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# Design of a Web-Based OSIS E-Voting System Using the Waterfall Method at SMPN 3 Naringgul

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ABSTRACT

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**Background:** The election of the Student Council President (Ketua OSIS) at SMPN 3 Naringgul has so far been conducted manually, which often causes errors in vote counting and delays in announcing results. **Objective:** This study aims to develop a web-based E-Voting System to improve the efficiency, accuracy, and transparency of OSIS elections. **Method:** This research used a structured Waterfall Methodology for software development, covering requirement analysis, system design with UML diagrams, implementation using PHP/MySQL, and system testing using Black-Box Testing for verification. **Results:** The resulting e-voting system has features such as secure voter login, a candidate selection interface, real-time vote counting, and an admin panel for data management. Testing results show that the system can speed up the election process, minimize human error, and increase result transparency. **Conclusion:** The developed system effectively supports the digitalization of school election management and provides a faster and more reliable alternative compared to manual election methods.

## 1. Introduction

Digital evolution affects various sectors of life, including education. Digitalization encourages modernization of school administration and student organization activities to be more efficient, transparent, and accountable. One important activity affected is the election of the OSIS board. In many schools, the OSIS election is still carried out manually using paper ballots. This manual process creates various obstacles, including delays in result announcements for several days, errors in vote recording, and the potential for fraud or manipulation of results.

SMPN 3 Naringgul, a junior high school in Cianjur Regency with 320 students (grades VII–IX) and 48 teachers and staff, has so far conducted the election of the Student Council President conventionally. As a result, there are delays of 2–3 days and disruption of learning activities while the election is held. Based on an internal survey of 50 grade VIII and IX students, about 84% of respondents stated that they preferred a web-based e-voting system because it was considered faster, more accurate, and aligned with the technology they use every day. The study by Ramadan et al. (2022) at SMKN 2 Rancaek also showed that implementing e-voting can cut vote recapitulation time by up to 70% and increase voter satisfaction.

Previous studies indicate that e-voting in school environments can increase the speed and reliability of the election process. According to Syam et al. (2020), a web-based e-voting system can reduce the risk of vote manipulation and lower the workload of the student election committee. Setiawan & Nugroho (2023) added that digitalization of school governance, including the implementation of electronic OSIS elections, has been proven to increase student participation and result transparency. Nationally, the research trend on e-voting in education continues to grow. A bibliometric analysis by Sakir et al. (2025) highlights increasing research focus on developing school e-voting applications in Indonesia. In addition, Halim et al. (2023) revealed that integrating digital technology in schools is in line with the concept of smart schools to support educational transformation. These findings confirm the urgency of innovating OSIS elections electronically.

From a technical perspective, the Waterfall Methodology is considered suitable for information system development projects in educational settings where needs are clear and stable. Putra & Yusuf (2022) used UML diagrams in designing a web-based e-voting application with the Waterfall model and successfully produced a structured and easily testable system. Jurnal Mantik (2021) also described the use of UML diagrams and flowcharts in building a web-based school e-voting system integrated with a database. The Waterfall model has even been effectively applied in e-voting projects in higher education environments, demonstrating its reliability for similar systems.

This study aims to design a web-based OSIS e-voting system at SMPN 3 Naringgul using the Waterfall method to increase efficiency of elections, reduce recording errors, and strengthen the transparency of OSIS election results. With the development of this system, it is expected that the school's election process can take place more modernly, accurately, and credibly.

## 2. Method

This research uses the Waterfall software development method (the classic System Development Life Cycle model) which is sequential and structured. Each stage in the Waterfall model must be completed before moving on to the next stage. This method is suitable for projects with requirements clearly defined from the beginning, such as the development of a school e-voting application. According to Pressman & Maxim (2015), the Waterfall model has five main stages implemented sequentially. The stages are as follows.

### 2.1 Requirements Analysis

At this stage, requirements were collected through observation of the ongoing OSIS election process, interviews with the OSIS advisor and the election committee, and literature study related to e-voting in education. The output of this stage is a software requirements specification document that becomes the basis for system design. The document includes functional features that must exist in the system, for example voter login, the voting module, automatic vote counting, and so on.

