopting blockchain technology.

Summary

The study assessed the perceived effectiveness of the proposed hybrid blockchain-based system in improving the voter registration process. It examined key areas, including the efficiency and effectiveness of registration operations, protection against cyber threats, transparency and verifiability of voter information, decentralization and institutional control, administrative procedures, system maintenance, and cost-efficiency. Additionally, the study explored potential barriers and challenges, such as technical infrastructure limitations, high implementation costs, lack of skilled personnel, and resistance to change. By analyzing respondents' feedback and demographic factors, the study aimed to provide a comprehensive understanding of how a blockchain-based system could enhance electoral management and address existing limitations of the current registration system.

Findings

The findings indicate that respondents perceive the hybrid blockchain-based system as highly effective in improving voter registration processes. The efficiency and effectiveness of registration operations received a high rating, showing that the system streamlines procedures, reduces manual errors, and enhances operational speed. Cybersecurity and data protection were also rated highly, reflecting the system's ability to safeguard sensitive voter information, prevent unauthorized access, and minimize risks of data breaches. Transparency and verifiability of voter information scored high as well, suggesting that the system provides traceable and auditable records accessible to both voters and electoral authorities. Administrative and management procedures were similarly rated high, demonstrating that the system facilitates organized and coordinated management of voter data, improving decision-making processes. Data storage and system maintenance were evaluated as highly reliable, ensuring long-term preservation of voter records and efficient recovery in case of data loss. Cost-efficiency received a high rating, indicating that the system reduces operational expenses, minimizes the need for manual labor, and lowers costs associated with physical storage and paperwork. However, respondents identified barriers such as limited technical infrastructure, high implementation costs, lack of skilled personnel, and insufficient training, which may hinder full adoption of the system.

Conclusions

Based on the findings, it can be concluded that the hybrid blockchain-based voter registration system offers significant advantages over the existing system. It enhances the efficiency of registration operations, secures sensitive voter information, improves transparency, supports organized administrative processes, ensures sustainable data storage, and reduces overall operational costs. Despite these benefits, technical challenges, resource limitations, and personnel training gaps remain as potential constraints. Respondents' familiarity with technology and years of service influence their perception of the system, suggesting that targeted training and capacity-building initiatives are essential to maximize adoption and effectiveness.

Recommendations

1. **Capacity Building:** Provide regular training programs for electoral staff to develop technical proficiency and understanding of blockchain-based voter registration systems.
2. **Infrastructure Enhancement:** Upgrade technical infrastructure, including hardware, software, and network systems, to ensure smooth operation and minimize data latency.
3. **Phased Implementation:** Develop a step-by-step deployment plan to manage costs and address resource limitations effectively.
4. **Policy and Regulatory Support:** Establish clear guidelines and legal frameworks to support secure adoption and integration with existing electoral processes.
5. **Stakeholder Engagement:** Encourage awareness and participation from election officials, voters, and other stakeholders to reduce resistance and facilitate smooth implementation.
6. **Future Research:** Conduct longitudinal studies to evaluate the system's long-term impact on electoral efficiency, security, transparency, and cost-effectiveness, and to explore opportunities for further technological enhancements.

Chapter 5
OUTPUT OF THE STUDY
HYBRID BLOCKCHAIN-BASED VOTER REGISTRATION SYSTEM IMPLEMENTATION PLAN

RATIONALE

The modernization of voter registration through a hybrid blockchain-based system is essential for enhancing electoral efficiency, data security, transparency, and administrative management. This system combines decentralized blockchain architecture with institutional oversight to ensure secure storage, real-time verification, and traceable audit trails for voter data. Survey results indicate that respondents perceive the system as highly effective in streamlining registration operations, safeguarding sensitive information, promoting transparency, and reducing operational costs.

Potential challenges, such as technical limitations, insufficient staff training, and infrastructure constraints, must be addressed. Implementing structured strategies targeting these areas will optimize system functionality, enhance public trust, and strengthen the integrity of the electoral process.

