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Final User Manual

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Table of Contents

1. INTRODUCTION	1
2. OVERVIEW OF ELECTSG.....	2
3. DATA PROTECTION AND PRIVACY SAFEGUARDS	3
4. HOW ELECTSG WORKS	4
4.1 Public key cryptography tools and RingCT protocol	4
4.1.1 Generation of voting currency for each district voter populations.....	4
4.1.2 Candidate keys generation	5
4.1.3 Voter registration and generation of Hash identifier	5
4.1.4 Voter casts vote	6
5. PRIVACY-PRESERVING TRANSACTION VERIFICATION.....	10
6. VERIFIABLE SECURITY: UNIT TESTING IN CRYPTOGRAPHIC SYSTEMS... 	10
7. USING ELECTSG AS GENERAL USER.....	11
7.1 General User Home Page	11
7.2 General User View Announcements	12
7.3 General User View Districts	13
7.4 General User View Candidates and Ongoing Result	14
7.5 General User View Final Results	15
8. USING ELECTSG AS SYSTEM ADMIN.....	17
8.1 Admin Log in	17
8.2 Admin Interface	22
8.3 Admin Change Password.....	22
8.4 Admin Register WebAuthn.....	23
8.5 Admin Delete Own Account's Non-master Credentials.....	24
8.6 Admin Delete All Non-masters' Credentials	24
8.7 User Account.....	25
8.7.1 Creating an Account	25
8.7.2 Creating Multiple Candidate Accounts	25
8.7.3 Viewing Accounts	26
8.7.4 Updating an Account	26
8.7.5 Deleting an Account	28
8.7.6 Deleting an Account's Credentials.....	29
8.6.7 Searching an Account	29

8.8 User Profile.....	31
8.8.1 Creating a User Profile	31
8.8.2 Viewing User Profiles	31
8.8.3 Updating a User Profile	32
8.8.4 Deleting a User Profile.....	34
8.9 Electoral District	35
8.9.1 Creating a District	35
8.9.2 Creating Multiple Districts.....	35
8.9.3 Viewing Districts	36
8.9.4 Updating a District	36
8.9.5 Deleting a District	37
8.9.6 Searching a District	38
8.10 Announcement	39
8.10.1 Creating an Announcement.....	39
8.10.2 Viewing Announcements	40
8.10.3 Updating an Announcement	41
8.10.4 Deleting an Announcement	42
8.11 Election Party	43
8.11.1 Creating a Party.....	43
8.11.2 Viewing Parties.....	44
8.11.3 Updating a Party	44
8.11.4 Deleting a Party	46
8.12 Changing Election Phase.....	47
8.13 Downloading Non-voters List	48
8.14 Admin Log out	49
9. USING ELECTSG AS CANDIDATE	51
9.1 Candidate Log in	51
9.2 Candidate Interface	55
9.3 Candidate Change Password	56
9.4 Candidate Register WebAuthn.....	56
9.5 Candidate Delete Own Account's Credentials	57
9.6 Election Poster	57
9.6.1 Uploading a Poster	57
9.6.2 Viewing a Poster.....	59

9.6.3 Deleting a Poster	59
9.7 Candidate Statement	61
9.7.1 Editing a Statement	61
9.7.2 Viewing a Statement.....	62
9.7.3 Deleting a Statement	63
9.8 Profile Picture	64
9.8.1 Uploading a Profile Picture	64
9.8.2 Viewing a Profile Picture.....	65
9.8.3 Deleting a Profile Picture	66
9.9 Candidate Log out.....	67
10. USING ELECTSG AS VOTER	68
10.1 Voter Log in	68
10.2 Voter Interface.....	69
10.3 Viewing Candidates	69
10.4 View Candidate's poster and statement.....	70
10.5 Casting Vote.....	71
10.6 Voter Log out.....	73
11. ADMIN STARTUP GUIDE.....	74
11.1 Startup Guide for ElectSG.....	74
11.1.1 Application Hosting and Handover	74
11.1.2 Admin Account Setup	74
11.1.3 FIDO2 Device Registration for WebAuthn.....	74
11.1.4 Managing WebAuthn Devices	75
11.1.5 Security and Best Practices.....	75
12. APPENDIX: VOTE RECORD	76

1. Introduction

This user manual provides comprehensive guidance on using our e-voting system, developed specifically for the Singapore general election. Using Ring Confidential Transactions (RingCT) technology, this system ensures high levels of data and user anonymity by securely concealing voter identities and their vote selections.

This manual includes a detailed, step-by-step guide to help all users, including voters, candidates, and system administrators, efficiently use the e-voting system. The instructions provided will ensure a smooth and secure voting experience.

2. Overview of ElectSG

ElectSG is an e-voting platform designed to eliminate the manual processes involved in general elections while preserving the benefits of traditional physical voting. One of its key features is the enhancement of voter anonymity. Voter logins to the system via Singpass, however, there is no information stored in the system, the system stores the hash identifier of the voter instead. When a voter casts their vote on ElectSG, they use a linkable ring signature, which incorporates a one-time public key and a secret key. These keys are derived from non-identifiable view and spend keys, ensuring that no personal information is linked to the voter.

The voting process on ElectSG involves transforming the voter's choice into a cryptographic signature using advanced cryptographic tools. This transformation ensures that even the election authorities cannot determine the voter's choice. After the election concludes, the system can cryptographically tally the votes for each candidate by district without revealing the identities of the voters.

ElectSG successfully captures the essence of physical voting by maintaining voter anonymity. Additionally, it introduces two more layers of anonymity: the vote itself and the candidate receiving the vote remain confidential. This system allows the General Election Authority to maintain the orderly flow of the election process while ensuring the privacy and security of the voters' choices.

3. Data Protection and Privacy Safeguards

At ElectSG, we are committed to ensuring that the transition to electronic voting does not force a compromise between personal privacy and the integrity of the general election. Our platform is specifically designed to protect user privacy by not storing any personally identifiable information. The system includes several key safeguards:

- **No Collection of Personally Identifiable Information:** ElectSG does not store any personal information from a voter's Singpass login. Instead, we use a securely stored cryptographic hash identifier to maintain voter anonymity.
- **Unidentifiable Database Logs:** While election authorities have access to the voting logs, these logs are designed to be unidentifiable. This means that authorities cannot interpret the meaning of any outputs, ensuring that voter actions remain anonymous.
- **No Third-Party Access:** ElectSG ensures that third parties cannot access the voting logs, which consist of cryptographic outputs. This further protects the privacy and security of the voting process.

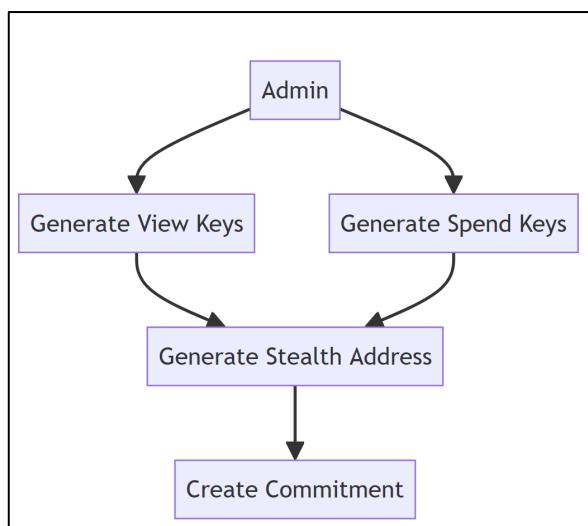
4. How ElectSG works

4.1 Public key cryptography tools and RingCT protocol

ElectSG utilizes Elliptic Curve Cryptography (ECC) with the Ed25519 curve for its cryptographic operations, which is crucial for implementing Ring Confidential Transactions (RingCT). Ed25519 is chosen because it offers high security with efficient performance, making it ideal for secure digital signatures. This curve provides strong protection against attacks while ensuring fast processing, which is essential for maintaining the privacy and integrity of votes in the e-voting platform. By centering its operations around Ed25519, ElectSG ensures that all cryptographic transactions are both secure and efficient, safeguarding voter anonymity and data integrity.

4.1.1 Generation of voting currency for each district voter populations

At the beginning of the election, the returning officer collects the total voter population for each district and inputs this data into the system. This process generates a corresponding number of view and spend keys for each voter in the district. The keys are stored in a separate database securely where the authority does not have access to.



These keys are then used to create a stealth address, also known as the transaction public key, for each voter. In the computation of stealth address, it requires two parties: sender and receiver. In ElectSG, the sender is the system itself, and the receiver is the voter. This is to ensure each voter would be given exactly one stealth address copy to spend on with outsider could not tell the receiver of the stealth address.

Then, the system would generate Perdersen commitment for the “voting currency” for each stealth address. The “voting currency” is concealed within the commitment itself as shown in the output snippet below.

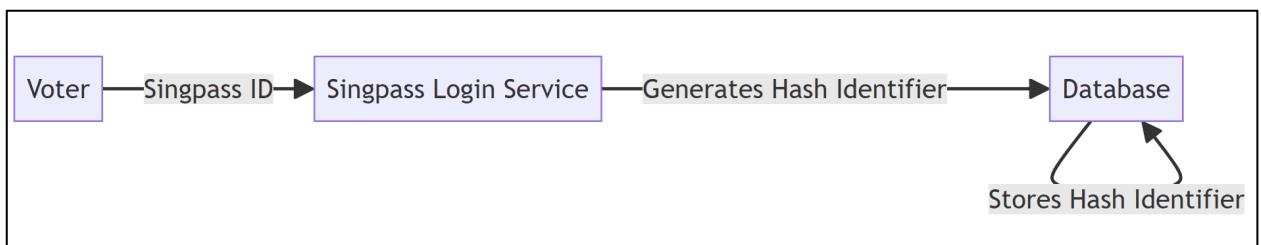
```
"stealth_address":7e4e3f197d852e74ad2853d8414450a73211f137ccb1b4733eb4acf586791e92,
{
  "rG": "b5a212217e74f635c04ae202572b81ff8f2a65bd24e7133708b840d8752e6a15",
  "commitment": {
    "amount_mask": "38a897e4671a2cce",
    "input_commitment": "3a4007876d919e0609e499dc96993ba63065aebd5d5f4ff8627b3c75ffda1acb",
    "output_commitment": "a0f414044e2cb8009469e204fa5b2db9229566bd9508206e36bdf65b3d3e6a2a",
    "pseudoout_commitment": "a0f414044e2cb8009469e204fa5b2db9229566bd9508206e36bdf65b3d3e6a2a"
  }
}
```

Record of generation of voting currency

4.1.2 Candidate keys generation

Candidates are also required to have view and spend keys to complete the RingCT protocol. Thus, the voter could access the candidate public view and spend keys to cast their vote to the candidate by forming cryptographic tools that will mentioned in the later section.

4.1.3 Voter registration and generation of Hash identifier

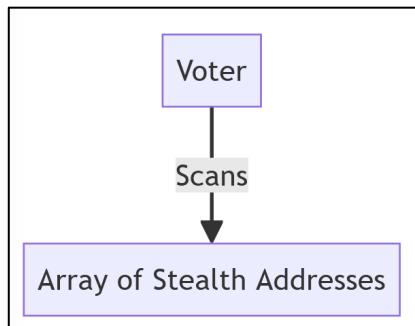


When a voter logs into the system via Singpass, it is treated as a registration to the voting platform. The backend service generates a unique hash identifier associated with the voter. Importantly, no personally identifiable information is required from the user. This hash identifier is then securely stored in the database. Then, the voter is assigned with one of the public viewing key from the step in the generation of voting currency.

4.1.4 Voter casts vote

Casting vote in ElectSG revolves around many steps. Here we would break down the step into small sections. And the full output of a voter transaction record is shown in the **Appendix**.

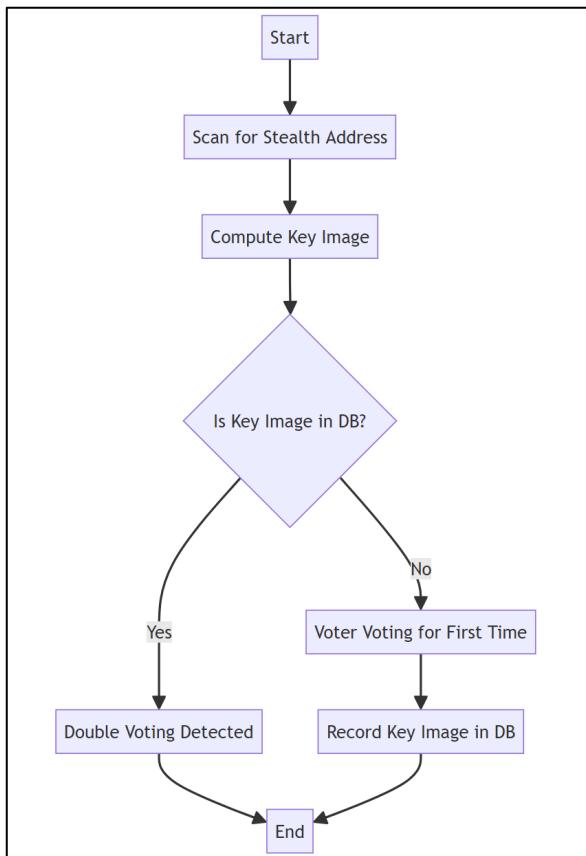
Voter casts vote: Voter scans for stealth address



After the voter logs in and casts their vote through the web application frontend, the backend service scans for the voter's stealth address. This is necessary because the stealth address lacks any identifiable information, requiring a database-wide scan to locate the correct address. A stealth address is a unique, one-time address that conceals the voter's identity in a transaction, ensuring that even if a transaction is visible in the database, it cannot be linked back to the voter. The stealth address only belongs to the user if the voter can compute the necessary cryptographic keys, ensuring that only the intended recipient (voter) can access the transaction.

Voter casts vote: Compute Key Image (Double Voting Detection)

Once the correct stealth address is identified, the system computes a key image. The key image is crucial because it acts as a unique identifier for each transaction without revealing the voter's identity. It ensures that each vote is counted only once, preventing double voting while maintaining the anonymity of the voter. This process is essential for preserving the integrity and security of the voting system.



A diagram outlines the flow of double voting

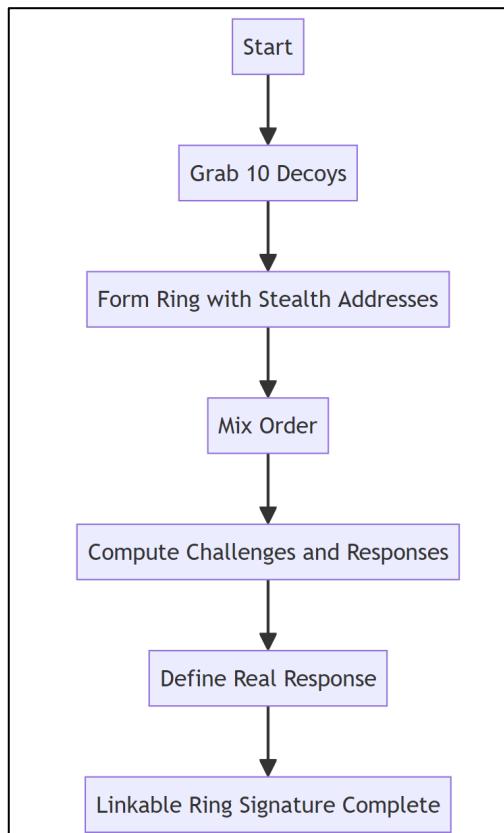
Voter casts vote: Compute commitment for Candidate

Similar to system generate the commitment (voting currency) for voter to use, the vote casting involves voter uses voting currency received to send to candidate. The use of voting currency prevents tampering and guarantees that every vote is accounted for accurately. Additionally, it allows for easy verification and auditing of the election process without exposing individual voter identities.

Voter casts vote: Range proof

Next, the system compute range proofs that are used to ensure that votes are valid without revealing the actual vote value. The range proof, based on Borromean signatures. This allows reviewer or auditor to verify the transaction falls within acceptable range while maintaining voter privacy while ensuring the integrity of the election process.

Voter casts vote: Back's Linkable Spontaneous Anonymous Group Signature



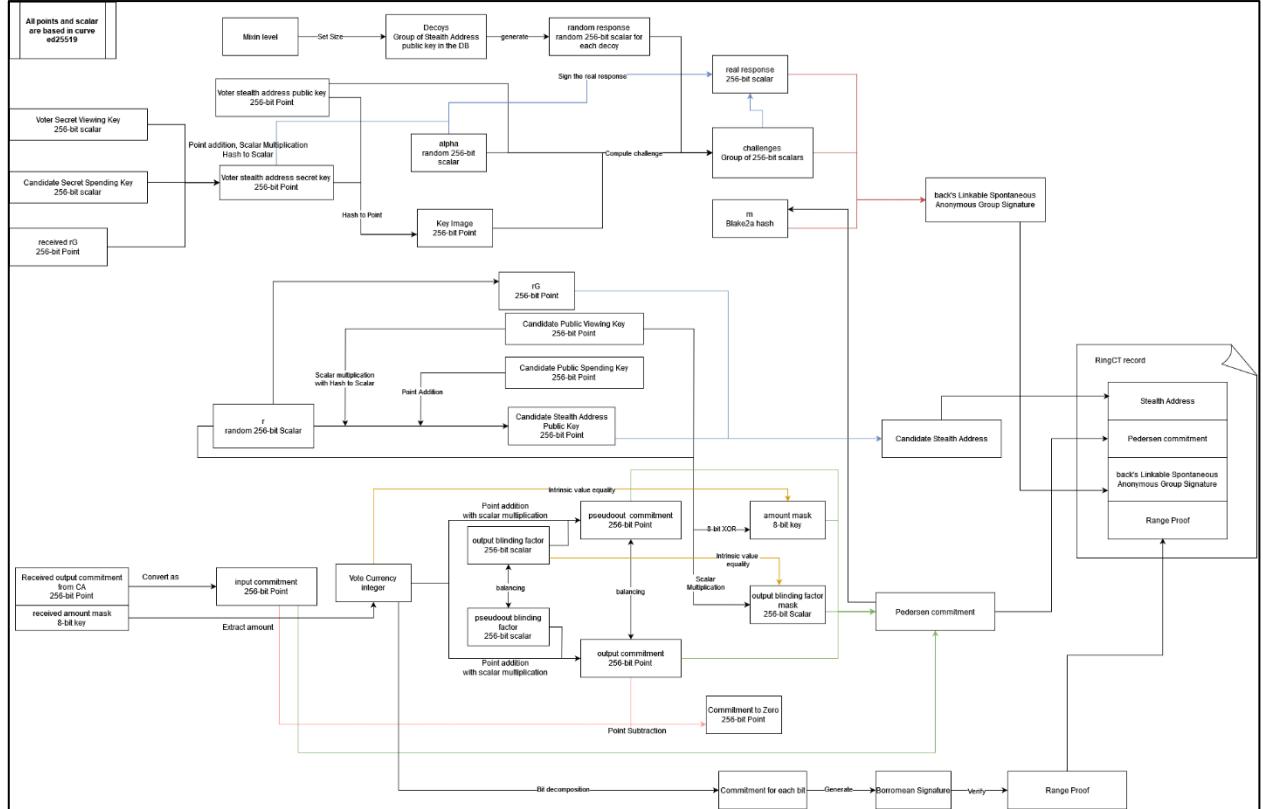
After the other prerequisites are done, the system generates the bLSAG (Back's Linkable Spontaneous Anonymous Group Signature) to ensure transaction voter anonymity and integrity. It begins by selecting 10 decoy addresses from a pool of stealth addresses to form a ring, which helps obscure the real signer. The order of these addresses is then mixed to further enhance privacy. Next, cryptographic challenges and responses are computed for each address in the ring. The real response is defined for the actual signer (voter), completing the linkable ring signature process. This method ensures that while the transaction is verifiable by the system or auditor, the identity of the signer remains anonymous.

Vote counting

Once polling concludes, the system tallies the votes by identifying the candidate linked to each stealth address. This approach ensures precise vote counting while keeping voter identities confidential. Stealth addresses allow the system to securely map votes to candidates, enhancing the election's integrity and transparency, and ensuring privacy is protected.

Data flow analysis

The following diagram shows the complete data flow of the whole election in terms of RingCT cryptographic operations.



5. Privacy-Preserving Transaction Verification

In ElectSG, we designed the entire database of election records to be both verifiable and privacy-preserving. This means that auditors of the general election can verify the integrity and authenticity of the transaction records without accessing any personally identifiable information. The system uses cryptographic techniques to ensure that while the data is transparent and auditible, individual voter identities remain confidential. This approach maintains the balance between transparency for auditing purposes and the privacy of voters, ensuring trust in the electoral process. One voter transaction record is provided in the Appendix section for demonstration purposes.

6. Verifiable Security: Unit Testing in Cryptographic Systems

To ensure the reliability and reproducibility of our cryptographic tools, we implement comprehensive unit tests. These tests are designed to validate each component of the cryptographic processes, ensuring that they function correctly and consistently under various conditions. By rigorously testing the algorithms and their implementations, we can detect any discrepancies or errors early in the development process. This approach guarantees that the cryptographic tools perform as expected, maintaining the security and integrity of the election records. Through these unit tests, we provide auditors with confidence in the system's ability to preserve privacy while enabling transparent verification of the election data.

7. Using ElectSG as General User

7.1 General User Home Page

Firstly, go to this url <https://elect-sg.cookndrum.com/> to access our system. The general user will land on this home page, as shown below.

The screenshot shows the ElectSG General User Home Page. At the top, there is a navigation bar with the ElectSG logo, Home, About us, and Log in links. The main content area has a red header with the title "Election Status: Polling Day". Below this, there are two boxes: "Election Starts" (The election has officially started.) and "Cooling Day" (Cooling Day has officially started.). A "View All" button is located at the bottom right of these boxes. To the right of the boxes is a map of Singapore divided into 29 constituencies, each labeled with a number. The constituencies are color-coded: blue (27, 28, 29), green (24, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1), pink (12, 11), yellow (18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1), and orange (1). The map also includes labels for "Caenewies", "Pulau Ubin", and "Sentosa". At the bottom, there is a footer with the ElectSG logo, Contact Us (Email: contact@electsg.com, Phone: +65 80656786), and Support (Email: support@electsg.com, Phone: +65 87666543).

7.2 General User View Announcements

1. Click “View All” as shown in the figure below.

Election Status: Polling Day

Election Starts
The election has officially started.

Cooling Day
Cooling Day has officially started. **1**

View All

Contact Us
Email: contact@electsg.com
Phone: +65 80656786

Support
Email: support@electsg.com
Phone: +65 87666543

2. The general user will see the announcements as below.

All Announcements

Election Starts
The election has officially started.
Date: Jan. 1, 2024, 8 a.m.

Cooling Day
Cooling Day has officially started.
Date: Jan. 1, 2024, 8 a.m.

Polling Starts
The polling has officially started.
Date: Jan. 1, 2024, 8 a.m.

7.3 General User View Districts

- Click the districts picture as shown in the figure below.