### 2.2 System Design

This stage includes creating a comprehensive system design, both architecture and technical details. The design covers user interface design, database design (using an entity-relationship diagram or ERD), and modeling with UML diagrams such as the use case diagram and class diagram. At this stage, the structure and components of the system are determined, including how user actors interact with the system and how data is managed. Ristiani et al. (2019) showed that using UML diagrams in the design stage can help ensure that the e-voting system meets functional requirements consistently.

### 2.3 Implementation

At the implementation stage, the system design was translated into program code. This e-voting application was developed using web technology according to needs: PHP as the server-side programming language, MySQL as the database management system, and HTML, CSS, and JavaScript for the user interface. The output of this stage is a functional OSIS e-voting application according to the design, covering the main modules such as authentication, voting, and administration.

### 2.4 Testing

After implementation, system testing was carried out to ensure all functions run according to specifications. Testing used Black-Box Testing, where each feature is tested based on usage scenarios without looking at internal code. Testing focuses on components such as voter login, candidate selection, real-time vote counting, and operations in the admin panel (e.g., adding voter and candidate data). Each test scenario is evaluated by comparing the actual system output with the expected result.

### 2.5 Maintenance

The final stage covers maintenance of the running system. Maintenance includes fixing bugs or errors found during use, performance optimization if needed, and adding new features if there are changing needs. This stage ensures the e-voting system continues to operate properly and adapts to evolving needs.

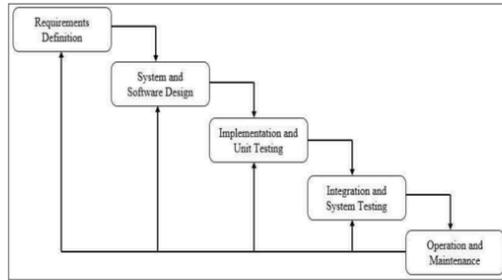


Figure 1. Waterfall Methodology

Source :

[https://www.researchgate.net/publication/367510293\\_Analisis\\_dan\\_Perancangan\\_Sistem\\_Raport\\_Digital\\_Metode\\_Waterfall](https://www.researchgate.net/publication/367510293_Analisis_dan_Perancangan_Sistem_Raport_Digital_Metode_Waterfall)

The Waterfall method above was used as the framework for system development. Each deliverable from one stage becomes input for the next, minimizing the risk of errors in development. With this approach, system development proceeds in a structured and well-documented manner.

### 2.6 Data Analysis Technique

The data analysis technique in this study used Black-Box Testing by providing various input scenarios to the system and comparing the outputs with expectations to ensure all features run according to specification.

### 2.7 System Design

#### 1. Diagram Usecase

The use case diagram describes interactions between user actors and the system. It helps define the scope of the system and the features accessible to each actor. In the OSIS e-voting system, there are two main actors: Admin and Voter. The Admin is authorized to manage election data (voters, candidates, classes) and view vote counts. The Voter is authorized only to log in and cast a vote (select a candidate). The use case diagram ensures each actor can access functions according to their role, maintaining data security and integrity.

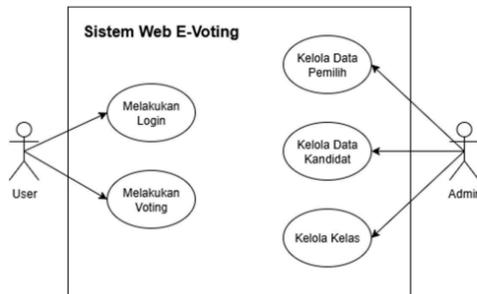


Figure 2. UseCase Diagram

#### 2. Flowchart

The flowchart is used to visualize system processes in a structured manner using standard symbols. The flowchart of the OSIS e-voting system explains the main steps from login (for admin and voters), user account validation, candidate voting by students, to real-time vote counting. It makes the process order easy to understand for developers and users and verifies that system logic matches the planned scenarios.

The flowchart is divided into two main parts: the Admin flow (data management and monitoring) and the Voter flow (ballot casting). This separation clarifies the responsibilities of each user role.