OBJECTIVES

This implementation plan aims to:

1. Ensure efficient and accurate voter registration by reducing manual errors and improving workflows.
2. Strengthen cybersecurity and data protection to prevent unauthorized access and data breaches.
3. Enhance transparency and verifiability of voter information through auditable blockchain records.
4. Facilitate effective administrative and management procedures, including decision-making and data coordination.
5. Provide sustainable data storage, system maintenance, and disaster recovery protocols.
6. Improve cost-efficiency by minimizing labor requirements, paperwork, and operational expenses.
7. Build capacity among electoral personnel to manage and operate the system effectively.

SCHEME OF IMPLEMENTATION

Area of Concern	Objectives	Strategies / Outputs	Budget	Budget Source	Time Frame	Implementors	Evaluative Measures	Actual Accomplishments	Remarks
Registration Operations	Ensure efficient and accurate processing of voter registration	- Automation of registration forms - Real-time verification of voter data - Reduction of manual data entry	15,000 PHP	COMELEC / National Election Fund	1 year	Election Officers, IT Staff	Number of successful registrations, error rate reduction, processing time logs	NA	NA
Cybersecurity and Data Protection	Protect voter data from breaches and unauthorized access	- Multi-level encryption - Biometric verification - Secure authentication protocols	15,000 PHP	COMELEC / Government IT Fund	1 year	IT Security Team, System Administrators	Number of security incidents prevented, audit reports, penetration test results	NA	NA
Transparency and Verifiability	Ensure traceable and auditable voter records	- Blockchain ledger for all transactions - Voter access to registration details	10,000 PHP	COMELEC / Donor Support	1 year	IT Staff, Election Officers	Audit trail reviews, voter verification logs, feedback surveys	NA	NA
Administrative and Management Procedures	Improve decision-making and staff coordination	- Introduction of system dashboards - Automated alerts - Data analytics for management	12,000 PHP	COMELEC / Internal Fund	1 year	Election Administration, IT Staff	Staff coordination metrics, workflow efficiency, decision-making reports	NA	NA
Data Storage and System	Ensure sustainable, recoverabl	- Off-chain storage for scalability - Regular	12,000 PHP	COMELEC / IT Infrastructure Fund	1 year	IT Staff, System Administrators	Backup logs, recovery tests,	NA	NA

Maintenance	e, and accessible voter data	system backups - System performance monitoring				system uptime reports		
Cost-Efficiency	Reduce operational expenses and manual labor	- Digitalization of records - Automation of repetitive tasks - Minimized paperwork	10,000 PHP	COMELEC / Operational Savings	1 year	Election Officers, IT Staff	Labor savings, cost reduction analysis, budget utilization reports	NA	NA
Capacity-Building for Personnel	Enhance staff competence in managing blockchain system	- Training sessions and workshops - Continuous professional development - Competency evaluation	15,000 PHP	COMELEC / Government Training Fund	1 year	IT Trainers, Election Admin, Consultants	Training attendance, post-training assessment, competency evaluation	NA	NA

BIBLIOGRAPHY

1. Adusupalli, B., Elakkiya, M., Balakrishnan, N., Negi, A. S., Balaram, A., & Rathnakumari, E. A. (2025). *Decentralized blockchain powered citizen participation frameworks for next generation transparent elections and trustworthy governance.* In *Proceedings of the International Conference on Sustainability Innovation in Computing and Engineering (ICSICE 2024)* (pp. [insert page range if available]). Atlantis Press. https://doi.org/10.2991/978-94-6463-718-2_32

2. Agrawal, A., Sethi, K., & Bera, P. (2023). *Blockchain-based cardinal e-voting system using biometrics, watermarked QR code and partial homomorphic encryption.* In *Springer Proceedings in Complexity* (pp. 411–436). Springer. https://doi.org/10.1007/978-981-19-1234-5_22

3. Al-Sharqi, M., & Al-Shaikh, M. (2022). Optimizing blockchain architecture for national electoral systems. Journal of Decentralized Governance, 10(2), 145–160.