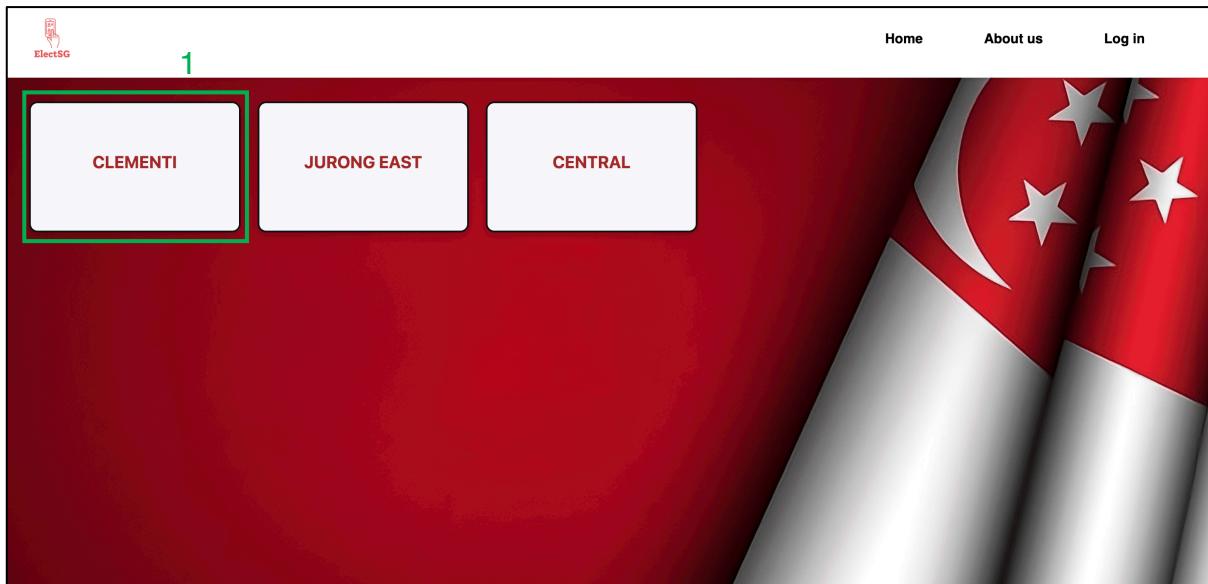
The screenshot shows the ElectSG website interface. At the top, there is a red header bar with the ElectSG logo, navigation links for 'Home', 'About us', and 'Log in', and a small red icon. Below the header is a main content area with a dark red background. On the left, there are two white boxes: 'Election Starts' (with the message 'The election has officially started.') and 'Cooling Day' (with the message 'Cooling Day has officially started.'). A green button labeled 'View All' is located at the bottom right of these boxes. To the right is a map of Singapore divided into numbered districts (1 through 28) and labeled areas like 'Clementi', 'Jurong East', 'Central', 'Sentosa', 'Pulau Ubin', and 'Changi Airport'. A green box highlights district 1, and a green arrow points to it from the text above. At the bottom of the page, there is a footer bar with the ElectSG logo, contact information for 'Contact Us' (Email: contact@electsg.com, Phone: +65 80656786), and support information (Email: support@electsg.com, Phone: +65 87666543).

- The general user will see all the available districts.

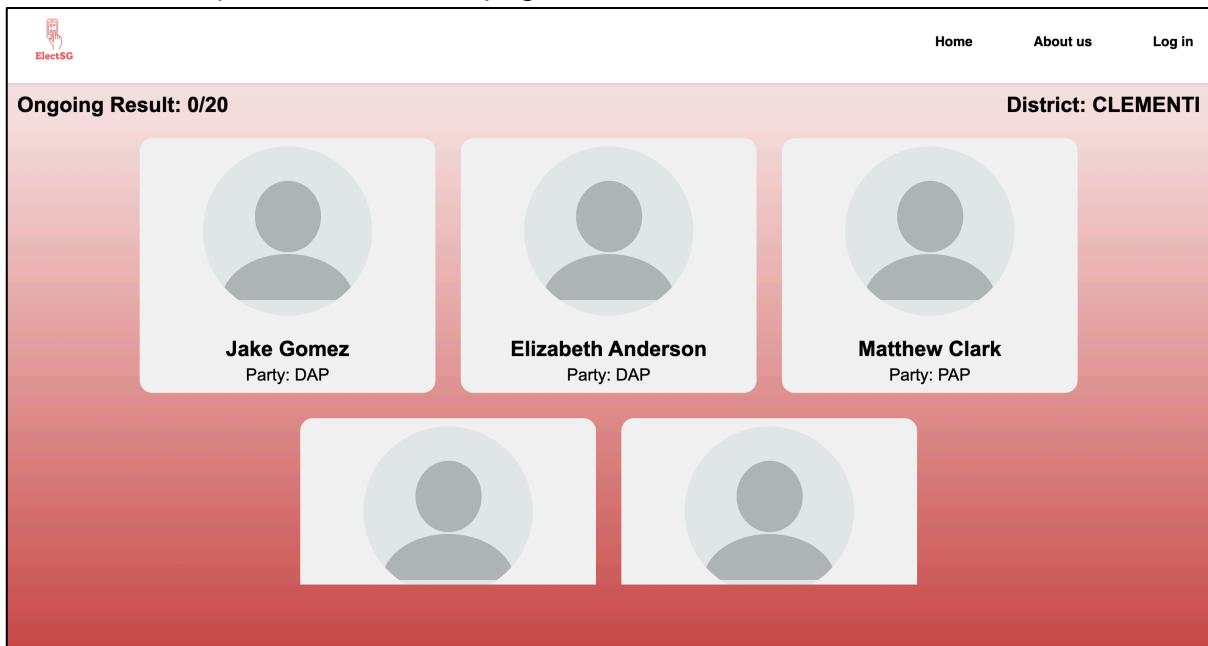
The screenshot shows the ElectSG website interface. At the top, there is a red header bar with the ElectSG logo, navigation links for 'Home', 'About us', and 'Log in', and a small red icon. Below the header is a main content area with a dark red background. In the center, there are three large, light-colored rectangular buttons with rounded corners, each containing a district name in red capital letters: 'CLEMENTI', 'JURONG EAST', and 'CENTRAL'. To the right of these buttons is a large, stylized graphic of the Singapore flag. At the bottom of the page, there is a footer bar with the ElectSG logo, contact information for 'Contact Us' (Email: contact@electsg.com, Phone: +65 80656786), and support information (Email: support@electsg.com, Phone: +65 87666543).

7.4 General User View Candidates and Ongoing Result

1. Click the specific “district” to see the candidates in that district. As an example, I will click the Clementi district.

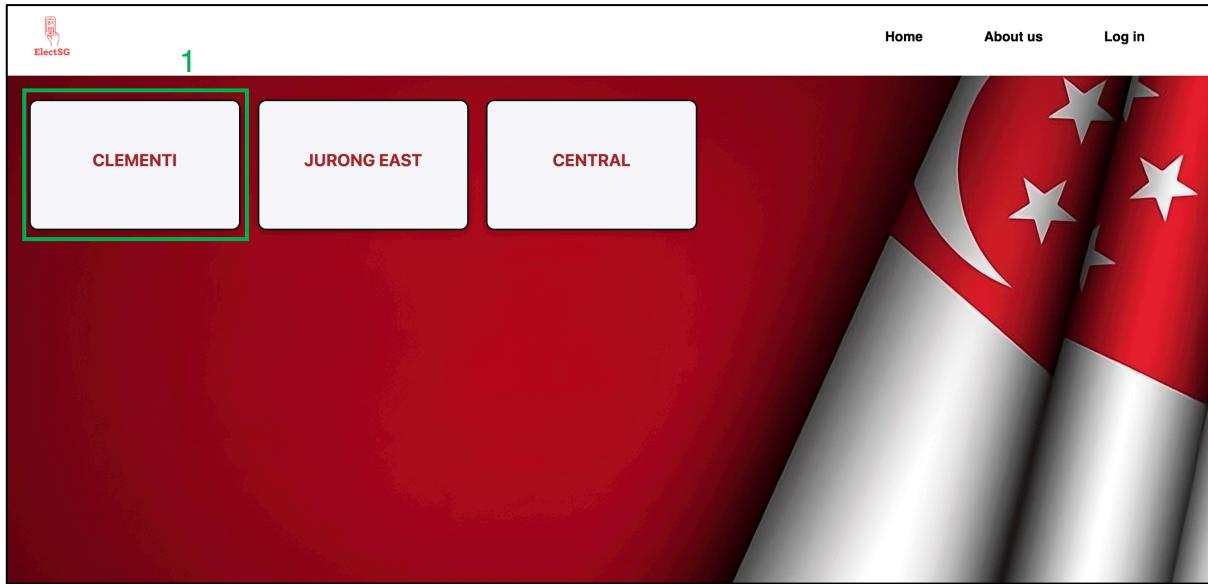


2. The general user will see all the candidates in the Clementi district and ongoing result on the top left corner of the page.



7.5 General User View Final Results

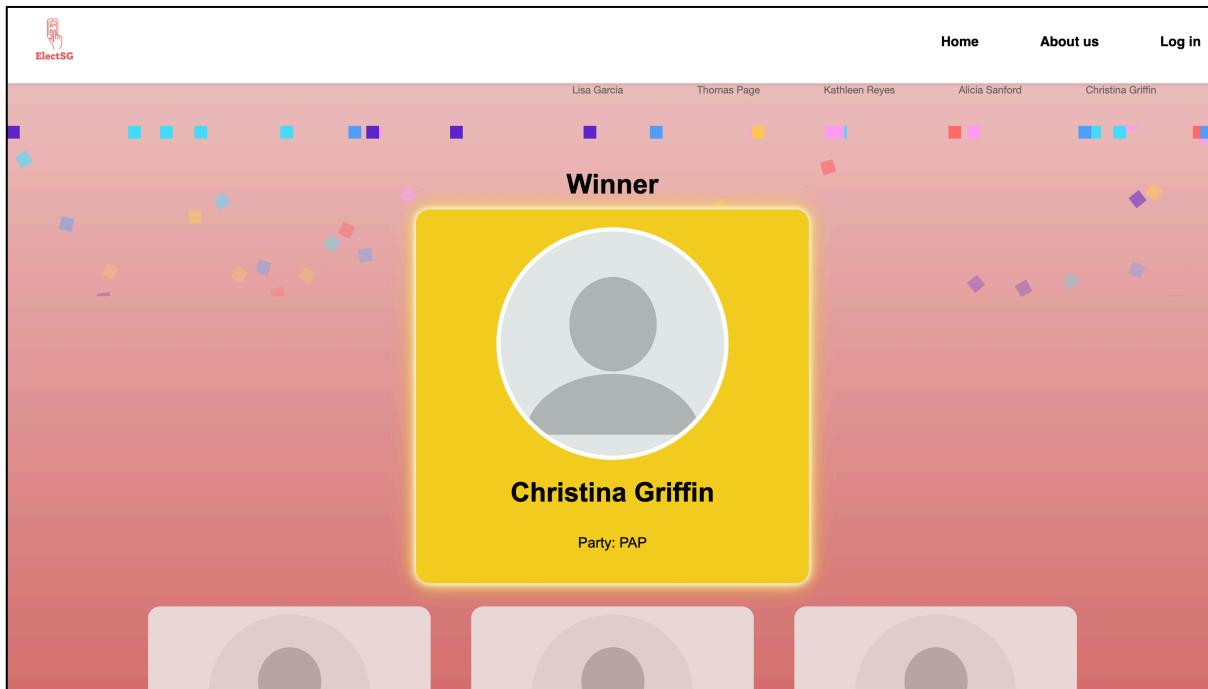
1. Click the specific “district” to see the final result in that district. As an example, I will click the Clementi district.



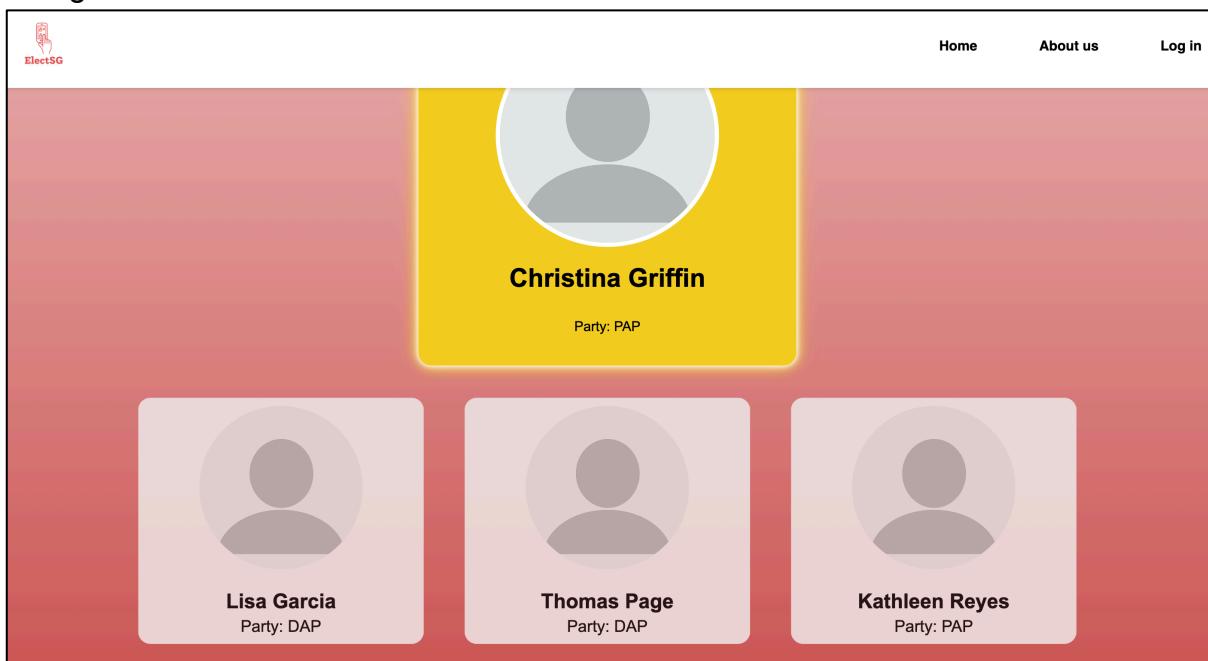
2. The general user will see the final result showing with the pie chart and histogram in that Clementi district.



The general user will also see the winner candidate as below.



The general user will also see the candidates who did not win as below.



8. Using ElectSG as System Admin

8.1 Admin Log in

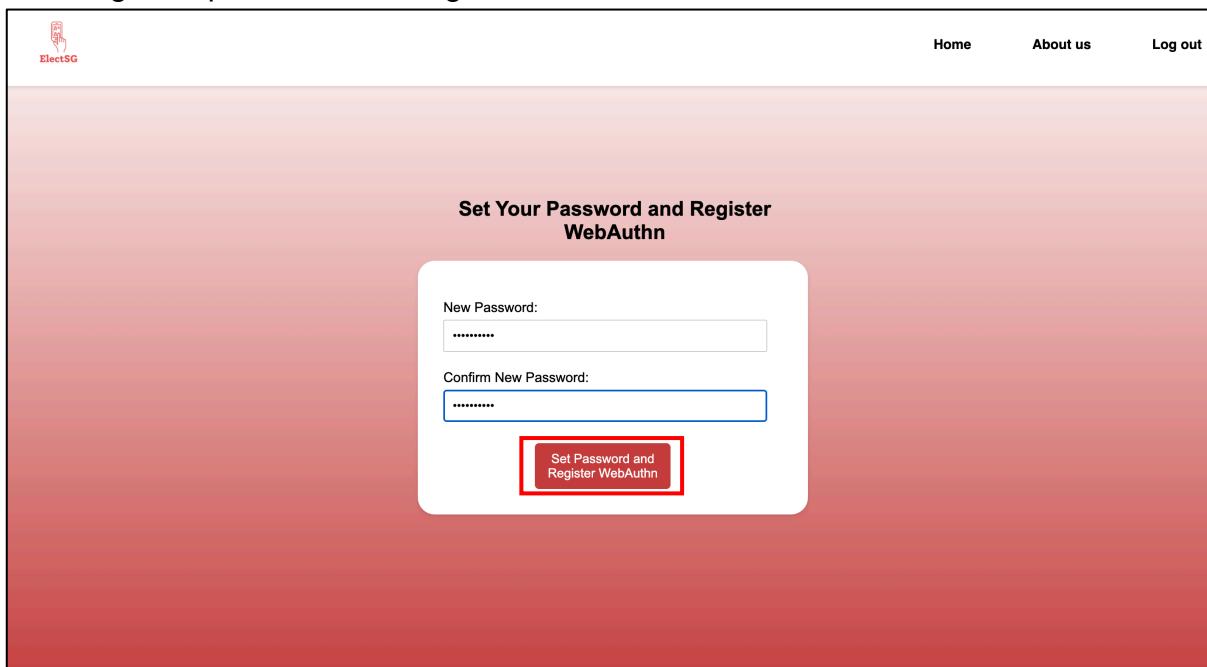
1. The admin click the “Login” in the navigation bar.

The screenshot shows the main dashboard of the ElectSG system. At the top, there's a navigation bar with links for "Home", "About us", and "Log in". The "Log in" button is highlighted with a red box. Below the navigation bar is a large red banner with the text "Election Status: Polling Day". On the left side of the banner, there are two boxes: "Election Starts" (with the message "The election has officially started.") and "Cooling Day" (with the message "Cooling Day has officially started."). Below these boxes is a "View All" button. To the right of the banner is a map of Singapore divided into 29 constituencies, each labeled with a number. The constituencies are color-coded: green (24, 25, 26, 27, 28, 29, 21, 22), blue (20, 19, 18, 17), yellow (16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1), pink (18), and red (1). At the bottom of the page, there's a footer section with "Contact Us" and "Support" information, along with "My Account", "Home", and "About us" links.

2. Fill in Username and Password. Then click “Login”.

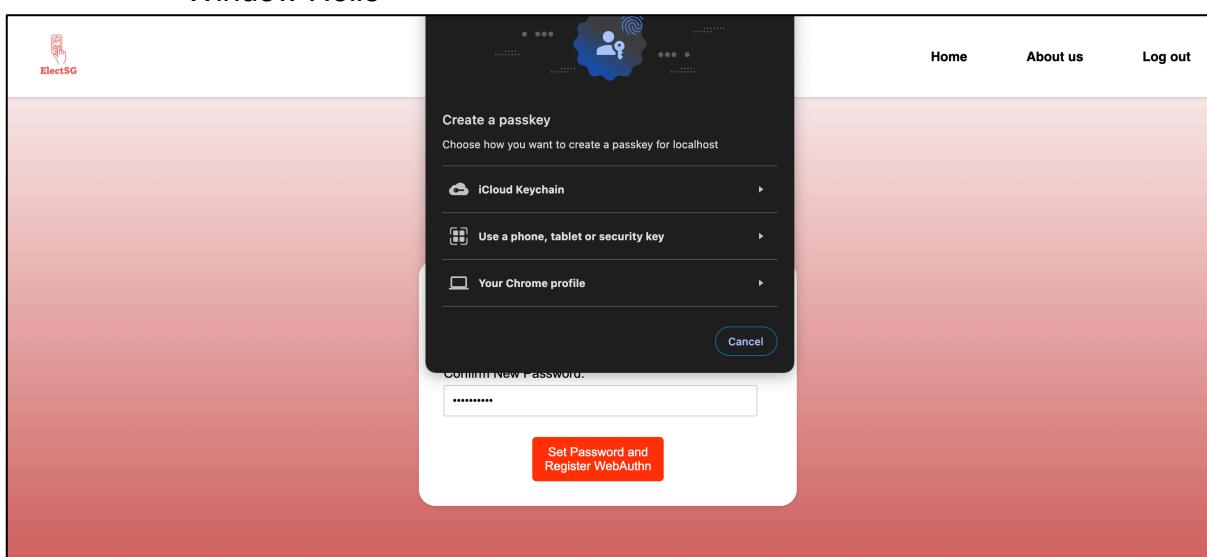
The screenshot shows the login page of the ElectSG system. At the top, there's a navigation bar with links for "My Account", "Home", and "About us". The "My Account" link is highlighted with a red box. Below the navigation bar is a "Login" form. It includes a "Login with Singpass" button, a "Or" link, and input fields for "Username" and "Password". The "Login" button at the bottom of the form is also highlighted with a red box. At the bottom of the page, there's a footer section with "Contact Us" and "Support" information, along with "My Account", "Home", and "About us" links.

3. If the user is logging in for the first time, he will be redirect to “set password and register web authn” page.
4. Fill in the new password then click “Set Password and Register WebAuth” button to change the password and register the web authentication.

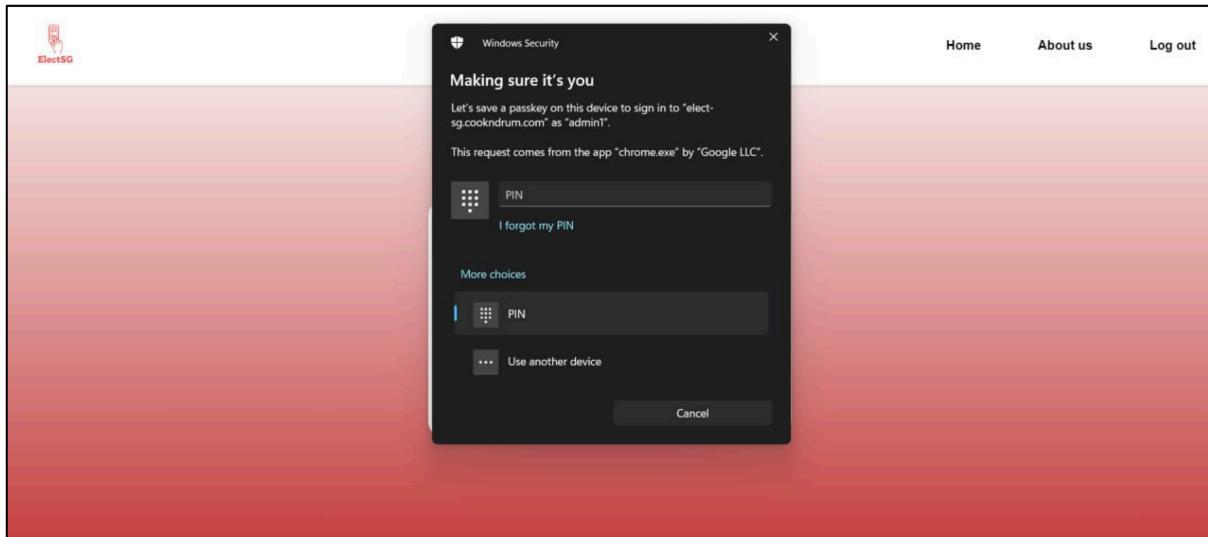


The user will be given several options based on the device he is using:

- iCloud Keychain
- Your Chrome Profile
- Use a phone, tablet or security key
- Window Hello



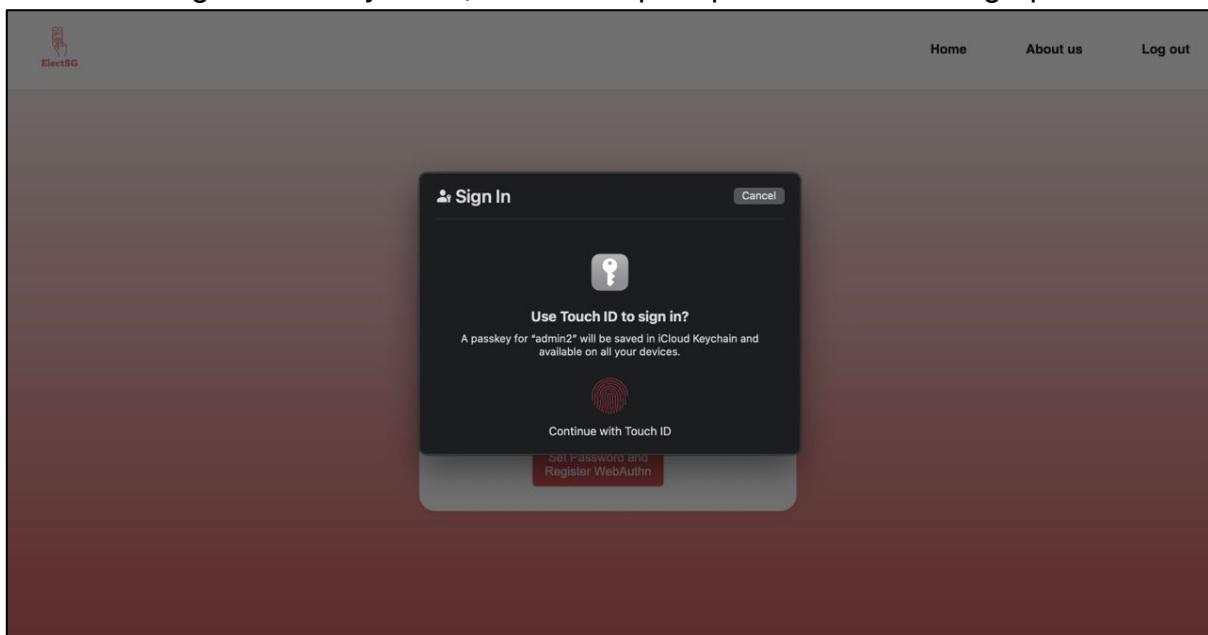
The above picture is the screenshot of the device that has biometric built-in.