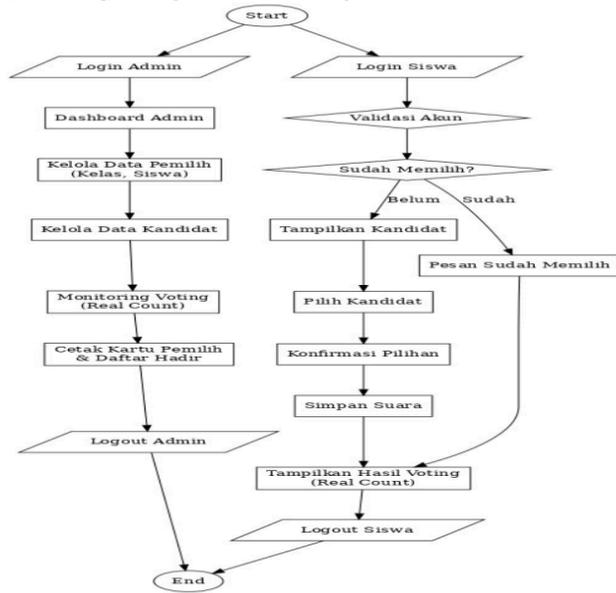


Figure 3. Flowchart

### 3. Class Diagram

The class diagram models the static data structure and components of the system. It shows classes in the system with attributes, methods, and relationships among classes. In the developed OSIS e-voting system, five main classes were identified: Admin, Voter, Candidate, Voting, and Settings. For example, the Voter class has attributes such as nis, username, password, and status (to indicate whether the voter has voted), while the Candidate class has id, candidate name, vision, mission, and photo. Relationships include one-to-many between Voter and Voting (one voter is associated with one voting transaction) and between Candidate and Voting (each voting entry is linked to a particular candidate). These relationships ensure vote data integrity with candidate and voter entities. The class diagram supports database and application logic design consistent with functional needs.

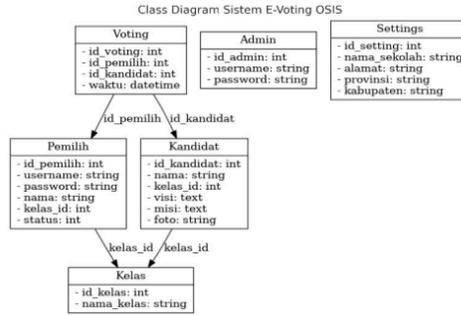


Figure 4. Class Diagram

### 3. Results and Discussion

After the design stage, the web-based OSIS e-voting system was implemented according to specifications. The system consists of two main components: the frontend for voters (students) and the backend for admins (election committee). The following are the main interfaces and their functionality.

#### 3.1 Presentation of Findings

##### 1. Voter Login Screen

Students enter the given username and password to access the e-voting system. The login page has a show/hide password feature to help ensure correct input. Credential validation occurs upon pressing the login button; only registered voters can proceed to the candidate selection page.

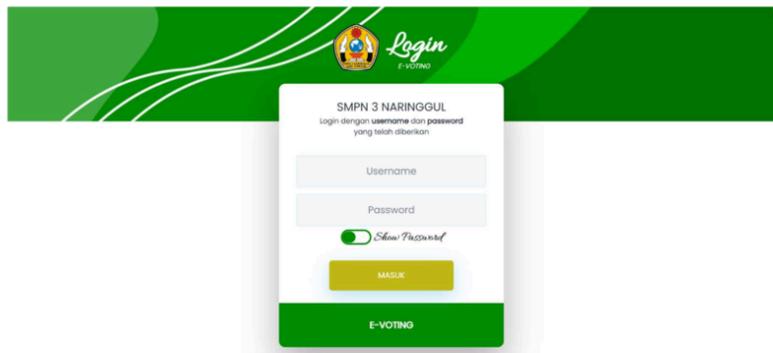


Figure 5. Voter Login Screen

##### 2. Voter Voting Page

This page displays the list of Student Council President candidates, including photos, names, and summaries of vision and mission. Students cast their vote by pressing the "Vote" button on the chosen candidate. The system automatically verifies voter status; only voters who have not yet voted are allowed to access this page. After clicking vote, the ballot is saved to the database and the voter is redirected to a confirmation page.