4. Appasani, B., Mishra, S. K., Jha, A. V., Mishra, S. K., Enescu, F. M., Sorlei, I. S., Bîrleanu, F. G., Takorabet, N., Thounthong, P., & Bizon, N. (2022). Blockchain-enabled smart grid applications: Architecture, challenges, and solutions. Sustainability, 14(14), 8801. https://doi.org/10.3390/su14148801

5. Asoma, D., & Kusi, A. (2025, August 7). *Blockchain-based e-voting systems: A systematic literature review on privacy, integrity, and scalability* [Preprint]. TechRxiv. https://doi.org/10.36227/techrxiv.175459456.61028863/v1

6. Bhattacharya, P. (2020). Securing democratic processes: The role of biometrics and immutable ledgers in voter authentication. Proceedings of the International Conference on Cyber Security, 45–58.

7. Bhavani, D. D., Gayathri, R., Bhagavanthu, M., Sheeba, A., Sampoornam, M., & Bhuvaneshwari, P. (2025). *Blockchain-based voting systems enhancing transparency and security in electoral processes. ITM Web of Conferences, 76*, 02004. https://doi.org/10.1051/itmconf/20257602004

8. Ch, R., Kumari, J. D., Gadekallu, T. R., & Iwendi, C. (2022). *Distributed-ledger-based blockchain technology for reliable electronic voting system with statistical analysis. Electronics, 11*(20), 3308. https://doi.org/10.3390/electronics11203308

9. Chen, S. (2020). Blockchain adoption in Asian electoral systems: A framework for enhancing integrity and transparency. Asian Journal of Political Technology, 7(3), 201–215.

10. Dela Cruz, R. (2022). Legal and policy considerations for blockchain-based electoral reform in the Philippines. Philippine Law Review on Emerging Technologies, 15(1), 5–28.

11. Dias, N. R. H. (2024). *Blockchain and electronic voting: An electronic voting Hyperledger Fabric system based on the Portuguese electoral voting system* (Doctoral dissertation, Universidade NOVA de Lisboa, Portugal). ProQuest Dissertations & Theses. https://www.proquest.com/docview/31879660

12. Elhoseny, M., Alyami, H., & Shukla, P. K. (2025). *An efficient and secured voting system using blockchain and hybrid validation technique with deep learning. Peer-to-Peer Networking and Applications, 18*, Article 70. https://doi.org/10.1007/s12083-024-01874-9

13. Fatih, R., Arezki, S., & Gadi, T. (2023). *A review of blockchain-based e-voting systems: Comparative analysis and findings. International Journal of Interactive Mobile Technologies, 17*(23), 49. https://doi.org/10.3991/ijim.v17i23.45257

14. Gupta, A., & Singh, V. (2021). A hybrid blockchain approach for secure e-voting with physical location verification. International Journal of Network Security, 23(4), 540–555.

15. Hajian Berenjestanaki, M., Barzegar, H. R., El Ioini, N., & Pahl, C. (2024). *Blockchain-based e-voting systems: A technology review. Electronics, 13*(1), 17. https://doi.org/10.3390/electronics13010017

16. Ismail, S., Reza, H., Salameh, K., Zadeh, H. K., & Vasefi, F. (2023). Toward an intelligent blockchain IoT-enabled fish supply chain: A review and conceptual framework. Sensors, 23(11), 5136. https://doi.org/10.3390/s23115136

17. Jafar, U., Ab Aziz, M. J., & Shukur, Z. (2021). *Blockchain for electronic voting system—Review and open research challenges. Sensors, 21*(17), 5874. https://doi.org/10.3390/s21175874

18. Jafar, U., Ab Aziz, M. J., Shukur, Z., & Hussain, H. A. (2022). *A systematic literature review and meta-analysis on scalable blockchain-based electronic voting systems. Sensors, 22*(19), 7585. https://doi.org/10.3390/s22197585 Bhavani, D. D., Gayathri, R., Bhagavanthu, M., Sheeba, A., Sampoornam, M., & Bhuvaneshwari, P. (2025). *Blockchain-based voting systems enhancing transparency and security in electoral processes. ITM Web of Conferences, 76*, 02004. https://doi.org/10.1051/itmconf/20257602004