The above picture is the screenshot of the device that doesn't have biometric built-in.

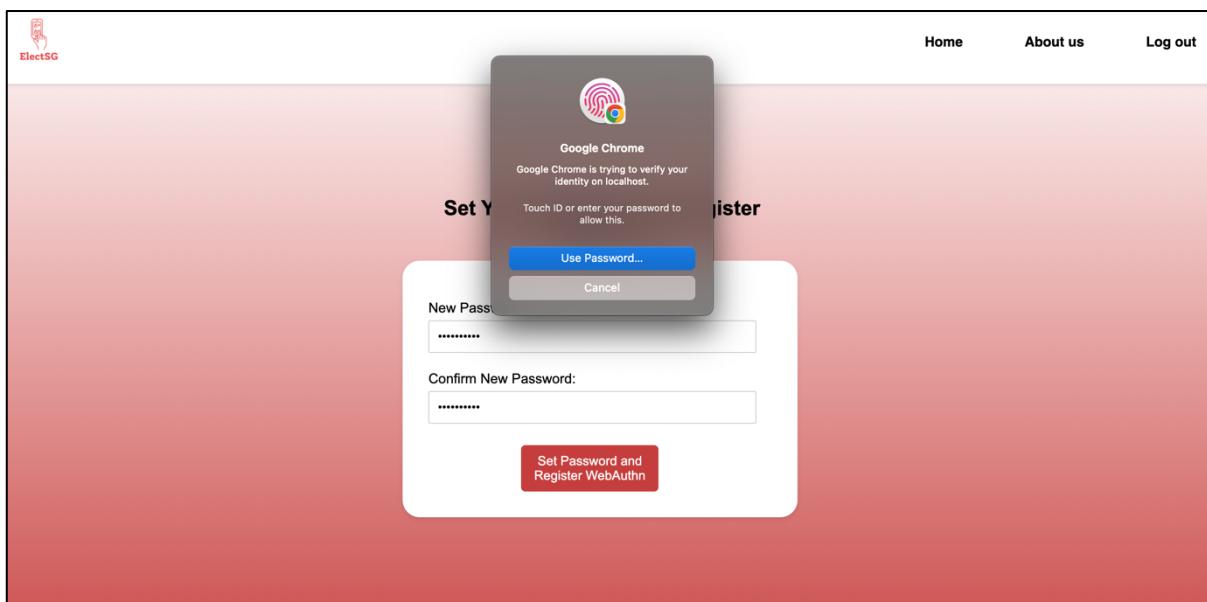
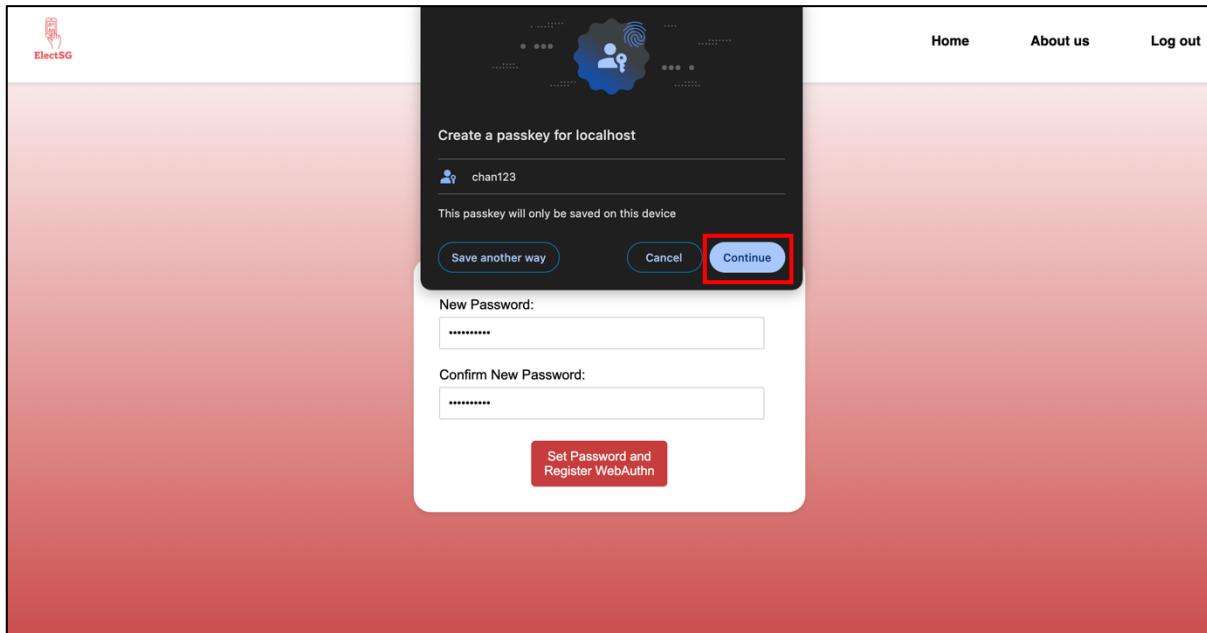
[Option 1 – iCloud Keychain]

After choosing 'iCloud Keychain', the user is prompted to enter his fingerprint.



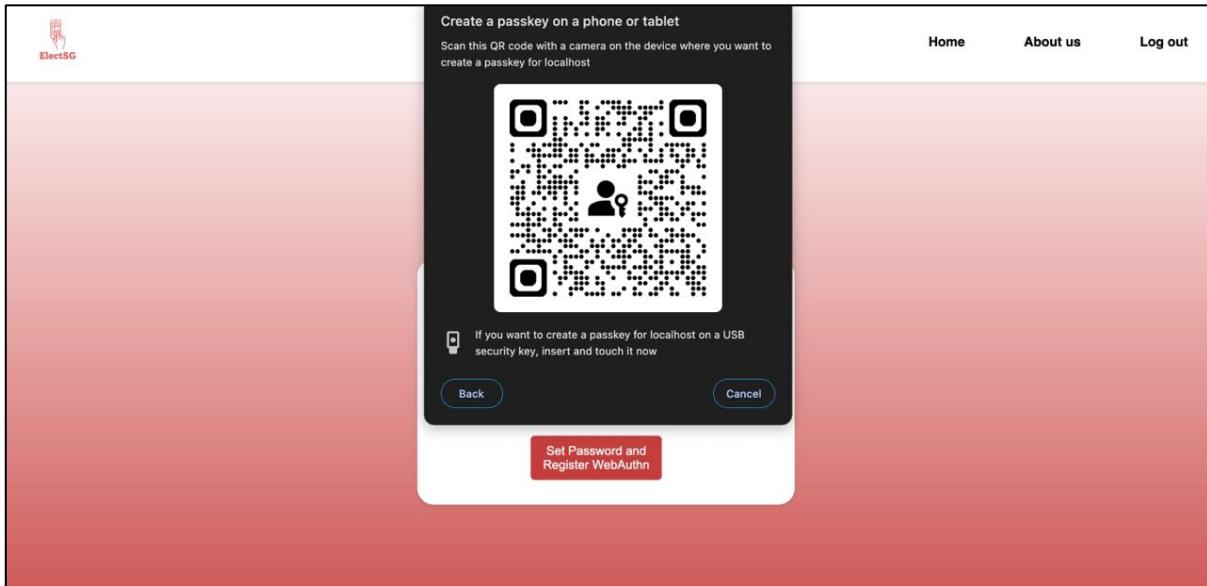
[Option 2 – Your Chrome Profile]

After choosing ‘Your Chrome Profile, the user is prompted to enter his fingerprint.



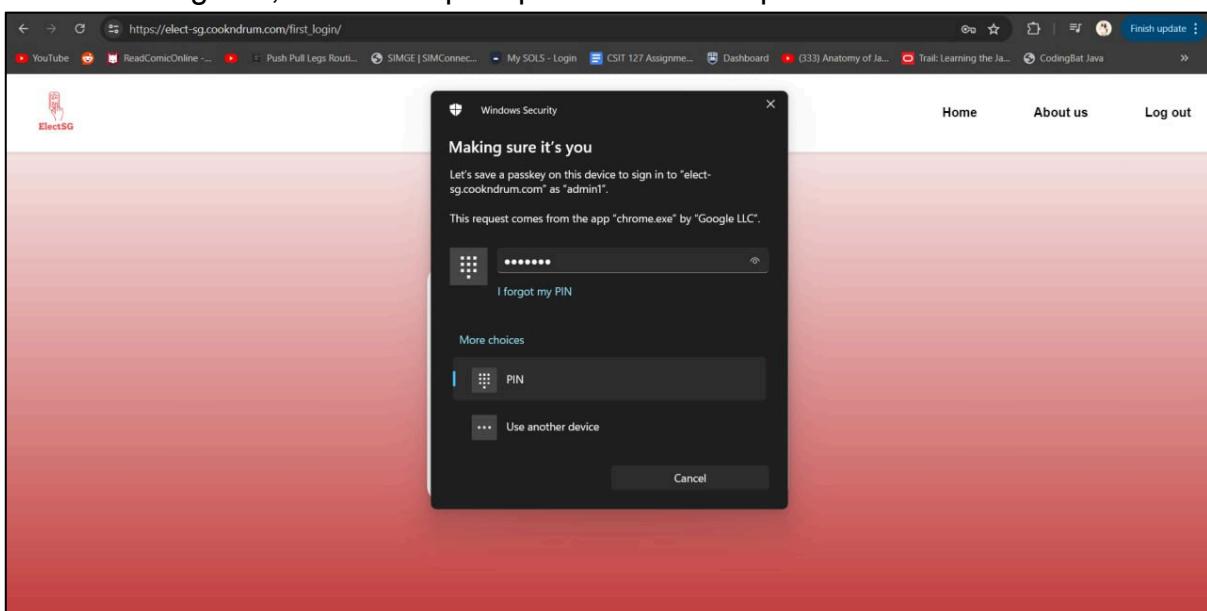
[Option 3 – Use a phone, tablet or security key]

After choosing ‘Use a phone, tablet or security key’, the user is prompted to scan the QR code with the phone or tablet.



[Option 4 – Window Hello]

After choosing ‘Pin, the user is prompted to enter the pin number.



After setting password and registering webauthn, the user will be redirected to ‘Admin Home’ page.

8.2 Admin Interface

This is Admin Homepage that admin will see after logging in.

The screenshot shows the Admin Homepage with a red sidebar on the left containing navigation links: User Account, User Profile, District, Election Status, Announcement, and Party. The main content area displays three announcements in boxes:

- Election Starts**: The election has officially started. Date: Jan. 1, 2024, 8 a.m.
- Cooling Day**: Cooling Day has officially started. Date: Jan. 1, 2024, 8 a.m.
- Polling Starts**: The polling has officially started. Date: Jan. 1, 2024, 8 a.m.

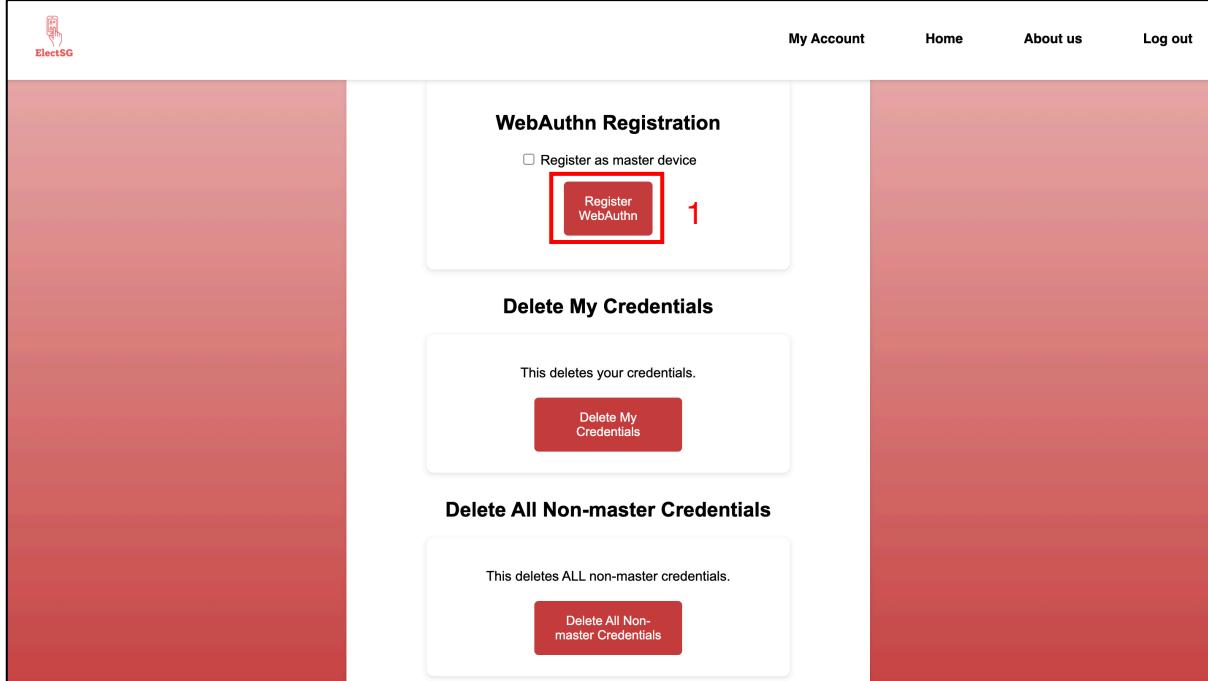
8.3 Admin Change Password

1. Fill in appropriate details in respective fields.
2. Click “Change Password”.

The screenshot shows the "My Account" section with a "Change Password" form. The form contains three input fields: "Current Password", "New Password", and "Confirm New Password". A red bracket labeled "1" groups the "New Password" and "Confirm New Password" fields. A red box labeled "2" surrounds the "Change Password" button.

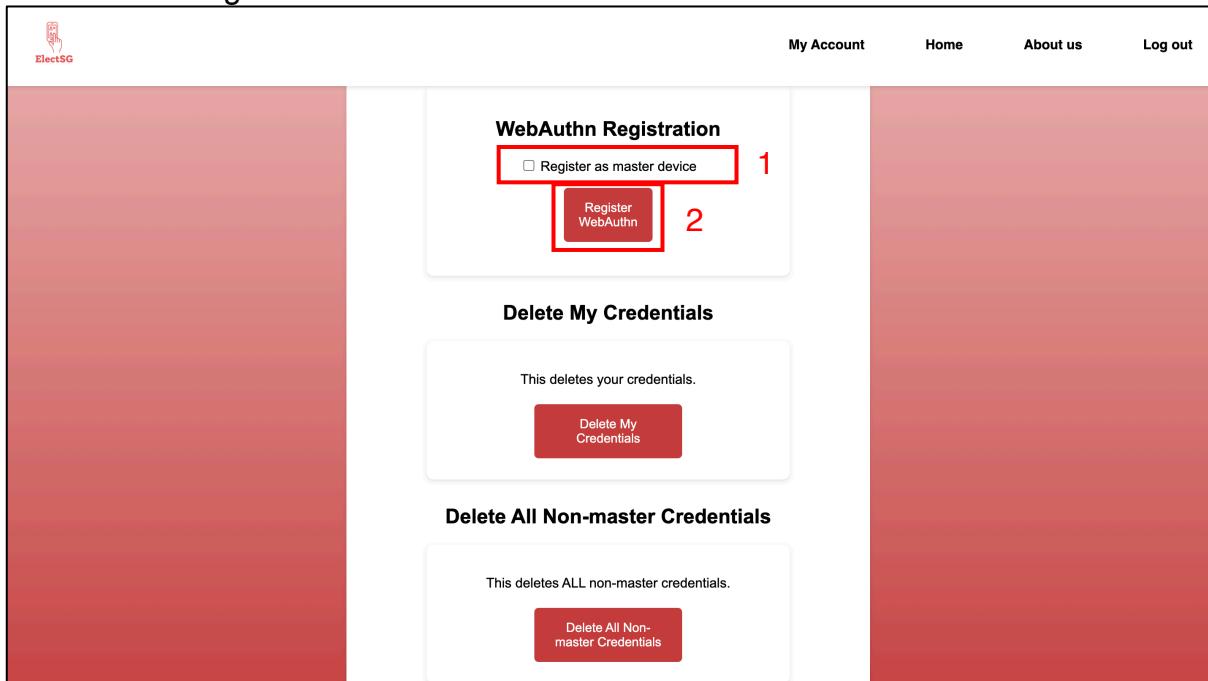
8.4 Admin Register WebAuthn

1. Click the “Register WebAuthn” button.



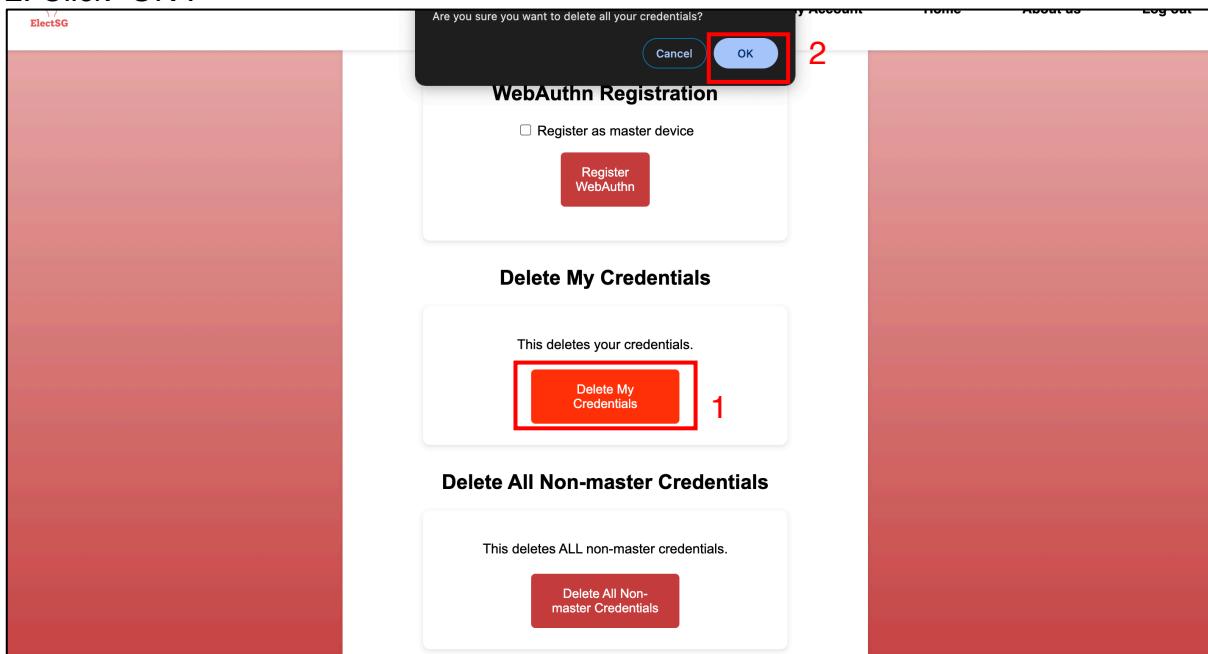
If admin wants to register as master device,

1. Mark the check box.
2. Click the “Register WebAuthn” button.



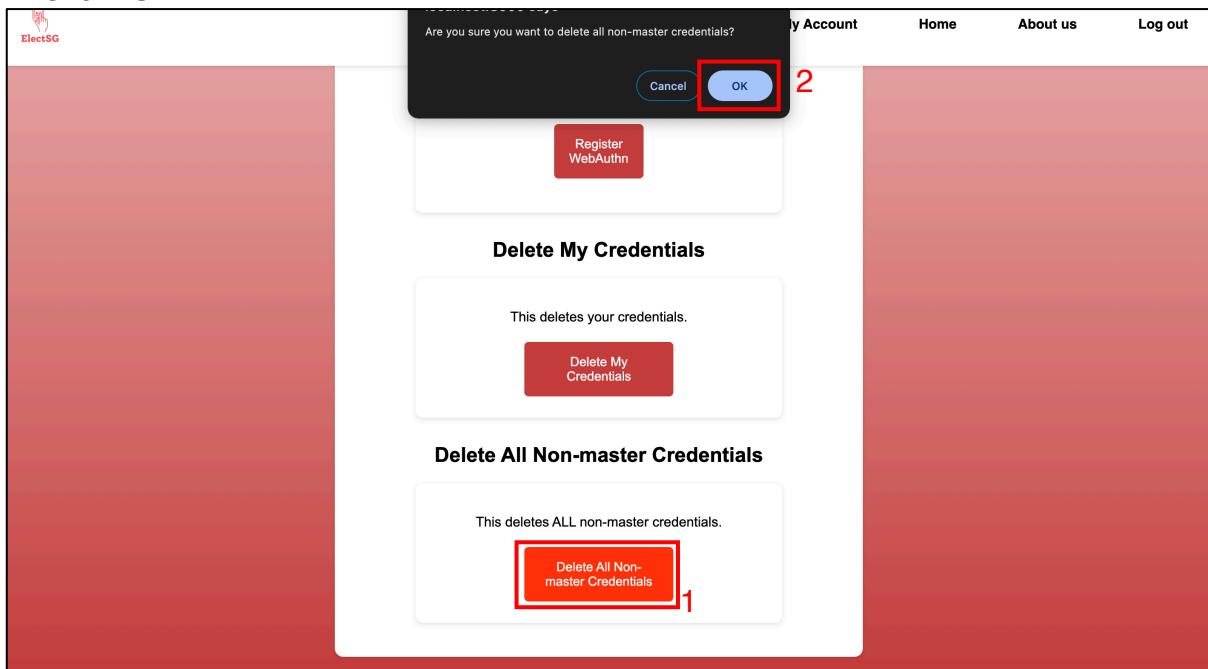
8.5 Admin Delete Own Account's Non-master Credentials

1. Click the “Delete My Credentials” button.
2. Click “OK”.



8.6 Admin Delete All Non-masters' Credentials

1. Click the “Delete All Non-master Credentials” button.
2. Click “OK”.



8.7 User Account

8.7.1 Creating an Account

1. Click “Create User Account” located in the side bar under “User Account” tab.
2. Fill in appropriate details in respective fields.
3. Click “Create New Account”.

Create New User Account

Username: _____

Full name: _____

Date of birth: dd/mm/yyyy

Password: _____

Role: _____

Party: _____

District: _____

Create New Account 3

Or

Csv file: No file chosen

Create New Accounts 2 3

8.7.2 Creating Multiple Candidate Accounts

1. Click “Create User Account” located in the side bar under “User Account” tab.
2. Click “Choose File” and upload appropriate csv file.
3. Click “Create New Accounts”.