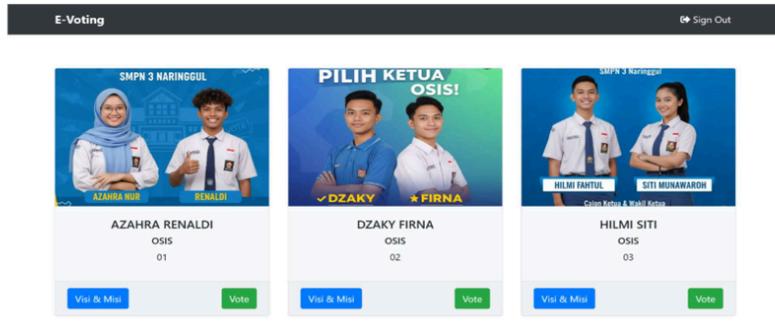


Figure 6. Voter Voting Page

### 3. Voter Confirmation Page

After voting, the system displays a confirmation page stating the vote has been recorded. It assures students that their choice is stored. The page also states the process is complete and the voter cannot vote again.



Figure 7. Voter Confirmation Page

### 4. Already-Voted Notification

If a student who already voted tries to log in again, the system denies access and shows the notification "Anda sudah memilih" ("Anda Sudah Memilih"). This prevents multiple voting and ensures authenticity of results.

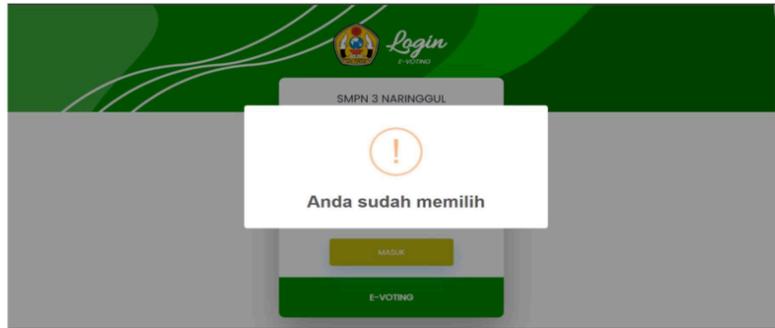


Figure 8. Already-Voted Notification

#### 5. Admin Login

A dedicated login page for the election committee. Once authenticated, the admin accesses the admin panel menus, including voter, candidate, and class data management, and real-time vote counts.

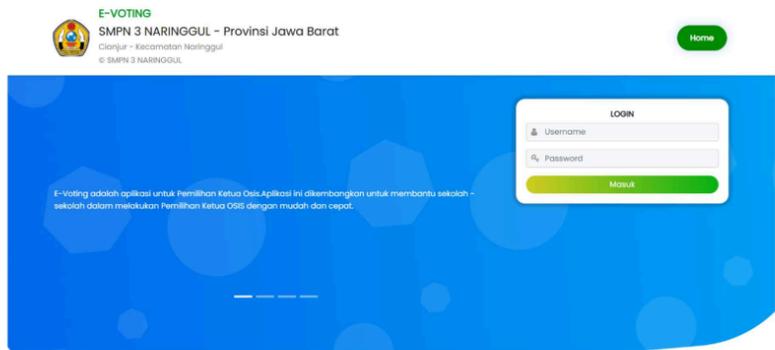


Figure 9. Admin Login

#### 6. Dashboard

The main admin page shows summaries and simple charts. Example: 3 classes (grades 7, 8, 9), 3 registered candidates, and 41 votes submitted. A chart visualizes interim vote percentages per candidate.

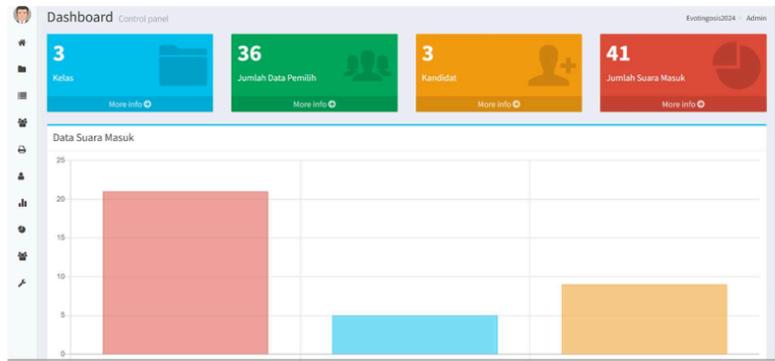


Figure 10. Dashboard

### 7. File Manager

Allows uploading supporting data in Excel to import voter or class data in bulk. The system processes and adds them to the database and displays the new entries.