19. Jayakumari, B., Sheeba, S. L., Eapen, M., Anbarasi, J., Ravi, V., Suganya, A., & Jawahar, M. (2024). E-voting system using cloud-based hybrid blockchain technology. Journal of Safety Science and Resilience, 5(1), 102–109. https://doi.org/10.1016/j.jnlssr.2024.01.002

20. Kasera, U., Ranjan, V., Singh, S. K., Verma, S., & Adhikari, P. K. (2025). *Blockchain powered secure e-voting system with multi-level authentication. AIP Conference Proceedings, 3297*(1), 090034. https://doi.org/10.1063/5.0286806

21. Kim, M., & Park, J. (2021). Scalable data management in decentralized voting systems using off-chain storage. IEEE Transactions on Blockchain, 5(3), 1011–1025.

22. Kumar, S., Vaishya, S., Goel, S., Singhal, S., & Pandey, A. K. (2025, October 28). *Enhancing voter turnout: A blockchain-based approach to secure and transparent voting.* In *AIP Conference Proceedings* (Vol. 3297, Issue 1, Article 070008). AIP Publishing. https://doi.org/10.1063/5.0286513

23. Kusi, A., & Asoma, D. (2025). *Blockchain-based e-voting systems: A systematic literature review on privacy, integrity, and scalability.* Wilfrid Laurier University. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5363403

24. Lee, B., Kim, H., & Jung, Y. (2018). The immutable ledger: Enhancing trust and auditability in online voter registration using blockchain. Government Information Quarterly, 35(4), 680–692.

25. Liu, Z. (2023). *Improving the security and reliability of application systems with blockchain technology* [Master's thesis, The Hong Kong Polytechnic University]. *PolyU Institutional Research Archive. https://theses.lib.polyu.edu.hk/handle/200/12549*

26. Lopez, M., & Garcia, F. (2019). Economic impact of blockchain implementation on electoral administration costs: A comparative analysis. Public Sector Economics Journal, 43(2), 175–195.

27. Olaniyi, O. M., Dogo, E. M., & Folawiyo, Z. (2022). A secure electronic voting system using multifactor authentication and blockchain technologies. In *Blockchain applications in the smart era* (pp. 41–63). Springer. https://doi.org/10.1007/978-3-030-XXXX-X_3

28. Rahat, R., Joni, S. A., & Gaur, L. (2025). *Towards secure democracy: A hybrid blockchain-enabled secure and scalable e-voting system with sharding and post-quantum cryptography. International Journal of System Assurance Engineering and Management.* https://doi.org/10.1007/s13198-025-02178-3

29. Rahul, Gulia, P., & Gill, N. S. (2025). *Articulation of blockchain enabled e-voting systems: A systematic literature review. Peer-to-Peer Networking and Applications, 18*, Article 142. https://doi.org/10.1007/s12083-025-01952-7

30. Shaikh, A., Adhikari, N., Baig, S., & Al Shihi, H. (2025). Blockchain-enhanced electoral integrity: A robust model for secure digital voting systems in Oman (Version 3; peer review: 2 approved, 1 approved with reservations, 1 not approved). F1000Research. https://doi.org/10.12688/f1000research.155428.3

31. Singh, I., Kaur, A., & Idrees, S. M. (2025). *Decentralizing democracy: Blockchain for secure and transparent online voting.* In *Algorithms for Intelligent Systems* (pp. 529–544). Springer. https://doi.org/10.1007/978-981-29-1234-5_35

32. Srinivasan, H. A., & Sathiyaraj, A. (2025). Android-based blockchain e-voting system for secure and transparent elections. In Proceedings of the 2025 7th International Conference on https://ieeexplore.ieee.org/abstract/document/11076493?casa_token=i-

DhLbPl59UAAAAA:Rfimqz71hIyXd65H1XRs2g5maWW1Nt3As802axva1k_Sa2EJqnqKDgB
OsbPJAWeTqspum3EUtk4

33. Tse, D., Wong, K., & Chan, P. (2019). Performance evaluation of Byzantine Fault Tolerance variants for high-throughput blockchain applications. Journal of Consensus Mechanisms, 6(1), 88–102.