Create New User Account

Username: _____

Full name: _____

Date of birth: dd/mm/yyyy

Password: _____

Role: _____

Party: _____

District: _____

Create New Account

Or

Csv file: No file chosen

Create New Accounts 2 3

8.7.3 Viewing Accounts

- Click “View User Account” located in the sidebar under “User Account” tab. Then, you can see a list of created user accounts.

ID	Username	Full Name	Date of Birth	Role	Party	District	Actions		
2	admin2	Mary James	Jan. 1, 1980	Admin	None	None	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
3	mr._nathaniel_hudson	Mr. Nathaniel Hudson	Nov. 5, 1959	Candidate	PAP	CENTRAL	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
4	william_conner	William Conner	April 26, 1965	Candidate	PAP	JURONG EAST	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
5	ricky_kim	Ricky Kim	April 28, 1967	Candidate	PAP	CENTRAL	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
6	jake_gomez	Jake Gomez	Sept. 22, 1960	Candidate	DAP	CLEMENTI	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
7	elizabeth_anderson	Elizabeth Anderson	Dec. 15, 1960	Candidate	DAP	CLEMENTI	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
8	ariel_williams	Ariel Williams	March 4, 1965	Candidate	DAP	JURONG EAST	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
9	matthew_clark	Matthew Clark	July 17, 1960	Candidate	PAP	CLEMENTI	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>

8.7.4 Updating an Account

- Click “Update” on the account you want to update.

ID	Username	Full Name	Date of Birth	Role	Party	District	Actions		
2	admin2	Mary James	Jan. 1, 1980	Admin	None	None	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
3	mr._nathaniel_hudson	Mr. Nathaniel Hudson	Nov. 5, 1959	Candidate	PAP	CENTRAL	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
4	william_conner	William Conner	April 26, 1965	Candidate	PAP	JURONG EAST	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
5	ricky_kim	Ricky Kim	April 28, 1967	Candidate	PAP	CENTRAL	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
6	jake_gomez	Jake Gomez	Sept. 22, 1960	Candidate	DAP	CLEMENTI	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
7	elizabeth_anderson	Elizabeth Anderson	Dec. 15, 1960	Candidate	DAP	CLEMENTI	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>
8	ariel_williams	Ariel Williams	March 4, 1965	Candidate	DAP	JURONG EAST	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>

2. Update the field you want to update.

3. Click “Save Changes”.

As an example, I updated the district from “Clementi” to “Jurong East”.

My Account Home About us Log out

Update User Account

Username:

Full name:

Date of birth:

District:

Party:

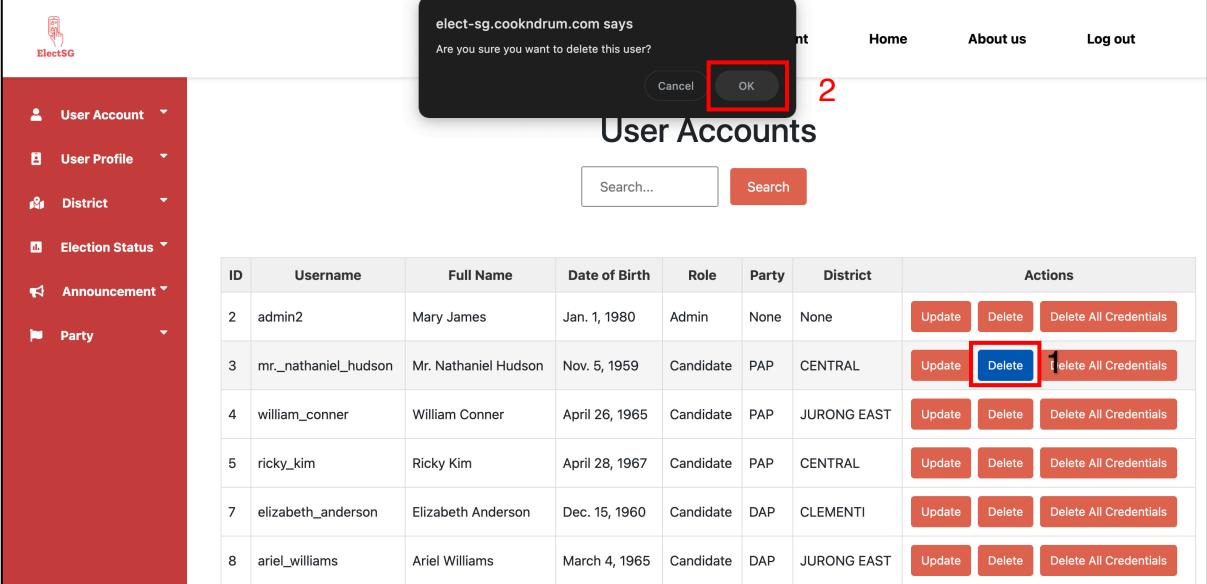
After updating, you will be redirected to “View User Account” page, and you can see the district has been updated.

My Account Home About us Log out

9	matthew_clark	Matthew Clark	July 17, 1960	Candidate	PAP	CLEMENTI	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
10	michelle_wright	Michelle Wright	Sept. 2, 1961	Candidate	PAP	JURONG EAST	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
11	richard_mitchell	Richard Mitchell	Jan. 2, 1969	Candidate	DAP	JURONG EAST	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
12	gregory_wallace	Gregory Wallace	Jan. 23, 1968	Candidate	PAP	CLEMENTI	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
13	susan_lara	Susan Lara	Nov. 9, 1964	Candidate	PAP	CENTRAL	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
14	kathryn_green	Kathryn Green	July 30, 1969	Candidate	PAP	CENTRAL	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
15	joshua_morton	Joshua Morton	May 28, 1967	Candidate	PAP	JURONG EAST	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
16	ashley_pope	Ashley Pope	July 12, 1969	Candidate	PAP	CLEMENTI	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
17	samantha_galloway	Samantha Galloway	July 27, 1963	Candidate	PAP	CENTRAL	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
1	admin1	John Doe	Jan. 1, 1980	Admin	None	None	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
18	pk123	Candler Bing	Dec. 12, 1950	Candidate	PAP	CLEMENTI	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	
6	jake_gomez	Jake Gomez	Sept. 22, 1960	Candidate	DAP	<input style="border: 2px solid red; width: 150px; height: 30px; padding: 5px; margin-bottom: 5px;" type="text" value="JURONG EAST"/>	<input type="button" value="Update"/>	<input type="button" value="Delete"/>	<input type="button" value="Delete All Credentials"/>	

8.7.5 Deleting an Account

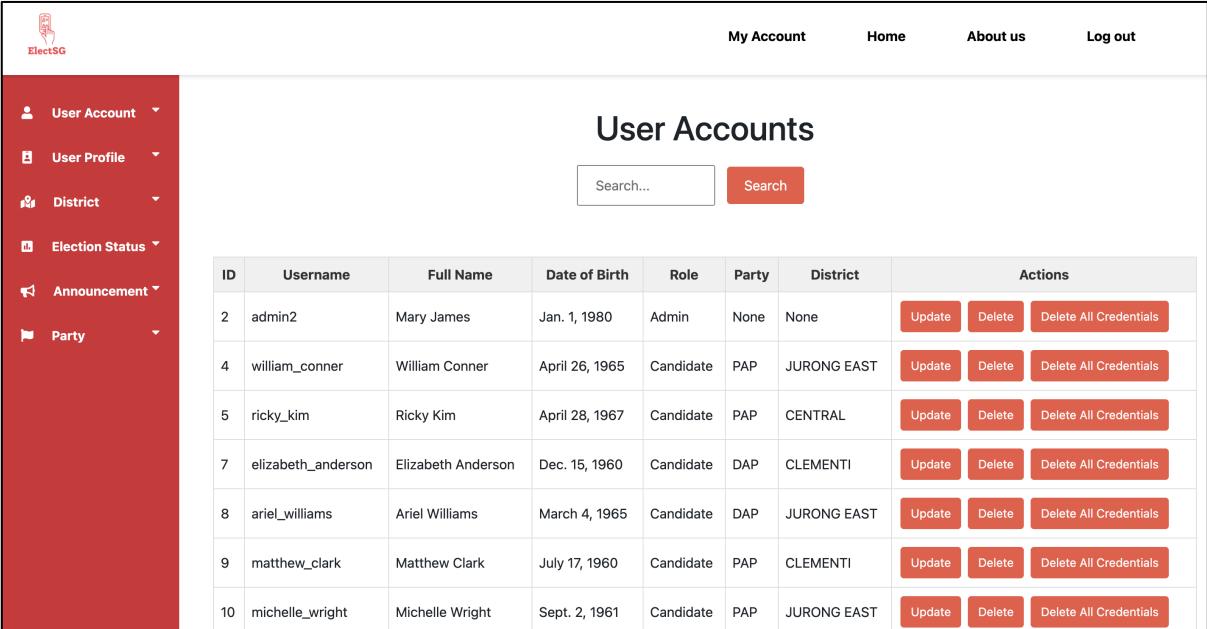
1. Click “Delete” on the account you want to delete.
2. Click “OK”.



The screenshot shows a user account management interface. On the left is a red sidebar with navigation links: User Account, User Profile, District, Election Status, Announcement, and Party. The main area is titled "User Accounts" and contains a table of user data. A modal dialog box is overlaid on the page, centered over the user "mr_nathaniel_hudson". The dialog box has a black background with white text and says "elect-sg.cookndrum.com says" followed by "Are you sure you want to delete this user?". It contains two buttons: "Cancel" and "OK". The "OK" button is highlighted with a red box and the number "2" above it. Below the dialog, the table lists users with columns for ID, Username, Full Name, Date of Birth, Role, Party, District, and Actions. The user "mr_nathaniel_hudson" is highlighted with a red box and the number "1" above it. The "Actions" column for each user includes "Update", "Delete", and "Delete All Credentials" buttons.

ID	Username	Full Name	Date of Birth	Role	Party	District	Actions
2	admin2	Mary James	Jan. 1, 1980	Admin	None	None	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
3	mr_nathaniel_hudson	Mr. Nathaniel Hudson	Nov. 5, 1959	Candidate	PAP	CENTRAL	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
4	william_conner	William Conner	April 26, 1965	Candidate	PAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
5	ricky_kim	Ricky Kim	April 28, 1967	Candidate	PAP	CENTRAL	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
7	elizabeth_anderson	Elizabeth Anderson	Dec. 15, 1960	Candidate	DAP	CLEMENTI	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
8	ariel_williams	Ariel Williams	March 4, 1965	Candidate	DAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>

You will see that the account has been deleted.

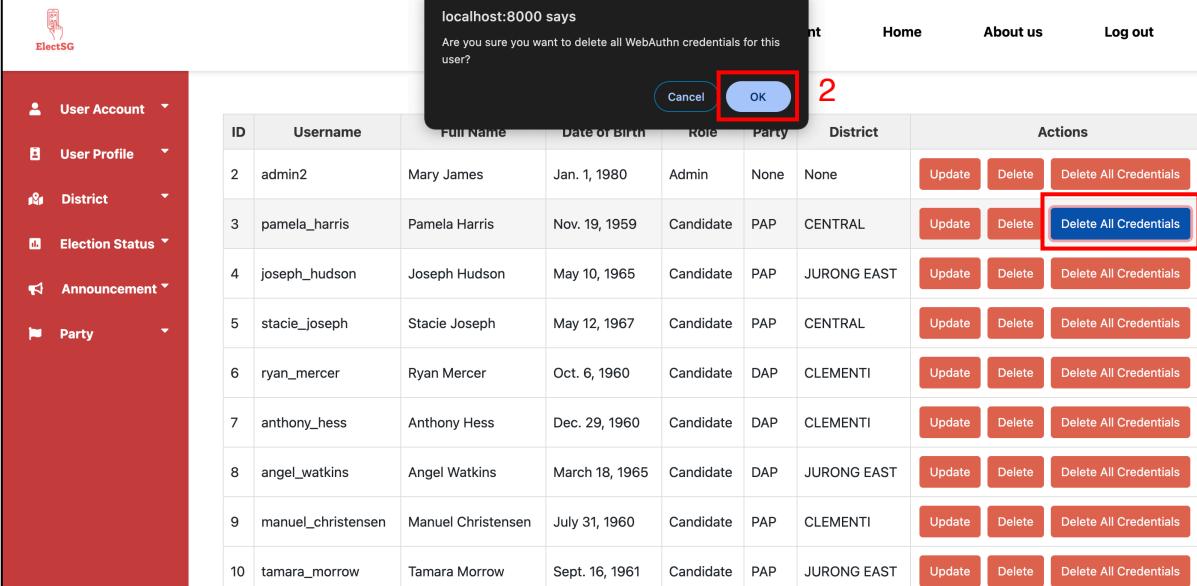


This screenshot shows the same user account management interface after the deletion. The modal dialog from the previous screenshot is no longer present. The user "mr_nathaniel_hudson" is now missing from the table. The table now lists 10 users, starting from ID 2 up to ID 10. The structure of the table and its columns (ID, Username, Full Name, Date of Birth, Role, Party, District, Actions) remains the same as in the previous screenshot.

ID	Username	Full Name	Date of Birth	Role	Party	District	Actions
2	admin2	Mary James	Jan. 1, 1980	Admin	None	None	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
4	william_conner	William Conner	April 26, 1965	Candidate	PAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
5	ricky_kim	Ricky Kim	April 28, 1967	Candidate	PAP	CENTRAL	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
7	elizabeth_anderson	Elizabeth Anderson	Dec. 15, 1960	Candidate	DAP	CLEMENTI	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
8	ariel_williams	Ariel Williams	March 4, 1965	Candidate	DAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
9	matthew_clark	Matthew Clark	July 17, 1960	Candidate	PAP	CLEMENTI	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
10	michelle_wright	Michelle Wright	Sept. 2, 1961	Candidate	PAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>

8.7.6 Deleting an Account's Credentials

1. Click “Delete” on the account you want to delete.
2. Click “OK”.

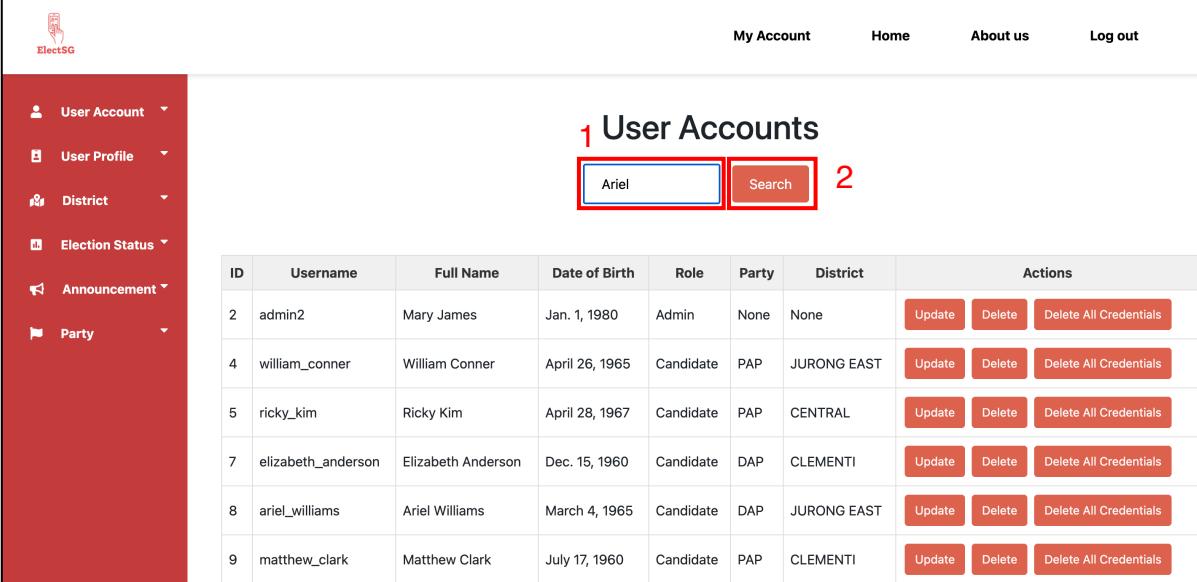


The screenshot shows a user account management interface. On the left is a sidebar with navigation links: User Account, User Profile, District, Election Status, Announcement, and Party. The main area displays a table of users with columns: ID, Username, Full Name, Date of Birth, Role, Party, District, and Actions. A modal dialog box is overlaid on the page, containing the text "localhost:8000 says" and "Are you sure you want to delete all WebAuthn credentials for this user?". It has two buttons: "Cancel" and "OK", with "OK" being highlighted by a red box. The number "2" is placed to the right of the modal. The table data is as follows:

ID	Username	Full Name	Date of Birth	Role	Party	District	Actions
2	admin2	Mary James	Jan. 1, 1980	Admin	None	None	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
3	pamela_harris	Pamela Harris	Nov. 19, 1959	Candidate	PAP	CENTRAL	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
4	joseph_hudson	Joseph Hudson	May 10, 1965	Candidate	PAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
5	stacie_joseph	Stacie Joseph	May 12, 1967	Candidate	PAP	CENTRAL	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
6	ryan_mercer	Ryan Mercer	Oct. 6, 1960	Candidate	DAP	CLEMENTI	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
7	anthony_hess	Anthony Hess	Dec. 29, 1960	Candidate	DAP	CLEMENTI	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
8	angel_watkins	Angel Watkins	March 18, 1965	Candidate	DAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
9	manuel_christensen	Manuel Christensen	July 31, 1960	Candidate	PAP	CLEMENTI	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
10	tamara_morrow	Tamara Morrow	Sept. 16, 1961	Candidate	PAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>

8.6.7 Searching an Account

1. Type in the search criteria of the account you want to search in the search box.
2. Click “Search”.



The screenshot shows a user account management interface. On the left is a sidebar with navigation links: User Account, User Profile, District, Election Status, Announcement, and Party. The main area displays a table of users with columns: ID, Username, Full Name, Date of Birth, Role, Party, District, and Actions. Above the table, a message "1 User Accounts" is displayed. A search bar contains the text "Ariel" and a "Search" button, both highlighted by a red box. The number "1" is placed above the search bar, and "2" is placed next to the search button. The table data is as follows:

ID	Username	Full Name	Date of Birth	Role	Party	District	Actions
2	admin2	Mary James	Jan. 1, 1980	Admin	None	None	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
4	william_conner	William Conner	April 26, 1965	Candidate	PAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
5	ricky_kim	Ricky Kim	April 28, 1967	Candidate	PAP	CENTRAL	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
7	elizabeth_anderson	Elizabeth Anderson	Dec. 15, 1960	Candidate	DAP	CLEMENTI	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
8	ariel_williams	Ariel Williams	March 4, 1965	Candidate	DAP	JURONG EAST	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>
9	matthew_clark	Matthew Clark	July 17, 1960	Candidate	PAP	CLEMENTI	<button>Update</button> <button>Delete</button> <button>Delete All Credentials</button>

You can see the account you searched.

The screenshot shows a web application interface for managing user accounts. On the left, there is a vertical sidebar with a red background containing several dropdown menu items: 'User Account', 'User Profile', 'District', 'Election Status', 'Announcement', and 'Party'. At the top right, there are links for 'My Account', 'Home', 'About us', and 'Log out'. The main content area has a title 'User Accounts' and a search bar containing the name 'Ariel'. Below the search bar is a table with the following data:

ID	Username	Full Name	Date of Birth	Role	Party	District	Actions		
8	ariel_williams	Ariel Williams	March 4, 1965	Candidate	DAP	JURONG EAST	<button>Update</button>	<button>Delete</button>	<button>Delete All Credentials</button>

8.8 User Profile

8.8.1 Creating a User Profile

1. Click “Create User Profile” located in the side bar under “User Profile” tab.
2. Fill in appropriate details in respective fields.
3. Click “Create”.

Create User Profile

Profile name: _____

Description: _____

Create 3

8.8.2 Viewing User Profiles

1. Click “View User Profile” located in the sidebar under “User Profile” tab. Then, you can see a list of created user profiles.

User Profiles

Profile Name	Actions
Candidate	Permanent Profile
Admin	Permanent Profile

8.8.3 Updating a User Profile

1. Click “Update” on the profile you want to update.

Profile Name	Actions
Candidate	Permanent Profile
Admin	Permanent Profile
Testing	1 Update Delete

2. Update the field you want to update.

3. Click “Save Changes”.

As an example, I updated the profile name from “Testing” to “Testing123”.

Profile name:

Description: This is only for testing.

2

3 Save changes

After updating, you will be redirected to “View User Profile” page, and you can see the profile name has been updated.

The screenshot shows a user interface for managing user profiles. On the left, there is a vertical sidebar with a red background containing several dropdown menu items: "User Account", "User Profile", "District", "Election Status", "Announcement", and "Party". At the top right, there are links for "My Account", "Home", "About us", and "Log out". The main content area is titled "User Profiles" and contains a table with three rows. The table has two columns: "Profile Name" and "Actions". The first two rows have "Candidate" and "Admin" as the profile names, both associated with "Permanent Profile". The third row has "Testing123" as the profile name, with "Update" and "Delete" buttons in the "Actions" column. The "Update" button is highlighted with a red background.

Profile Name	Actions
Candidate	Permanent Profile
Admin	Permanent Profile
Testing123	<button>Update</button> <button>Delete</button>

8.8.4 Deleting a User Profile

1. Click “Delete” on the profile you want to delete.
2. Click “OK”.

The screenshot shows a user profile management interface. On the left is a red sidebar with navigation links: User Account, User Profile, District, Election Status, Announcement, and Party. The main area is titled "User Profiles". A table lists profiles with columns for "Profile Name" and "Actions". The table contains three rows: "Candidate" (Permanent Profile), "Admin" (Permanent Profile), and "Testing123" (with "Update" and "Delete" buttons). A confirmation dialog box is overlaid on the screen, reading "elect-sg.cookndrum.com says Are you sure you want to delete this profile?" with "Cancel" and "OK" buttons. The "OK" button is highlighted with a red box and the number "2".

Profile Name	Actions
Candidate	Permanent Profile
Admin	Permanent Profile
Testing123	Update Delete 1

You will see that the profile has been deleted.

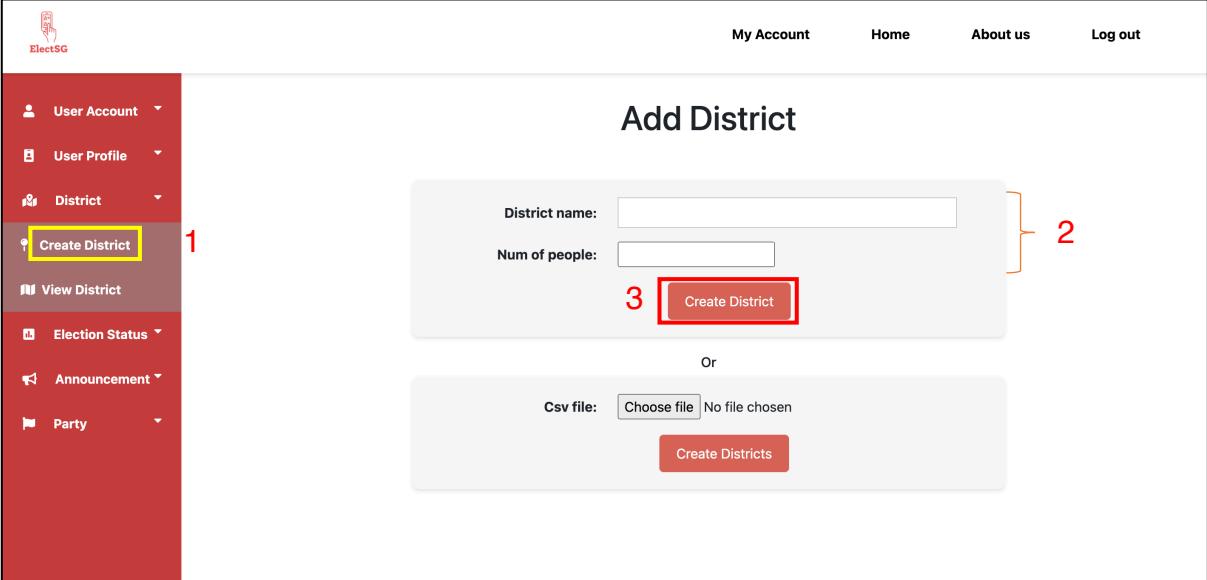
The screenshot shows the same user profile management interface after a profile has been deleted. The sidebar and main title "User Profiles" remain the same. The table now only contains two rows: "Candidate" and "Admin", both labeled as "Permanent Profile". The "Testing123" row from the previous screenshot is no longer present.