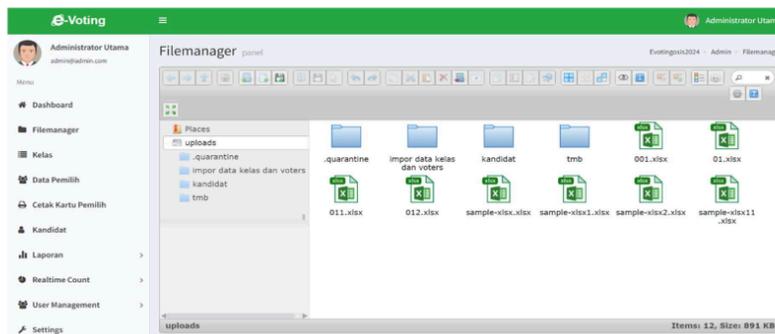


Figure 11. File Manager.

### 8. Class Data Input

Admins manage classes: add, import, export, or print. Each entry includes class name and number of students.

No	Kelas	Jumlah	Action
1	9	22	[Edit] [Delete]
2	8	20	[Edit] [Delete]
3	7	20	[Edit] [Delete]

Figure 12. Class Data Input

#### 9. Voter Data Input

Admins manage eligible students: add, update, delete. Columns include NIS, username, student name, class, gender, status, and edit options. Only active students can log in and vote.

No	NIS	Username	Nama	Kelas	L/P	Status	Aktif	Action
1	0304	miska	miska	9	P	Sudah Memilih	Aktif	[Edit] [Delete]
2	0303	ghea	ghea	9	P	Belum Memilih	Aktif	[Edit] [Delete]
3	0302	panji	panji	9	L	Sudah Memilih	Aktif	[Edit] [Delete]
4	0301	ilham	ilham	9	L	Sudah Memilih	Aktif	[Edit] [Delete]
5	0204	fani	fani	8	P	Sudah Memilih	Aktif	[Edit] [Delete]
6	0203	hanifah	hanifah	8	P	Sudah Memilih	Aktif	[Edit] [Delete]
7	0202	kamal	kamal	8	L	Sudah Memilih	Aktif	[Edit] [Delete]
8	0201	angga	angga	8	L	Sudah Memilih	Aktif	[Edit] [Delete]
9	0104	kawai	kawai	7	P	Sudah Memilih	Aktif	[Edit] [Delete]
10	0103	mesya	mesya	7	P	Sudah Memilih	Aktif	[Edit] [Delete]

Figure 13. Voter Data Input

#### 10. Voter Card Printing

Generates printable voter cards (name, class, username, unique password) for election day.



Figure 14. Voter Card Printing

### 11. Candidate Data Input

Admins add/edit candidate information (name, number, vision, mission, active status, photo).

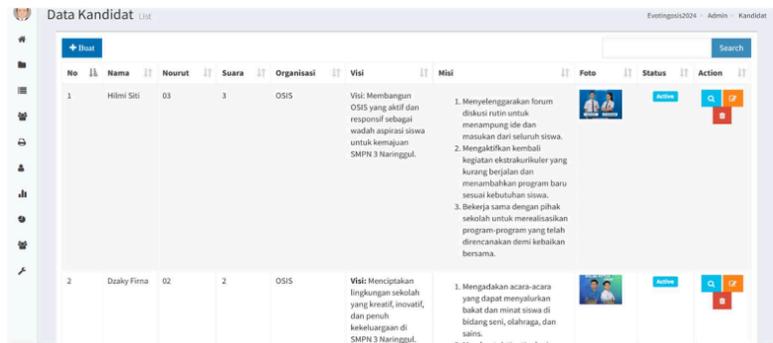


Figure 15. Candidate Data Input

### 12. Voter Attendance List

Shows participation status. Before voting, all are “not yet voted”; afterward, updated to “voted.”  
 Example: Bayu (grade 7) is present/already voted, Ghea (grade 9) is absent/not yet voted.