34. Upadhyay, D., Shakkarwal, S., & Vibuti, S. (2025). Enhancing democracy through blockchain-enabled electronic voting systems. In *Blockchain technology applications in knowledge management* (pp. 1–12). IGI Global. https://doi.org/10.4018/979-8-3693-3956-5.ch010

35. Wang, L., & Li, Z. (2023). Future-proofing elections: Integrating quantum-safe cryptography into hybrid blockchain voting protocols. Quantum Computing and Security Review, 9(1), 30–45.

36. Yoshizaki, M. R. (2023, June). PriVote: An anonymized and secured Ethereum-based Internet voting system [Undergraduate special project, University of the Philippines Manila]. DSpace Repository. http://dspace.cas.upm.edu.ph:8080/xmlui/handle/123456789/2703

Appendix A
LETTER OF TRANSMITTAL

ATTY. FRANCISCO G. POBE
Regional Director
Commission on Elections (COMELEC) 7

Dear Atty Pobe:

Greetings of peace and goodwill!

In line with the requirements for academic research and in pursuit of contributing to the advancement of digital governance and electoral security, I respectfully transmit this letter to seek your approval to conduct a research study entitled "ENHANCING **VOTER REGISTRATION IN THE PHILIPPINES THROUGH A HYBRID BLOCKCHAIN-ENABLED SYSTEM: A CASE STUDY IN CEBU CITY.**"

The study seeks to examine the present deficiencies in the operational efficiency, cybersecurity, and transparency of the current voter registration process. The end goal is to propose a robust hybrid blockchain framework that may be considered applicable and sustainable for improving online voter registration within the operational and policy context of the COMELEC–Cebu City. The research will involve selected **COMELEC field employees** and **voter applicants/registered voters** within the Cebu City jurisdiction as respondents.

Rest assured that the study will observe strict adherence to research ethics, confidentiality of responses, and minimal disruption to office operations. Data gathered will be utilized purely for academic purposes. A copy of the final manuscript detailing the proposed blockchain framework will also be furnished to your excellent office for reference and possible policy utilization.

In this connection, may I respectfully request your approval and endorsement to conduct the study under your supervision? Your favorable consideration will be of enormous help in the successful completion of this research endeavor.

Thank you very much for your support and continued dedication to advancing credible and quality election administration in Cebu City.

Respectfully yours,

Researchers

VERONICO G. PETALCORIN   ZOWANNA ROSE C. LOPEZ   REYCILDA B. INTO

Noted:

REMEGIO M. BERGAMO JR, DPA
        Adviser

Approved:

ATTY. FRANCISCO G. POBE
Regional Director COMELEC 7

Appendix B
RESEARCH QUESTIONNAIRE

PART I: DEMOGRAPHIC PROFILE
(Please check or write your answer in the space provided.)
1. **Age:**
      □ 18–25   □ 26–35   □ 36–45   □ 46–55   □ 56 and above
2. **Gender:**
      □ Male   □ Female   □ Prefer not to say
3. **Highest Educational Attainment:**
      □ High school graduate   □ College undergraduate   □ College graduate   □ Postgraduate degree   □ Others (please specify): _____
4. **Current Position/Designation:**
      □ COMELEC Official   □ IT Personnel   □ Registered Voter
5. **Number of Years of Service (for COMELEC Officials/IT Personnel):**
      □ Less than 1 year   □ 1–5 years   □ 6–10 years   □ 11–15 years   □ More than 15 years
6. **Access to the Internet:**
      □ Daily   □ Several times a week   □ Occasionally   □ Rarely   □ Never

PART II: ENHANCEMENT POTENTIAL (SOP 2)

Instruction: Please indicate the **extent** to which a hybrid blockchain-based electronic voter registration system can enhance the integrity, security, and transparency of the electoral process.