Profile Name	Actions
Candidate	Permanent Profile
Admin	Permanent Profile

8.9 Electoral District

8.9.1 Creating a District

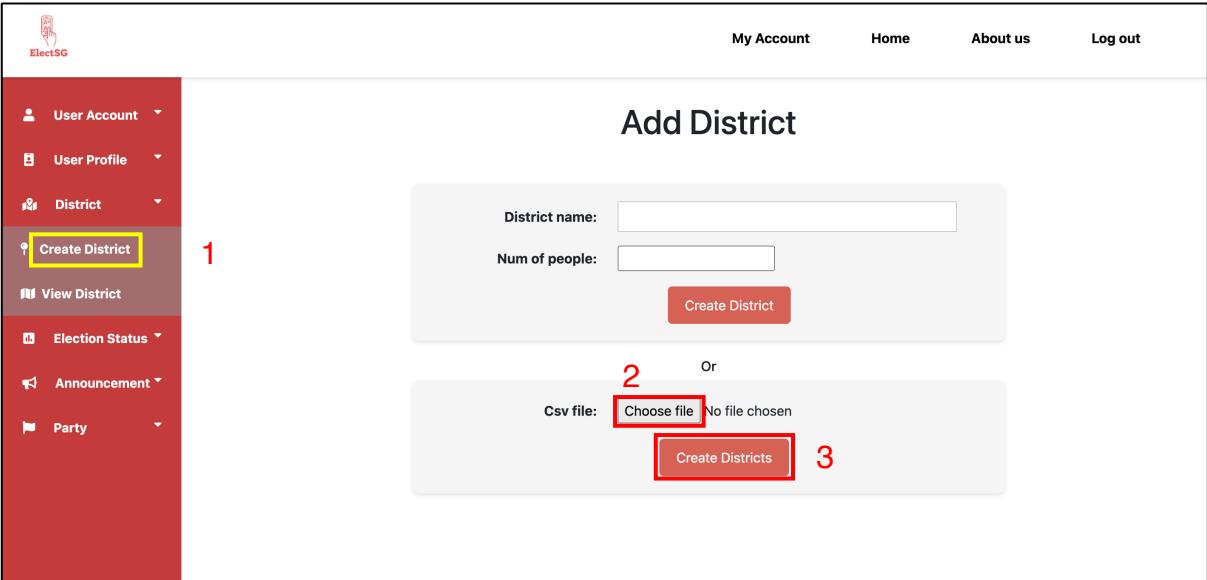
1. Click “Create District” located in the side bar under “District” tab.
2. Fill in appropriate details in respective fields.
3. Click “Create District”.



The screenshot shows the 'Add District' form. On the left, a sidebar menu has 'Create District' highlighted with a yellow box and a red number '1'. The main form area has two input fields: 'District name:' and 'Num of people:', both with red outlines. A red bracket labeled '2' groups these two fields. Below them is a red-bordered 'Create District' button labeled '3'. Further down, there's an 'Or' option with a 'Csv file:' input field containing 'Choose file No file chosen' and a 'Create Districts' button.

8.9.2 Creating Multiple Districts

1. Click “Create District” located in the side bar under “District” tab.
2. Click “Choose File” and upload appropriate csv file.
3. Click “Create Districts”.



This screenshot is identical to the one above, showing the 'Add District' form. The 'Create District' button in the sidebar is highlighted with a yellow box and a red number '1'. The 'Create Districts' button at the bottom is also highlighted with a red box and a red number '3'. In the 'Or' section, the 'Choose file' button within the 'Csv file:' input field is highlighted with a red box and a red number '2'.

8.9.3 Viewing Districts

- Click “View District” located in the sidebar under “District” tab. Then, you can see a list of created districts.

Name	Number of People	Actions	
CLEMENTI	20	<button>Update</button>	<button>Delete</button>
JURONG EAST	20	<button>Update</button>	<button>Delete</button>
CENTRAL	20	<button>Update</button>	<button>Delete</button>
TESTING	10	<button>Update</button>	<button>Delete</button>

8.9.4 Updating a District

- Click “Update” on the district you want to update.

Name	Number of People	Actions	
CLEMENTI	20	<button>Update</button>	<button>Delete</button>
JURONG EAST	20	<button>Update</button>	<button>Delete</button>
CENTRAL	20	<button>Update</button>	<button>Delete</button>
TESTING	10	1 <button>Update</button>	<button>Delete</button>

2. Update the name of the district.

3. Click “Save Changes”.

As an example, I updated the district from “TESTING” to “TESTING123”.

The screenshot shows the 'Edit District' page. On the left is a red sidebar with navigation links: User Account, User Profile, District (selected), Election Status, Announcement, and Party. The main area has a title 'Edit District'. A text input field contains 'TESTING123'. Below it is a label 'District name:' and a red-bordered 'Save changes' button. An orange bracket labeled '2' points to the input field, and another bracket labeled '3' points to the 'Save changes' button.

After updating, you will be redirected to “View District” page, and you can see the district name has been updated.

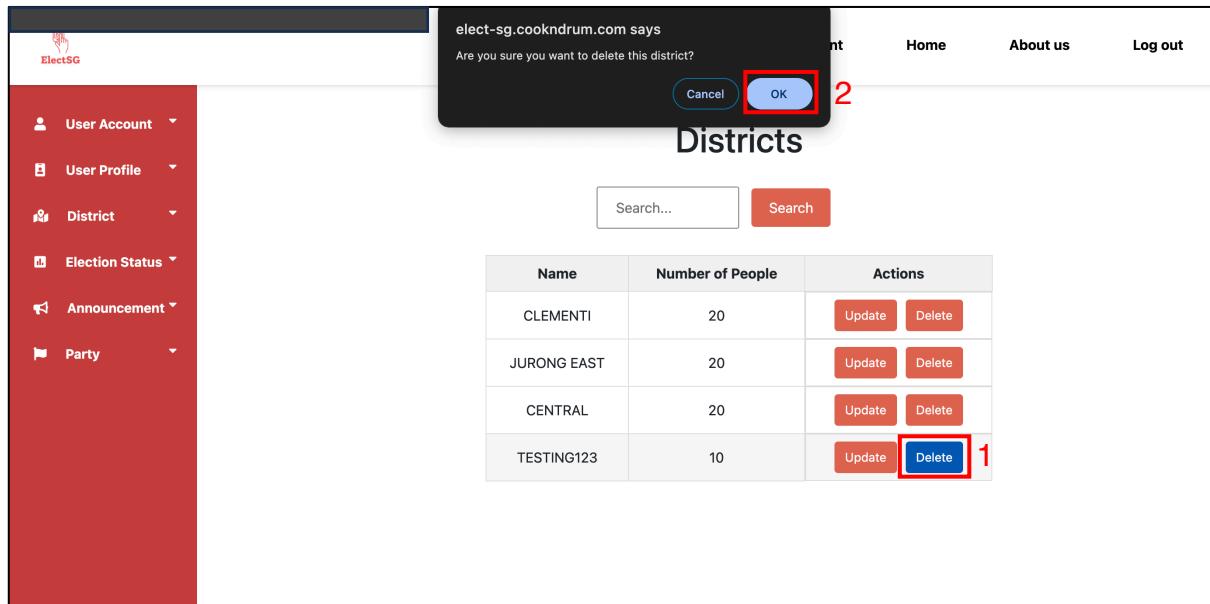
The screenshot shows the 'Districts' page. The left sidebar is identical to the previous screen. The main area has a title 'Districts' and a search bar with 'Search...' and 'Search' buttons. Below is a table:

Name	Number of People	Actions	
CLEMENTI	20	Update	Delete
JURONG EAST	20	Update	Delete
CENTRAL	20	Update	Delete
TESTING123	10	Update	Delete

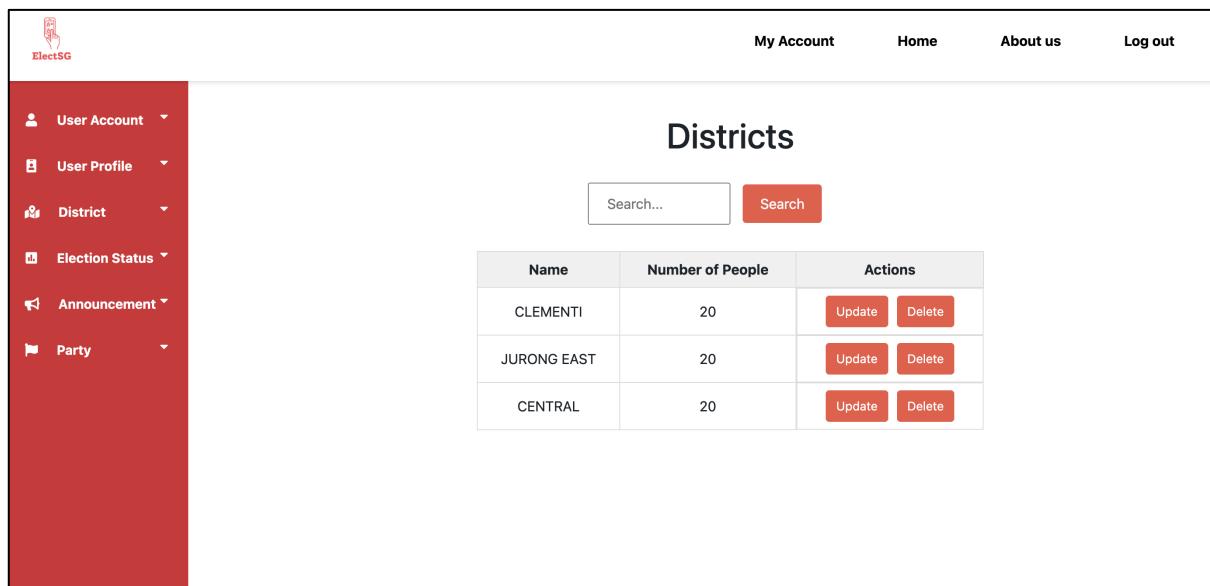
8.9.5 Deleting a District

1. Click “Delete” on the district you want to delete.

2. Click “OK”.



You will see that the district has been deleted.



8.9.6 Searching a District

1. Type in “District name” of the district you want to search in the search box.
2. Click “Search”.

Districts

Name	Number of People	Actions	
CLEMENTI	20	Update	Delete
JURONG EAST	20	Update	Delete
CENTRAL	20	Update	Delete

You will see the district that you searched.

Districts

Name	Number of People	Actions	
CLEMENTI	20	Update	Delete

8.10 Announcement

8.10.1 Creating an Announcement

1. Click “Create Announcement” located in the side bar under “Announcement” tab.
2. Fill in appropriate details in respective fields.
3. Click “Publish”.

Create Announcement

Header: Testing

This is for testing.

Content:

Publish

8.10.2 Viewing Announcements

1. Click “View Announcement” located in the sidebar under “Announcement” tab. Then, you can see a list of created announcements with the header.
2. Click “View” on the announcement that you want to view more.

Announcements

Header	Actions
Election Starts	View Update Delete
Cooling Day	View Update Delete
Polling Starts	View Update Delete
Hello World	View Update Delete
Testing	View Update Delete

You can see the detailed content of the announcement that you selected.

The screenshot shows the ElectSG application interface. At the top right, there are navigation links: "My Account", "Home", "About us", and "Log out". On the far left, a vertical red sidebar contains dropdown menus for "User Account", "User Profile", "District", "Election Status", "Announcement", and "Party". The main content area has a title "Testing" and a sub-instruction "This is for testing.". Below this are two buttons: "Update" and "Delete".

8.10.3 Updating an Announcement

1. Click “Update” on the announcement that you want to update.

The screenshot shows the "Announcements" page. At the top right, there are navigation links: "My Account", "Home", "About us", and "Log out". On the left, a vertical red sidebar contains dropdown menus for "User Account", "User Profile", "District", "Election Status", "Announcement", and "Party". The main content area has a title "Announcements" and a table listing five announcements:

Header	Actions
Election Starts	View Update Delete
Cooling Day	View Update Delete
Poling Starts	View Update Delete
Hello World	View Update Delete
Testing	View Update Delete

A red box highlights the "Update" button for the "Testing" announcement, and a red number "1" is placed below it.

2. Update the field you want to update.
3. Click “Save Changes”.

As an example, I updated the header from “Testing” to “Testing123”.

The screenshot shows the 'Edit Announcement' form. On the left is a red sidebar with navigation links: User Account, User Profile, District, Election Status, Announcement, and Party. At the top right are links for My Account, Home, About us, and Log out. The main area has a title 'Edit Announcement'. It contains a 'Header:' field with the value 'Testing123' and a 'Content:' text area with the placeholder 'This is for testing.' A red bracket on the right side of the content area is labeled '2'. Below the content area is a red-bordered 'Save changes' button, which is labeled '3'.

After updating, you will be redirected to “View Announcement” page, and you can see the header of the announcement has been updated.

The screenshot shows the 'Announcements' page. The sidebar and top navigation are identical to the previous screen. The main content area displays a table titled 'Announcements' with the following data:

Header	Actions		
Election Starts	View	Update	Delete
Cooling Day	View	Update	Delete
Polling Starts	View	Update	Delete
Hello World	View	Update	Delete
Testing123	View	Update	Delete

8.10.4 Deleting an Announcement

1. Click “Delete” on the announcement you want to delete.
2. Click “OK”.

elect-sg.cookndrum.com says
Are you sure you want to delete this announcement?

Header	Actions
Election Starts	View Update Delete
Cooling Day	View Update Delete
Polling Starts	View Update Delete
Hello World	View Update Delete
Testing123	View Update Delete 1

You will see that the announcement has been deleted.

Header	Actions
Election Starts	View Update Delete
Cooling Day	View Update Delete
Polling Starts	View Update Delete
Hello World	View Update Delete

8.11 Election Party

8.11.1 Creating a Party

1. Click “Create Party” located in the side bar under “Party” tab.
2. Fill in party name and description.

3. Click “Create”.

Create Party

Party name: Testing Party

Description: This is testing party.

Create

8.11.2 Viewing Parties

1. Click “View Party” located in the sidebar under “Party” tab. Then, you can see a list of created parties.

Party	Actions
PAP	Update Delete
DAP	Update Delete
Testing Party	Update Delete

8.11.3 Updating a Party

1. Click “Update” on the party that you want to update.

My Account Home About us Log out

Parties

Party	Actions	
PAP	Update	Delete
DAP	Update	Delete
Testing Party	1 Update	Delete

2. Update the party name.

3. Click “Save Changes”.

As an example, I updated the party name from “Testing Party” to “Testing Party 123”.

My Account Home About us Log out

Edit Party

Party name:

Description: This is testing party.

Save changes **3**

After updating, you will be redirected to “View Party” page, and you can see the name of the party has been updated.

The screenshot shows the 'Parties' page of the ElectSG application. The sidebar on the left is red and contains navigation links for User Account, User Profile, District, Election Status, Announcement, and Party. The main content area has a light gray background. The title 'Parties' is centered at the top. Below it is a table with three rows. The table has two columns: 'Party' and 'Actions'. The 'Party' column contains the names PAP, DAP, and Testing Party 123. The 'Actions' column for each row contains two buttons: 'Update' and 'Delete'.

Party	Actions
PAP	<button>Update</button> <button>Delete</button>
DAP	<button>Update</button> <button>Delete</button>
Testing Party 123	<button>Update</button> <button>Delete</button>

8.11.4 Deleting a Party

1. Click "Delete" on the party you want to delete.
2. Click "OK".

The screenshot shows a confirmation dialog box from the browser asking "Are you sure you want to delete this party?". The "OK" button is highlighted with a red box and the number "2". Below the dialog, the main content area is titled "Parties" and displays a table with three rows: PAP, DAP, and Testing Party 123. The "Delete" button for "Testing Party 123" is also highlighted with a red box and the number "1".

Party	Actions	
PAP	Update	Delete
DAP	Update	Delete
Testing Party 123	Update	Delete

You will see that the party has been deleted.

The screenshot shows the same "Parties" page after the deletion. The table now only contains two rows: PAP and DAP, with their respective "Update" and "Delete" actions.

Party	Actions	
PAP	Update	Delete
DAP	Update	Delete

8.12 Changing Election Phase

1. Click “Change Status” located in the side bar under “Election Status” tab.
2. Click “Activate” on the phase you want to activate.

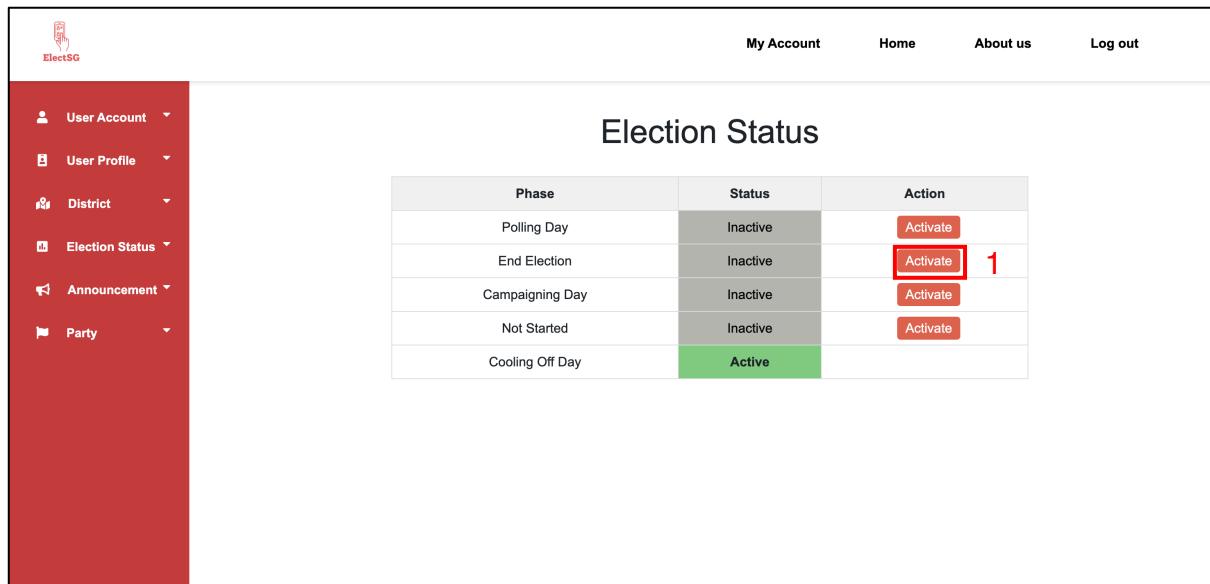
Phase	Status	Action
Cooling Off Day	Inactive	<button>Activate</button>
Polling Day	Inactive	<button>Activate</button>
End Election	Inactive	<button>Activate</button>
Campaigning Day	Inactive	<button>Activate</button>
Not Started	Active	

You can see “Cooling Off Day” phase is active.

Phase	Status	Action
Polling Day	Inactive	<button>Activate</button>
End Election	Inactive	<button>Activate</button>
Campaigning Day	Inactive	<button>Activate</button>
Not Started	Inactive	<button>Activate</button>
Cooling Off Day	Active	

8.13 Downloading Non-voters List

1. Change Election phase to “End Election”.

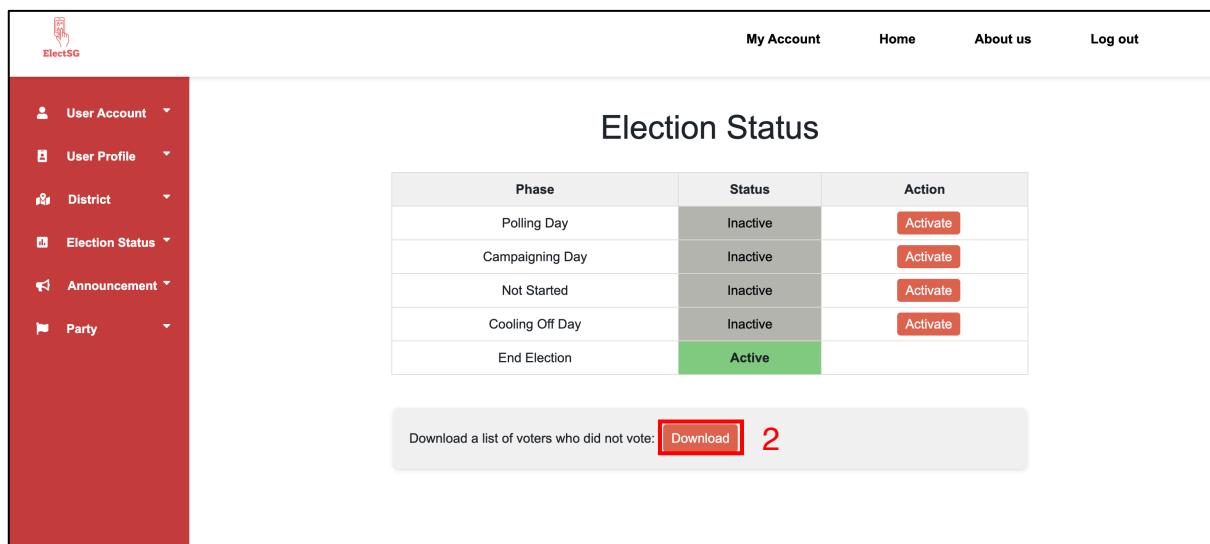


The screenshot shows the 'Election Status' page. On the left, there is a red sidebar with navigation links: User Account, User Profile, District, Election Status (which is selected), Announcement, and Party. At the top right, there are links for My Account, Home, About us, and Log out. The main content area has a title 'Election Status'. Below it is a table with columns 'Phase', 'Status', and 'Action'. The rows are: Polling Day (Inactive, Activate), End Election (Active, 1, highlighted with a red box), Campaigning Day (Inactive, Activate), Not Started (Inactive, Activate), and Cooling Off Day (Active). The 'End Election' row is highlighted with a red box and the number '1' is placed next to the 'Activate' button.

Phase	Status	Action
Polling Day	Inactive	Activate
End Election	Active	Activate 1
Campaigning Day	Inactive	Activate
Not Started	Inactive	Activate
Cooling Off Day	Active	

“End Election” phase is now active and “Download” button appears to download a csv file which includes a list of voters who did not vote during the election.

2. Click “Download”.



This screenshot is identical to the one above, showing the 'Election Status' page with the 'End Election' phase active. However, a new element is present: a button labeled 'Download' with a tooltip 'Download a list of voters who did not vote:' located below the table. The 'Download' button is highlighted with a red box and the number '2' is placed next to it.