**PRINT ME!**  
**DAFTAR TENDIR**  
**PESERTA PEMUNGUTAN DAN PENGHITUNGAN SUARA**  
**SMPN 3 NARINGGUL**

No	NISN	Nama	Kelas	Keterangan
1	0101	Byyu	7	Tidak Hadir
2	0102	zarif	7	Tidak Hadir
3	0103	nesya	7	Tidak Hadir
4	0104	kawani	7	Tidak Hadir
5	0201	angga	8	Tidak Hadir
6	0202	kamal	8	Tidak Hadir
7	0203	hanifah	8	Tidak Hadir
8	0204	fani	8	Tidak Hadir
9	0301	ilham	9	Tidak Hadir
10	0302	panji	9	Tidak Hadir
11	0303	ghea	9	Tidak Hadir
12	0304	miska	9	Tidak Hadir

Waktu Server 01/08/2025 21:28:10

Figure 16. Attendance (Before Voting)

**PRINT ME!**  
**DAFTAR TENDIR**  
**PESERTA PEMUNGUTAN DAN PENGHITUNGAN SUARA**  
**SMPN 3 NARINGGUL**

No	NISN	Nama	Kelas	Keterangan
1	0101	Byyu	7	Hadir
2	0102	zarif	7	Hadir
3	0103	nesya	7	Hadir
4	0104	kawani	7	Hadir
5	0201	angga	8	Hadir
6	0202	kamal	8	Hadir
7	0203	hanifah	8	Hadir
8	0204	fani	8	Hadir
9	0301	ilham	9	Hadir
10	0302	panji	9	Hadir
11	0303	ghea	9	Tidak Hadir
12	0304	miska	9	Hadir
13	0105	manul	7	Hadir
14	0106	muhammad	7	Hadir
15	0107	maudy	7	Hadir
16	0108	ina	7	Hadir
17	0205	adam	8	Hadir
18	0206	saputra	8	Hadir
19	0207	helias	8	Hadir
20	0208	ayu	8	Hadir
21	0305	amaludin	9	Hadir
22	0306	adib	9	Hadir
23	0307	miska	9	Hadir

Figure 17. Attendance (After Voting)

13. Real-time Count

Displays live results during voting, updating totals and percentages per candidate. Example: candidate no. 01 leading with 21 votes (58.3%).



Figure 18. Real-time Count

#### 14. System Settings

Manage organizer profile (school name, location, address, logo) which appears in reports and cards.

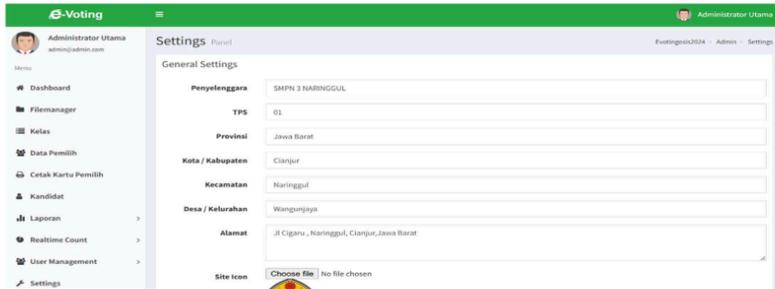


Figure 19. System Settings

After implementation, functional testing was carried out using Black-Box Testing. The goal is to ensure each function operates according to the defined specifications. Table 1 shows key scenarios and results.

Tabel 1. System Testing

No	Feature	Test Scenario	Test Data	Expected Result	Actual Result	Status
1	Voter Login	Login with valid credentials	Username: siswa01, Password: 12345	Successful login and redirected to voting page	As expected	Valid
2	Failed Voter Login	Login with wrong username/password	Username: siswa01, Password: xxxx	Access denied and error message shown	As expected	Valid
3	Admin Login	Admin login with valid credentials	Username: admin@admin.com, Password: admin123456	Successful login to dashboard	As expected	Valid