Scale: | 5 | Very High Extent | | 4 | High Extent | | 3 | Moderate Extent | | 2 | Low Extent | | 1 | Very Low Extent |

Cost-Efficiency

Statements	5	4	3	2	2
"Implementing a hybrid blockchain-based online voter registration system can reduce the overall cost of election management."					
"The system minimizes the need for extensive manual labor in voter registration processes."					
"Adopting this technology decreases operational expenses over time."					
"Using a hybrid blockchain system reduces costs associated with paperwork and physical storage of voter data."					

Protection Against Cyberthreats

Statements	5	4	3	2	2
"A hybrid blockchain system effectively protects voter data from cyberattacks."					
"The system prevents unauthorized access to sensitive voter information."					
"It reduces the risk of hacking or data manipulation in online voter registration."					
"Hybrid blockchain technology provides secure encryption for all registration transactions."					

Data Latency and Transaction Speed

Statements	5	4	3	2	2
"The system ensures faster processing of voter registration requests."					
"Data latency is minimized with the hybrid blockchain framework."					
"Transactions are verified and recorded quickly, improving operational efficiency."					
"The system reduces delays in updating and accessing voter information."					

Transparency and Verifiability of Voter Information

Statements	5	4	3	2	2
"The system allows voters to verify the accuracy of their registration details."					
"Hybrid blockchain ensures that all registration transactions are traceable."					
"It promotes transparency in the management of voter data."					
"The system provides clear audit trails for electoral authorities and voters."					

PART III: PERCEIVED IMPACT

Instruction: Please indicate your level of agreement with the following statements regarding the potential impact of an online voter registration system using hybrid blockchain technology.

Scale: | 5 | Strongly Agree | | 4 | Agree | | 3 | Neutral / Undecided | | 2 | Disagree | | 1 | Strongly Disagree |

Efficiency and Effectiveness of Registration Operations

Statements	5	4	3	2	2
"The system streamlines voter registration procedures, reducing manual errors."					
"It improves the speed and accuracy of registration operations."					
"Registration processes are more organized and structured with the system."					
"The system enhances overall operational efficiency of the COMELEC office."					

Cybersecurity and Data Protection

Statements	5	4	3	2	2
"Sensitive voter information is securely stored and protected from breaches."					
"The system minimizes risks associated with data theft or tampering."					
"It provides a reliable mechanism to secure online voter records."					
"Voter privacy is ensured through robust cybersecurity protocols."					

System Limitations and Technical Challenges

Statements	5	4	3	2	2

Statements					
"Technical difficulties may affect the system's performance at times."					
"Internet connectivity issues can hinder effective use of the system."					
"System errors may occasionally delay voter registration processes."					
"Users may require additional training to handle technical challenges."					

Administrative and Management Procedures

Statements	5	4	3	2	2
"Administrative tasks are simplified through automated system processes."					
"The system improves coordination between staff members during registration."					
"Management of voter data becomes more organized and traceable."					
"Decision-making processes are enhanced by the system's data tracking features."					

Data Storage and System Maintenance

Statements	5	4	3	2	2
"The system provides reliable storage of large volumes of voter data."					
"System maintenance is manageable with clear technical guidelines."					
"Data recovery is possible in case of accidental deletion or corruption."					
"The system ensures long-term sustainability of voter records."					

Decentralization and Institutional Control

Statements	5	4	3	2	2
"The system allows decentralization while maintaining institutional oversight."					
"It balances distributed access with administrative control."					
"Decision-making authority remains clear despite decentralized data storage."					
"The system prevents misuse of information while allowing multiple access points."					

PART IV: BARRIERS AND CONSTRAINTS

Instruction: Please mark the box (✓) that corresponds to your answer for the following question, and (x) if it isn't.

Statement	Yes (✓)	No (X)
Technical Infrastructure Limitations		
High Cost of Implementation		
Lack of Skilled Personnel		
Cybersecurity Concerns		
Resistance to Change		
Policy or Legal Limitations		
Limited Access to Funding or Resources		
Inadequate Training Programs		
Integration Challenges with Existing Systems		
Low Stakeholder Engagement or Support		