8.14 Admin Log out

1. Click “Log out”.

The screenshot shows the ElectSG application's home page. At the top right, there are navigation links: "My Account", "Home", "About us", and a red-bordered "Log out" button. A red number "1" is overlaid on the "Log out" button. On the left, a vertical red sidebar contains dropdown menu items: "User Account", "User Profile", "District", "Election Status", "Announcement", and "Party". The main content area displays three announcements in grey boxes:

- Hello World**
This is my first announcement.
Date: Aug. 1, 2024, 12:19 p.m.
- Election Starts**
The election has officially started.
Date: Jan. 1, 2024, 8 a.m.
- Cooling Day**
Cooling Day has officially started.
Date: Jan. 1, 2024, 8 a.m.

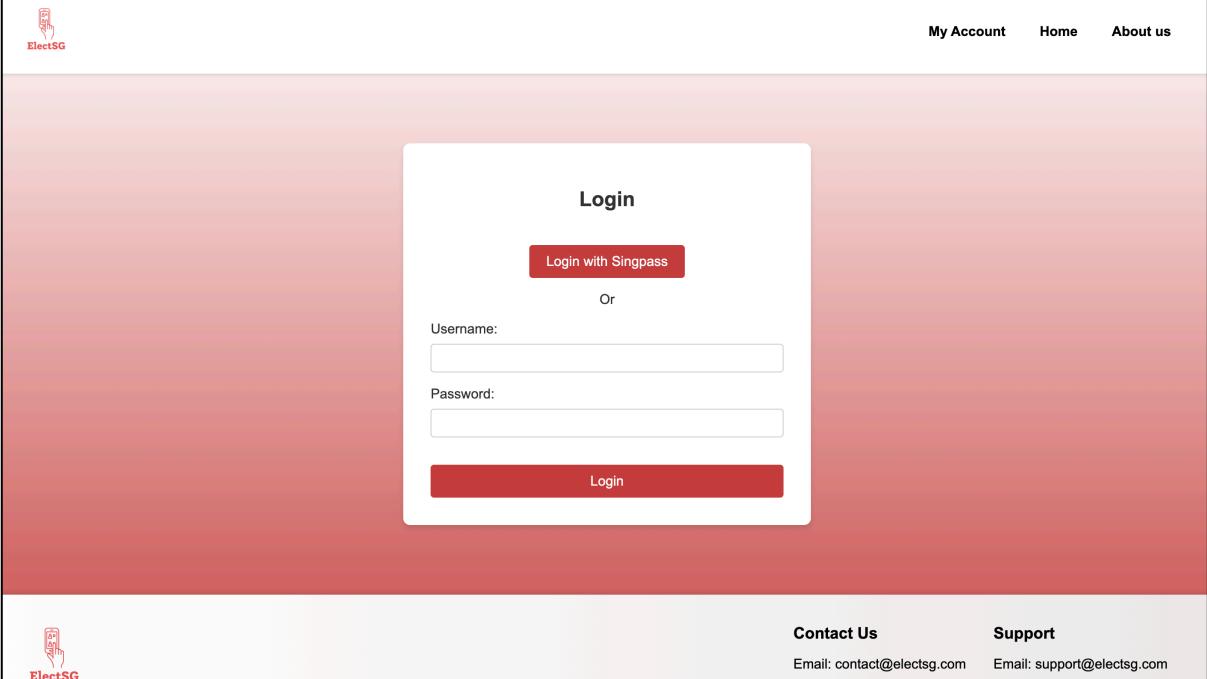
User will be redirected to log in page.

The screenshot shows the ElectSG login page. At the top right, there are navigation links: "My Account", "Home", and "About us". The main content area features a white login form with a red header "Login". It includes a "Login with Singpass" button, a "Or" link, and two input fields for "Username" and "Password". Below these is a red "Login" button. At the bottom, there are "Contact Us" and "Support" sections with their respective email addresses: Email: contact@electsg.com and Email: support@electsg.com. The ElectSG logo is visible at the bottom left and top left.

9. Using ElectSG as Candidate

9.1 Candidate Log in

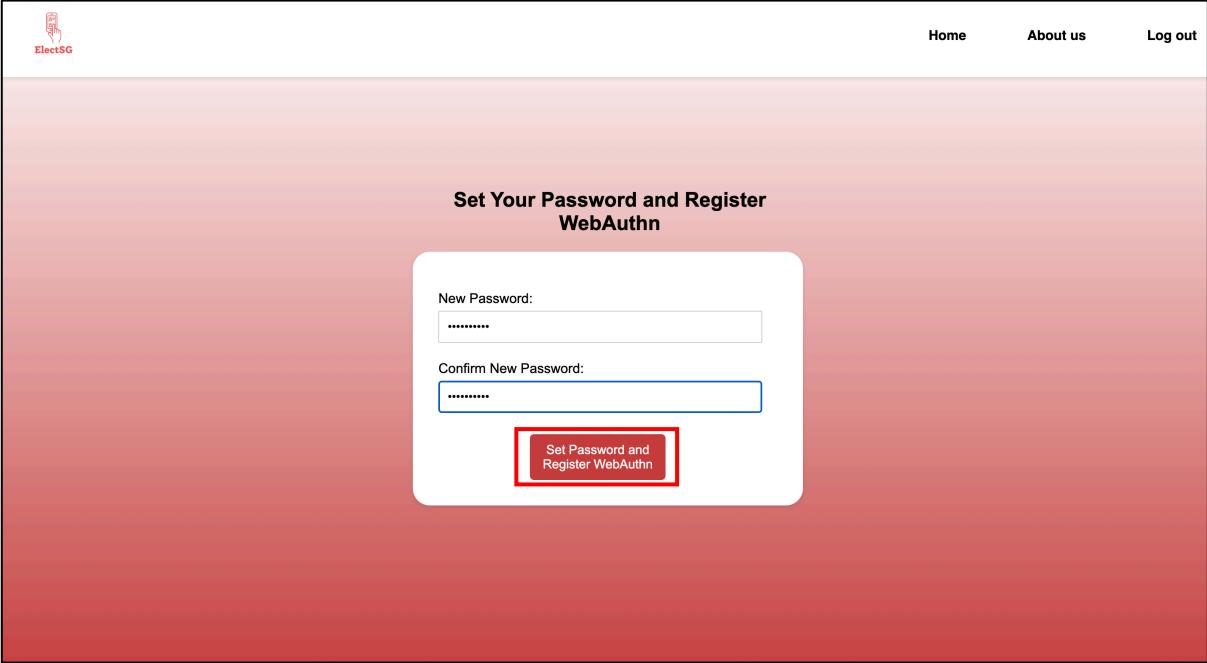
1. Fill in Username and Password. Then click “Login”.



The screenshot shows the ElectSG Candidate login interface. At the top right are links for "My Account", "Home", and "About us". On the left is the ElectSG logo. The main area has a light red gradient background. In the center is a white rectangular login form with a dark red header containing the word "Login". Below it is a red button labeled "Login with Singpass". Underneath is a small "Or" text, followed by two input fields: one for "Username" and one for "Password". At the bottom of the form is a dark red "Login" button.

2. If the user is logging in for the first time, he will be redirect to “Set Password and Register WebAuthn” page.

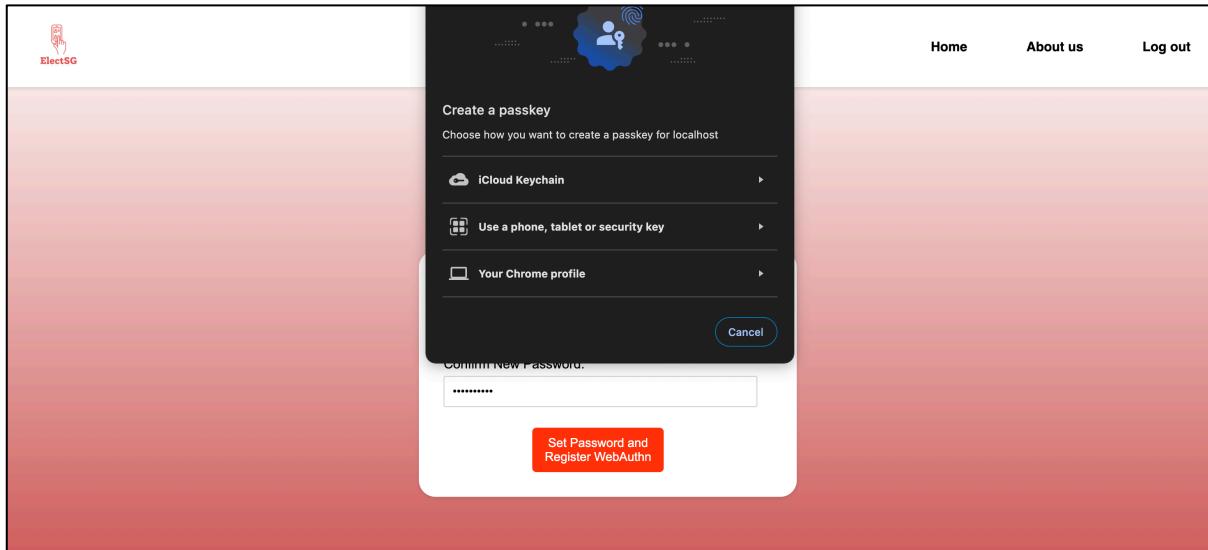
- 2.1. Fill in the new password then click “Set Password and Register WebAuthn” button to change the password and register the web authentication.



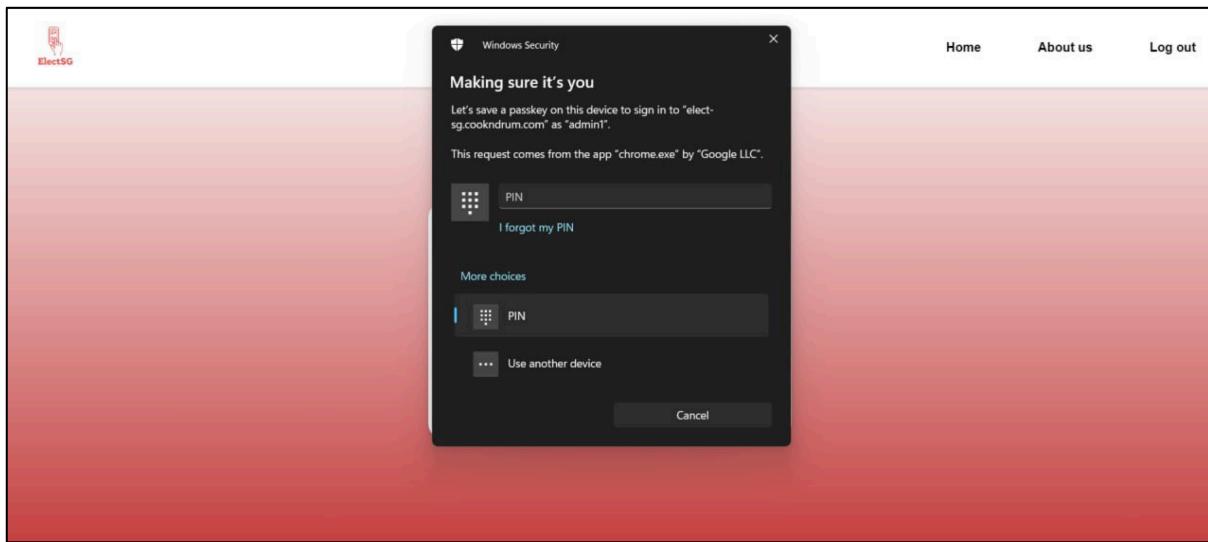
The screenshot shows the "Set Your Password and Register WebAuthn" page. At the top right are links for "Home", "About us", and "Log out". On the left is the ElectSG logo. The main area has a light red gradient background. In the center is a white rectangular form with a dark red header containing the text "Set Your Password and Register WebAuthn". It contains two input fields: "New Password" and "Confirm New Password", both with placeholder text consisting of five dots. At the bottom is a dark red "Set Password and Register WebAuthn" button, which is highlighted with a red border.

The user will be given several options based on the device he is using

- iCloud Keychain
- Your Chrome Profile
- Use a phone, tablet or security key
- Window Hello



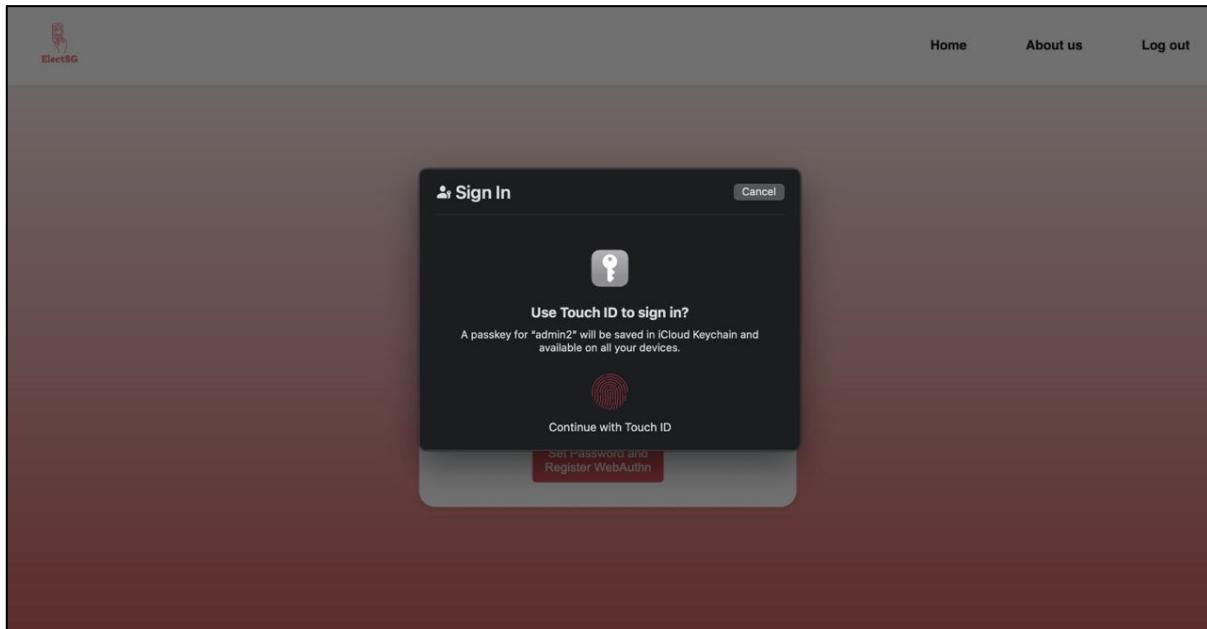
The above picture is the screenshot of the device that has biometric built-in.



The above picture is the screenshot of the device that doesn't have biometric built-in.

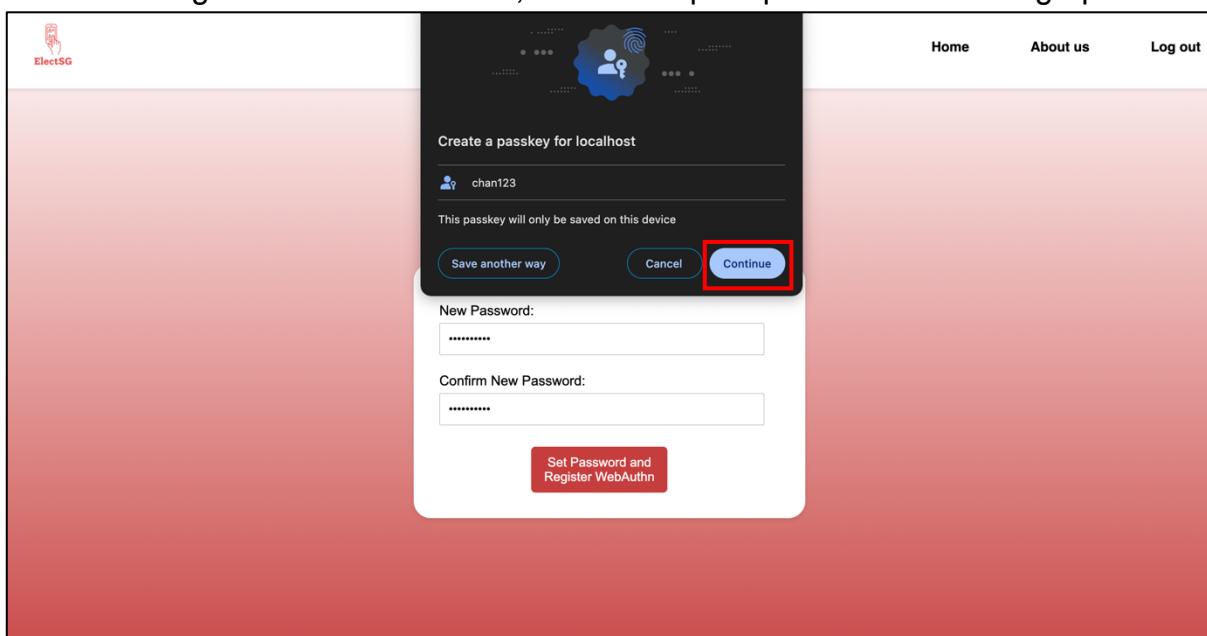
[Option 1 – iCloud Keychain]

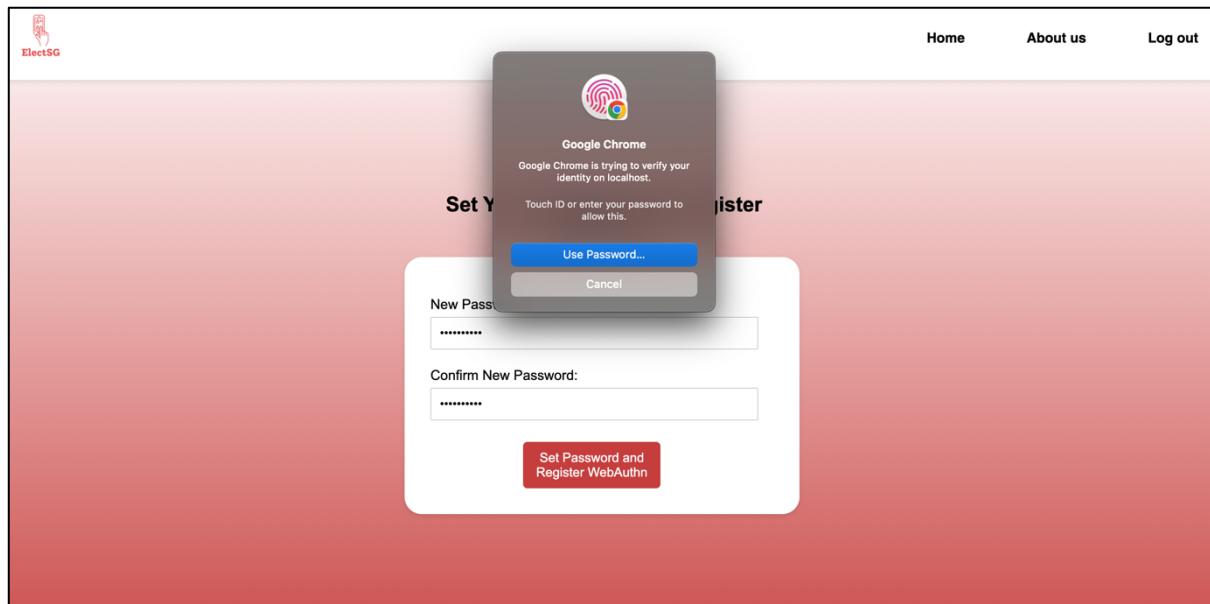
After choosing ‘iCloud Keychain’, the user is prompted to enter his fingerprint.



[Option 2 – Your Chrome Profile]

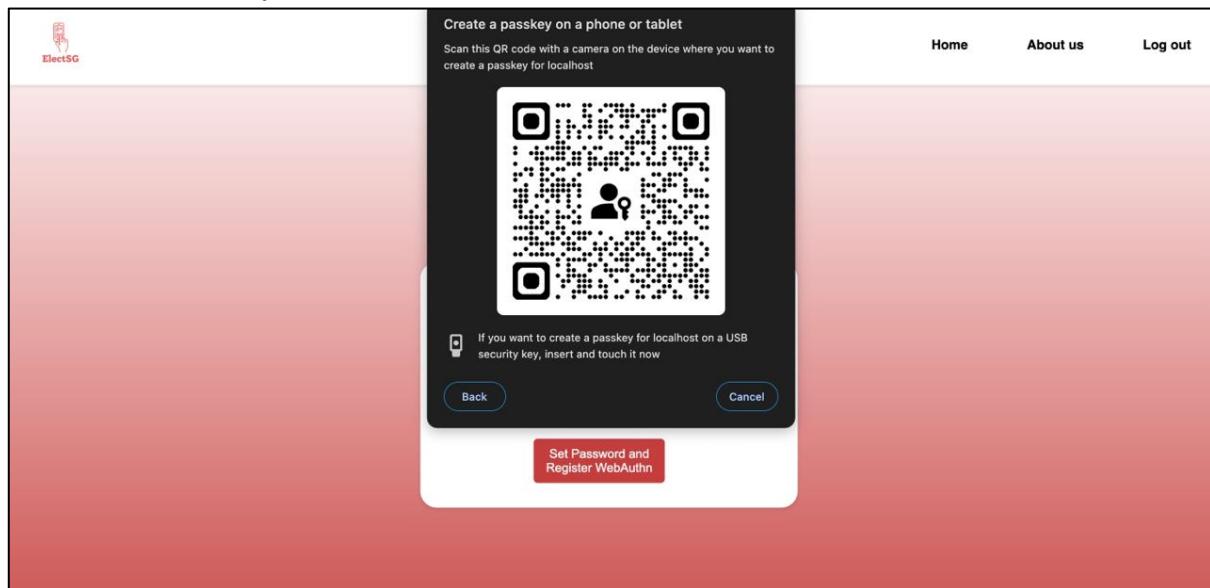
After choosing ‘Your Chrome Profile’, the user is prompted to enter his fingerprint.





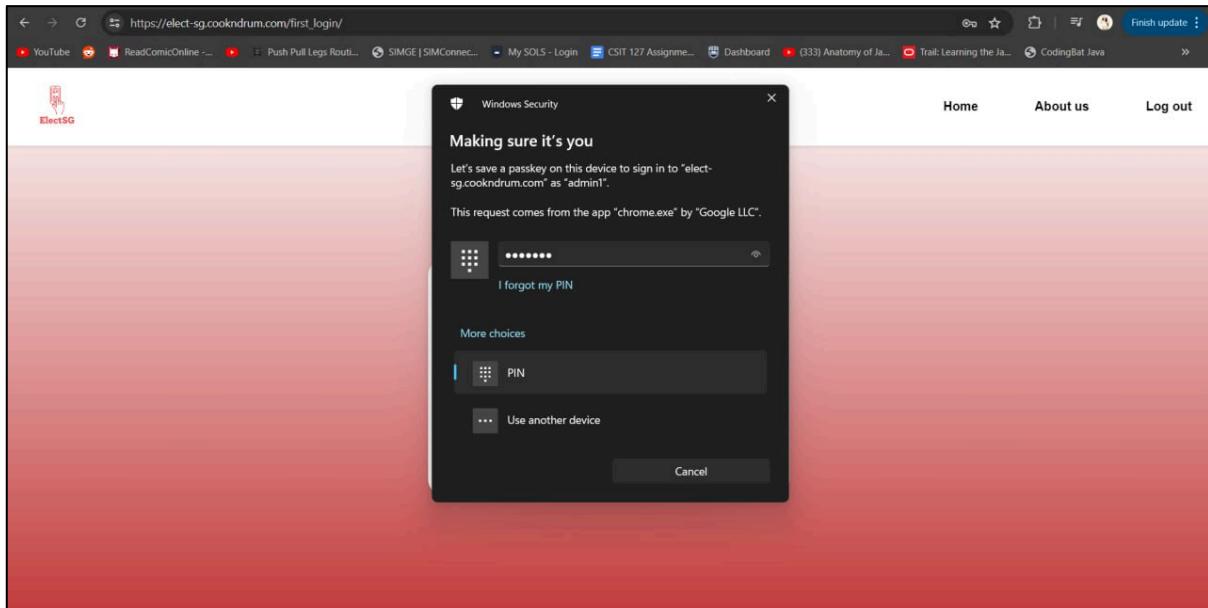
[Option 3 – Use a phone, tablet or security key]

After choosing 'Use a phone, tablet or security key', the user is prompted to scan the QR code with the phone or tablet.