No	Feature	Test Scenario	Test Data	Expected Result	Actual Result	Status
4	View Candidate List	Voter opens voting page	Click Voting after login	Displays candidate photos, names, vision, and mission	As expected	Valid
5	Candidate Voting	Voter selects one candidate	Click Vote on candidate 01	Vote saved to database and confirmation page shown	As expected	Valid
6	“Already Voted” Validation	Voter who has voted tries to log in again	Username: siswa01, Password: 12345	Access denied with “Anda sudah memilih”	As expected	Valid
7	Real-time Count	Admin monitors vote results	Access Real Count menu	Displays total votes and percentage per candidate in real-time	As expected	Valid
8	Manage Voter Data (Add)	Admin adds a new voter	Form: NIS, Name, Class, Username, Password	Data saved and appears in voter list	As expected	Valid
9	Manage Candidate Data (Add)	Admin adds a new candidate	Form: Nama, No, Urut, Visi, Misi, Foto	Data saved and appears on candidate page	As expected	Valid
10	Print Voter Cards	Admin prints per class	Select Class: VIII-A → Print	Select Class: VIII-A → Print	As expected	Valid
11	Voter Attendance List	Admin opens attendance list	Attendance menu	Shows voted/not-yet-voted status per voter	As expected	Valid
12	Manage Class Data (Add)	Admin adds a new class	Form: Class Name, Student Count	New class saved and shown in list	As expected	Valid
13	File Manager – Import Data	Admin imports voter data (Excel)	Valid pemilih.xlsx	Data imported successfully and appears in voter list	As expected	Valid
14	System Settings	Admin updates organizer profile	School Name, Address, Logo	Changes saved and reflected on the website	As expected	Valid

### 3.2 Findings Analysis

Black-Box functional testing on 14 scenarios shows all main modules work according to specifications. Authentication correctly verifies credentials, distinguishes admin and voter access, and prevents double voting by marking “already voted.” The election flow from candidate listing, choice confirmation, to storing votes proceeded without anomalies. The real-time count feature displays accumulated votes directly, enabling quick monitoring without manual recap. On the management side, the admin panel simplifies routine operations: bulk import (classes/voters), candidate updates, voter card printing, and attendance monitoring. Output consistency across scenarios indicates that the UML-based design and PHP–MySQL implementation were correctly translated into application functionality.

### 3.3 Implications

The findings have practical consequences: (1) operational efficiency increases as recapitulation no longer depends on manual calculation; results are accessible immediately after polls close; (2) data accuracy and integrity are better maintained via prevention of double voting, structured records, and immediate result visibility, strengthening trust in the election; (3) committee workload decreases thanks to automation (importing data, printing cards, monitoring); (4) from a software engineering perspective, the sequential success of Waterfall stages confirms suitability for projects with relatively stable requirements such as OSIS elections. Broader implications include replicability in other schools with minimal adjustments and fostering students' digital literacy through participation in ICT-based elections.

### 3.4 Limitations

This study has several limitations: (1) single-school scope limits generalization to contexts with larger electorates or varying network infrastructure; (2) advanced security (e.g., end-to-end encryption, multi-factor authentication, detailed audit trail) has not been fully implemented; (3) usability evaluation has not covered standardized metrics (e.g., SUS, UEQ) or accessibility testing, so user experience is not quantitatively measured; (4) load and scalability testing was not systematically conducted to simulate large concurrent access; (5) comparative studies with other e-voting platforms were not performed, so relative advantages are still described internally.

## 4. Conclusion

This study successfully realized a reliable web-based OSIS e-voting system for SMPN 3 Naringgul using the Waterfall Methodology. Core features—voter authentication, candidate selection, double-vote prevention, real-time count, and admin panel—worked as designed through Black-Box Testing. The implementation accelerated result acquisition, minimized recording errors, and strengthened transparency. Future work includes stronger security (end-to-end encryption, MFA, role-based access control, audit logs), performance testing (load, stress, scalability), standardized usability assessment, and cloud-based deployment options for easier maintenance and replication. With these steps, the system is expected to be ready for wider adoption as a good practice in digitalizing OSIS elections.

### Acknowledgment

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### Declarations

Author Contributions: Aziz Stiawan Amrullah designed the system architecture, developed the software, and conducted functional testing. T.D. (Tedjo Darmanto) supervised methodology design, validated results, and reviewed the manuscript. Both contributed to data analysis and final manuscript preparation.

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**Conflict of Interest:** The authors declare no conflict of interest.

**Additional Information:** Part of the research outcomes have been socialized to the school and received positive responses. The e-voting system is planned for use in the next OSIS election period at SMPN 3 Naringgul.

**Data and Software Availability:** The e-voting source code and datasets (sample voter and candidate data) are available from the corresponding author upon reasonable request. The application has also been deployed on the school's local server for trials and demonstrations.

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