[Option 4 – Window Hello]

After choosing ‘Pin, the user is prompted to enter the pin number.



After setting password and registering webauthn, the user will be redirected to ‘Candidate Home’ page.

9.2 Candidate Interface

This is Candidate Homepage that candidate will see after logging in.

9.3 Candidate Change Password

1. Fill in appropriate details in respective fields.
2. Click “Change Password”.

The screenshot shows the 'My Account' section with a 'Change Password' form. It includes fields for 'Current Password', 'New Password', and 'Confirm New Password'. A red bracket labeled '1' groups these three fields. Below them is a red box labeled '2' surrounding the 'Change Password' button.

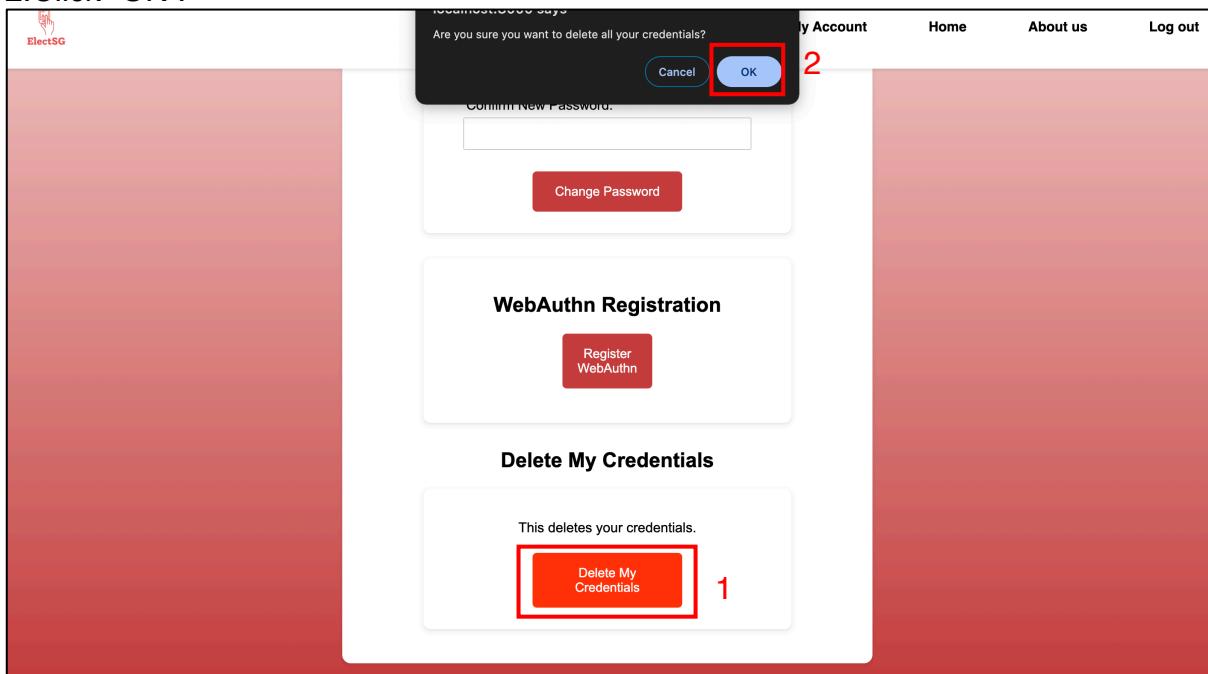
9.4 Candidate Register WebAuthn

1. Click the “Register WebAuthn” button.

The screenshot shows the 'My Account' section with a 'WebAuthn Registration' section. It features a red box labeled '1' surrounding the 'Register WebAuthn' button.

9.5 Candidate Delete Own Account's Credentials

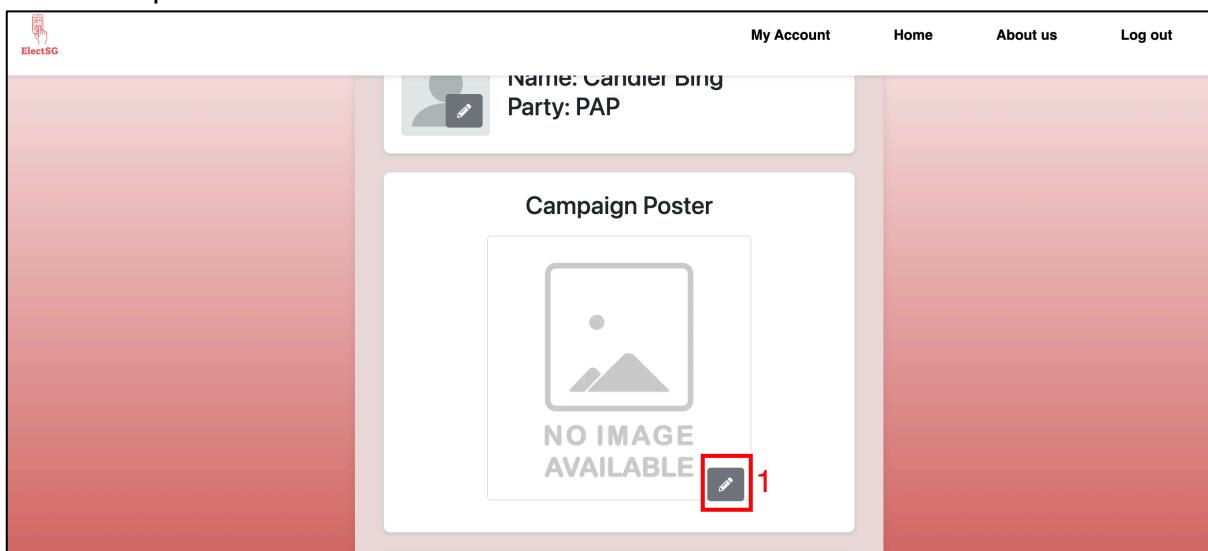
1. Click the “Delete My Credentials” button.
2. Click “OK”.



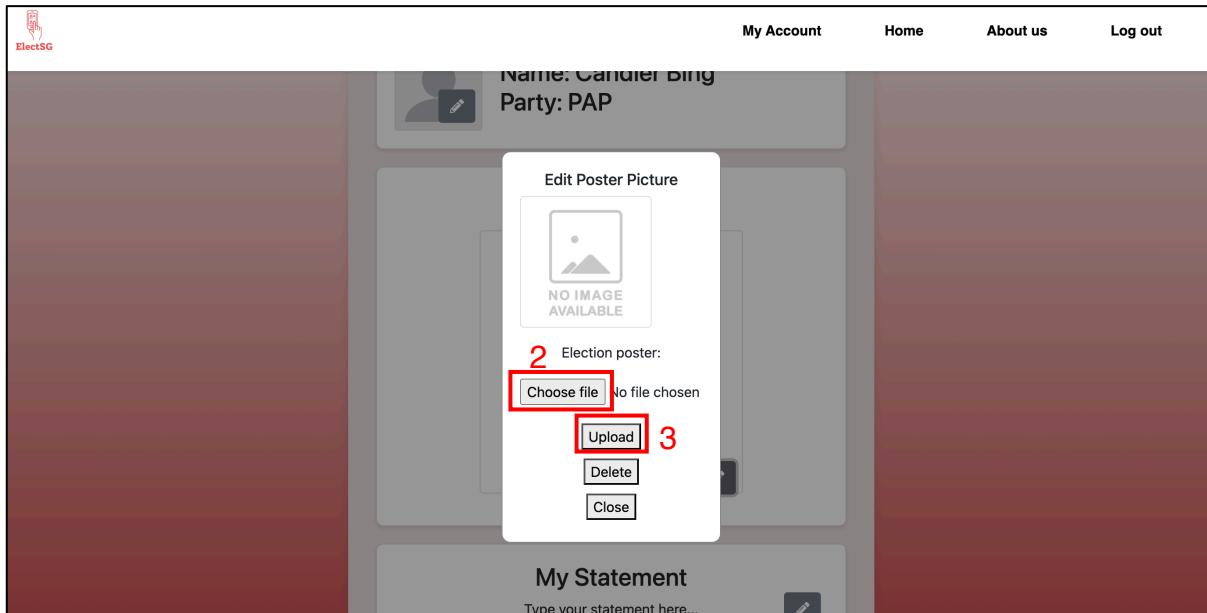
9.6 Election Poster

9.6.1 Uploading a Poster

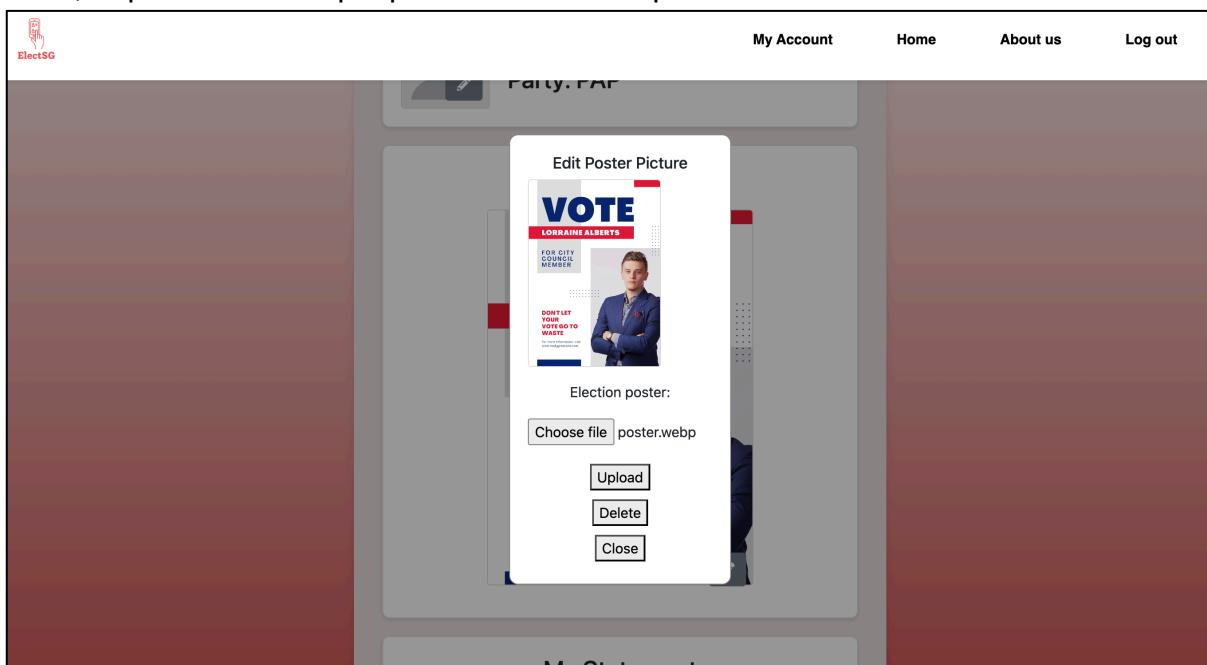
1. Click “Upload” button.



2. Click “Choose File” and pick your preference poster to upload.
3. Click “Upload”.

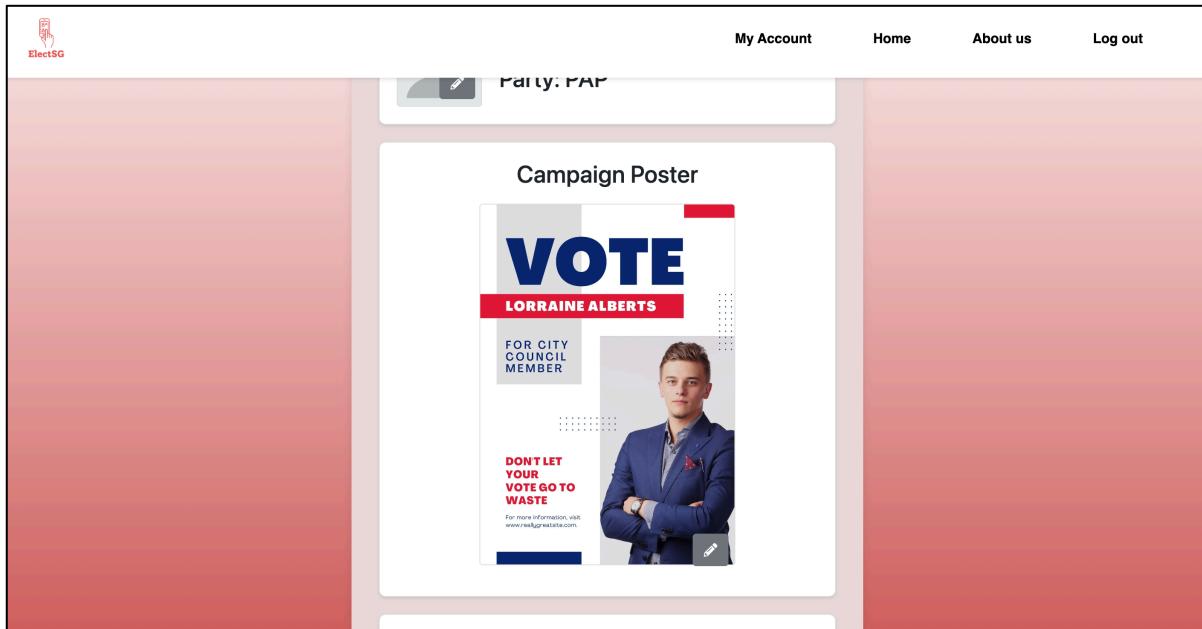


Here, I uploaded a sample poster as an example.



9.6.2 Viewing a Poster

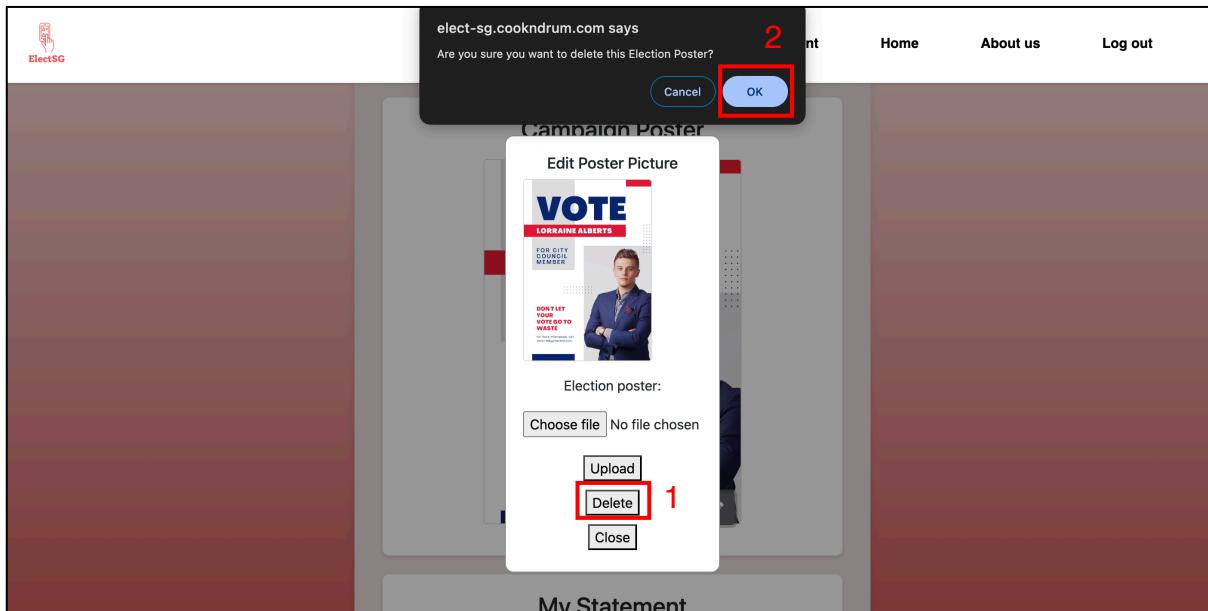
Candidate can see uploaded election poster in “Candidate Homepage”.



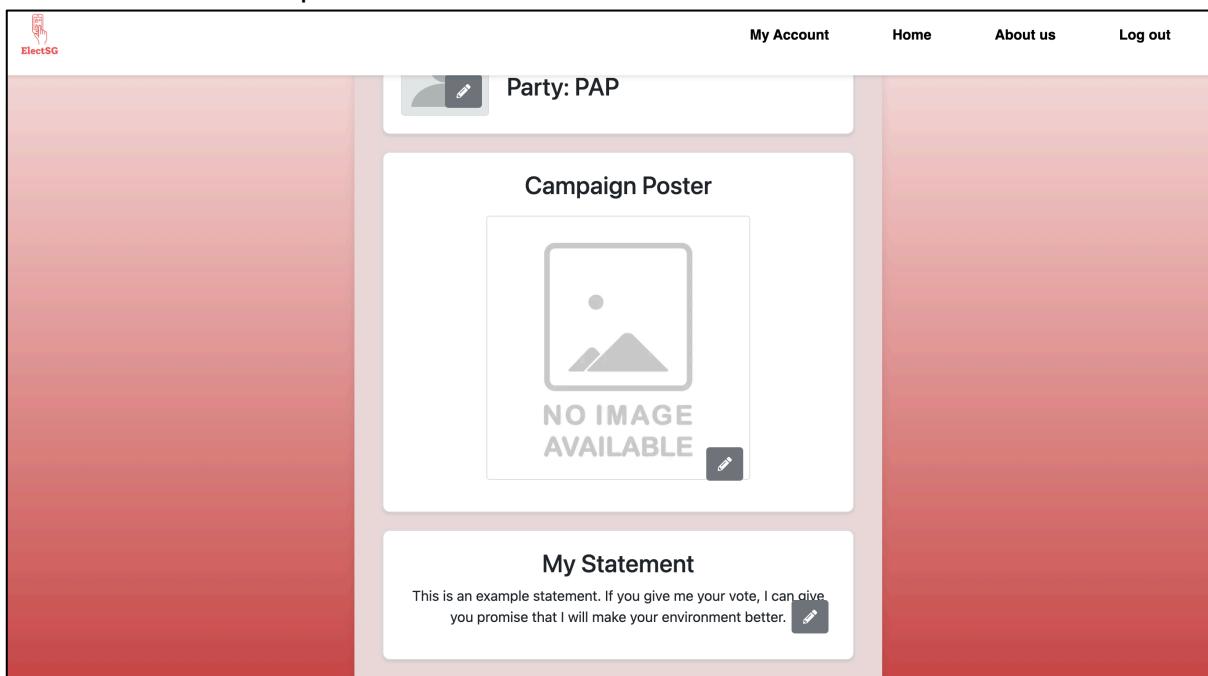
9.6.3 Deleting a Poster

1. Click “Delete” button.

2. Click “Ok” button.



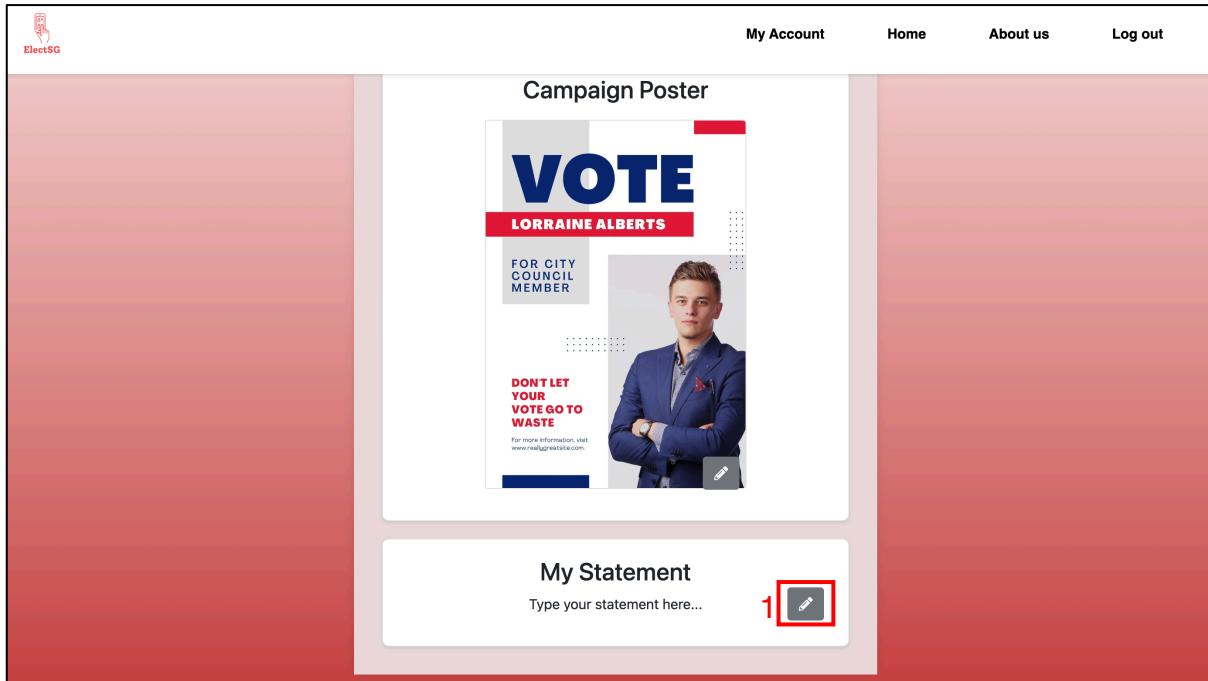
You will see that the poster has been deleted.



9.7 Candidate Statement

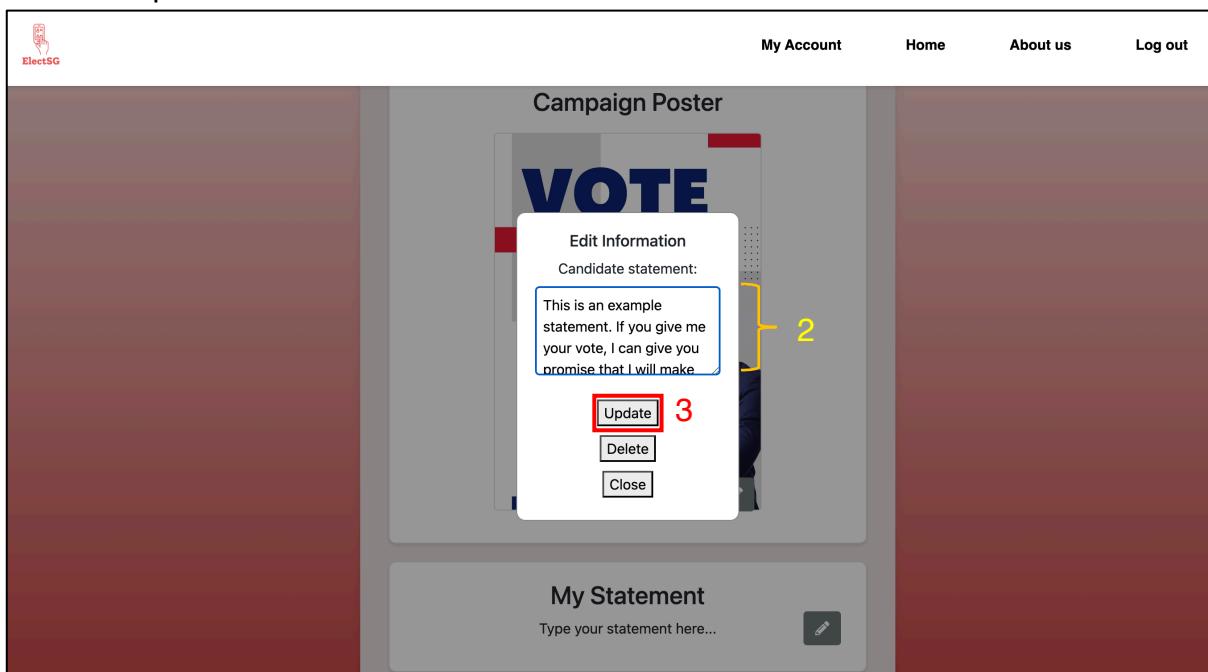
9.7.1 Editing a Statement

1. Click “Edit” button.



2. Fill in candidate statement.

3. Click “Update”.



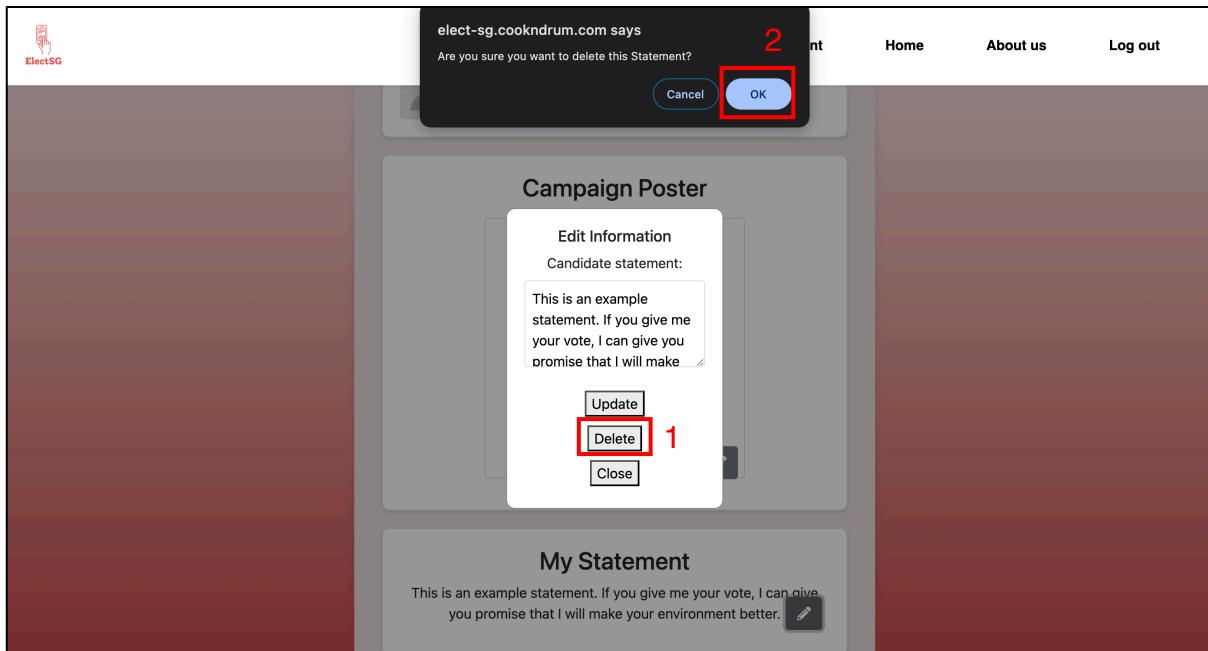
9.7.2 Viewing a Statement

Candidate can see uploaded candidate statement in “Candidate Homepage”.

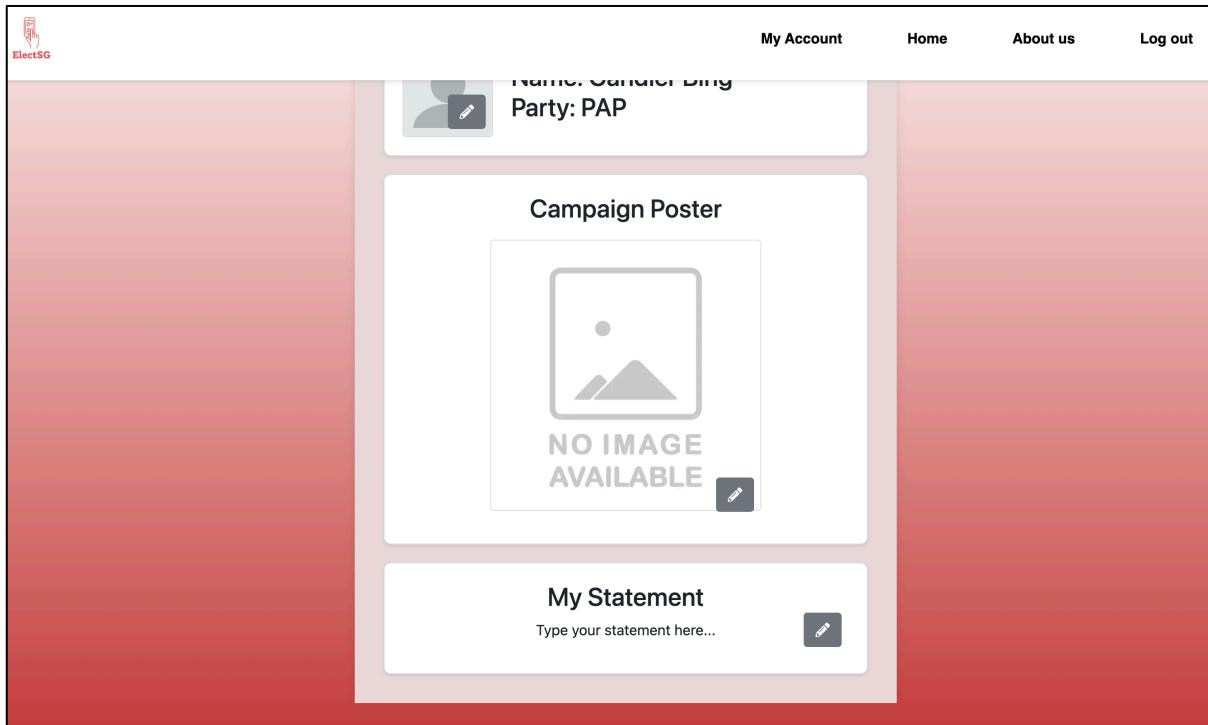
The screenshot shows a candidate's homepage. At the top, there is a navigation bar with links for "My Account", "Home", "About us", and "Log out". On the left, there is a logo for "ElectSG". The main content area features a "Campaign Poster" for "LORRAINE ALBERTS" running "FOR CITY COUNCIL MEMBER". The poster includes a photo of a man in a suit and a promise: "DON'T LET YOUR VOTE GO TO WASTE". Below the poster, there is a box titled "My Statement" containing placeholder text: "This is an example statement. If you give me your vote, I can give you promise that I will make your environment better." There is also a small edit icon next to the text.

9.7.3 Deleting a Statement

1. Click “Delete” button.
2. Click “Ok” button.



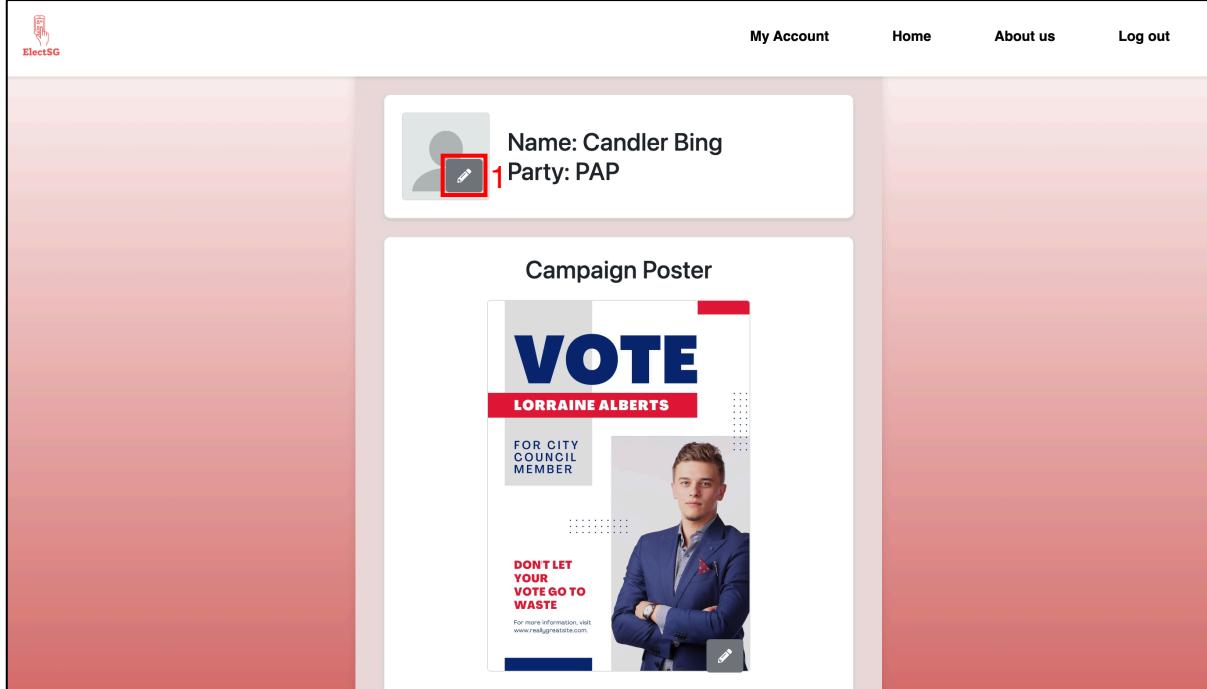
You will see that the statement has been deleted.



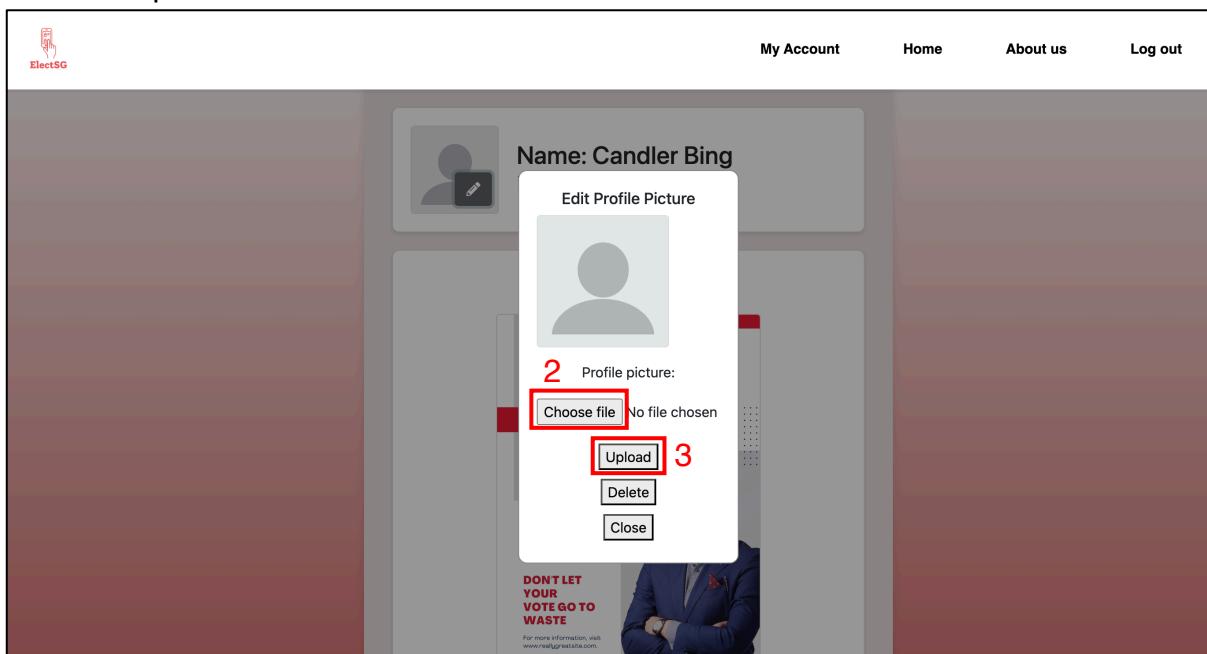
9.8 Profile Picture

9.8.1 Uploading a Profile Picture

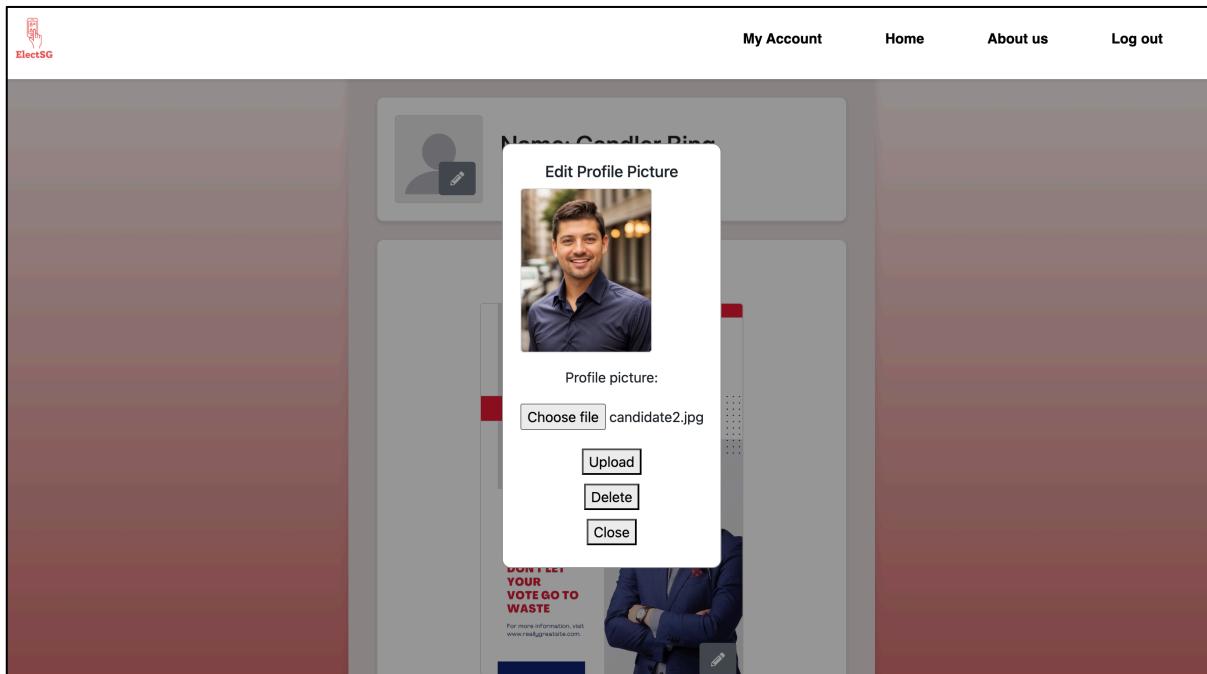
1. Click “Upload” button.



2. Click “Choose File” and pick your preference profile picture to upload.
3. Click “Upload”.

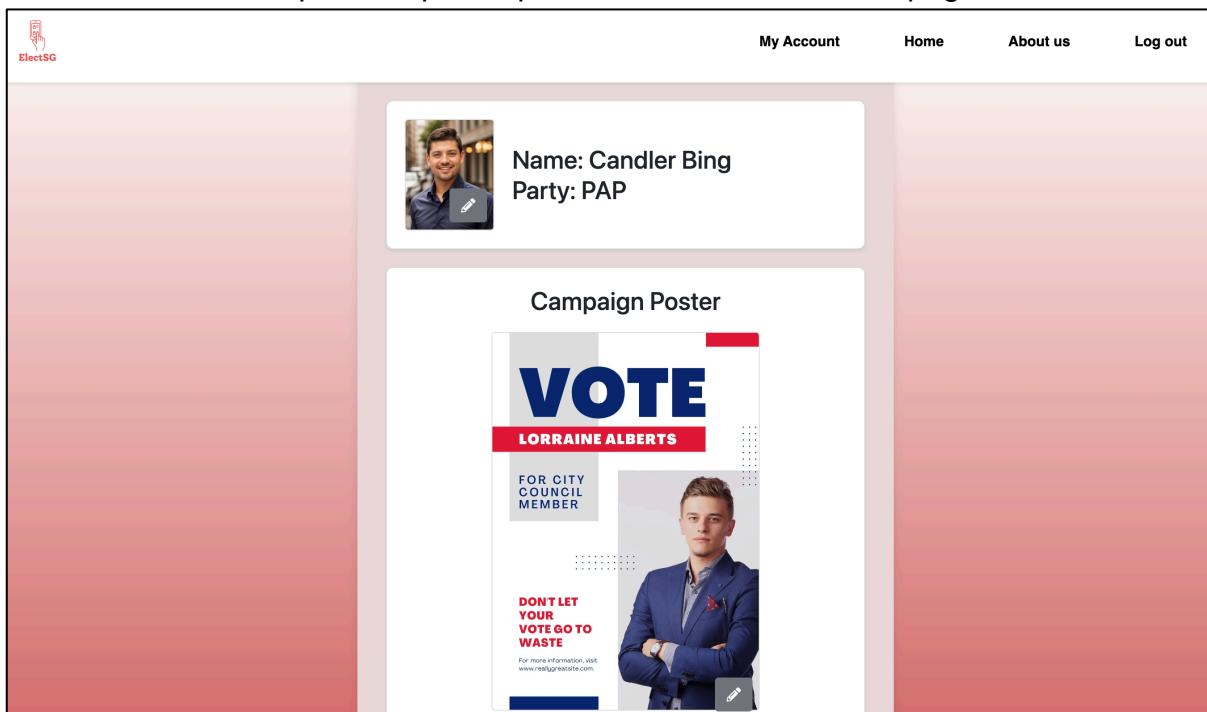


Here, I uploaded a sample profile picture as an example.



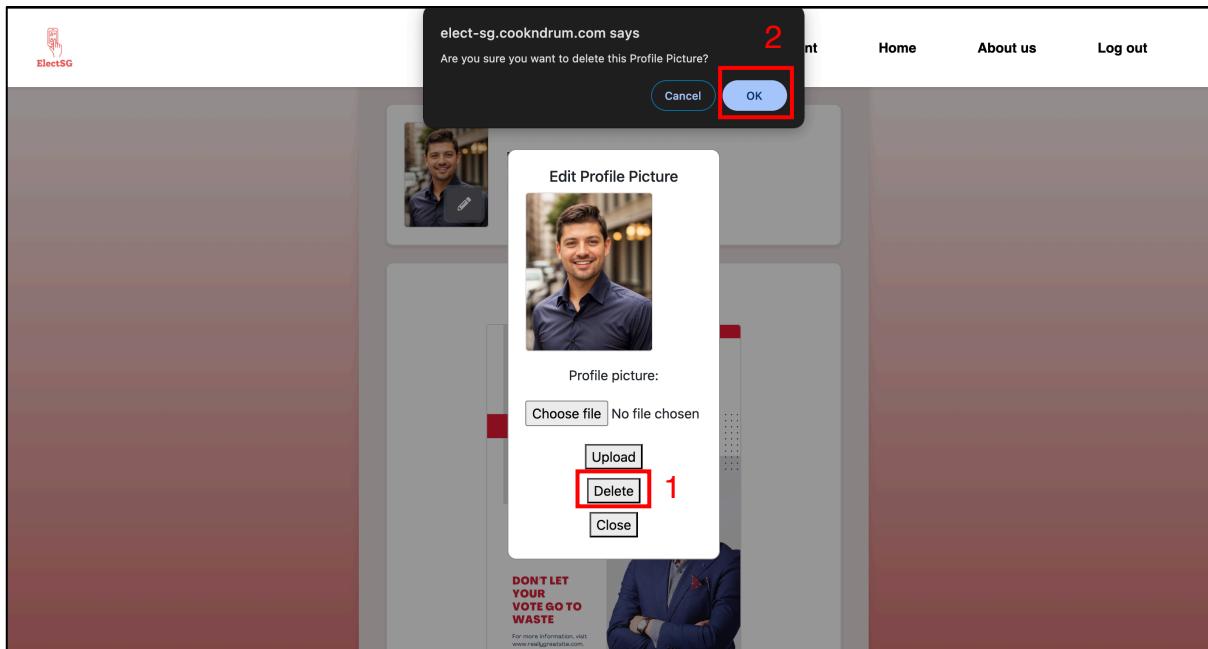
9.8.2 Viewing a Profile Picture

Candidate can see uploaded profile picture in “Candidate Homepage”.

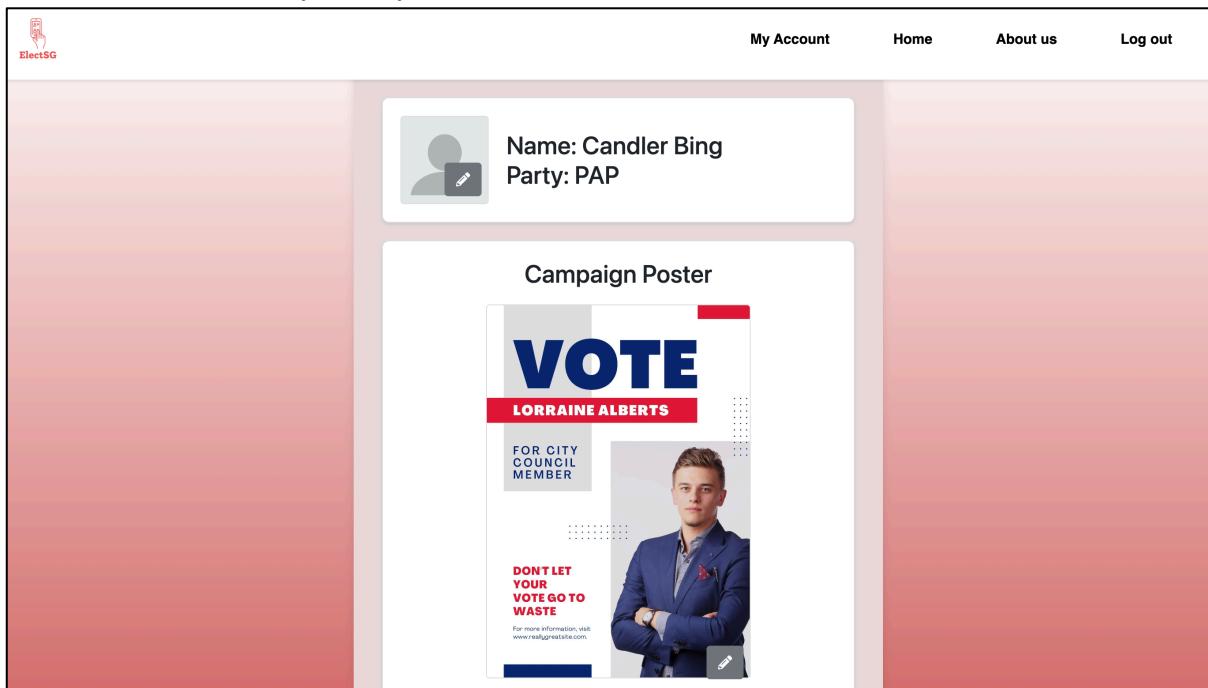


9.8.3 Deleting a Profile Picture

1. Click “Delete” button.
2. Click “Ok” button.

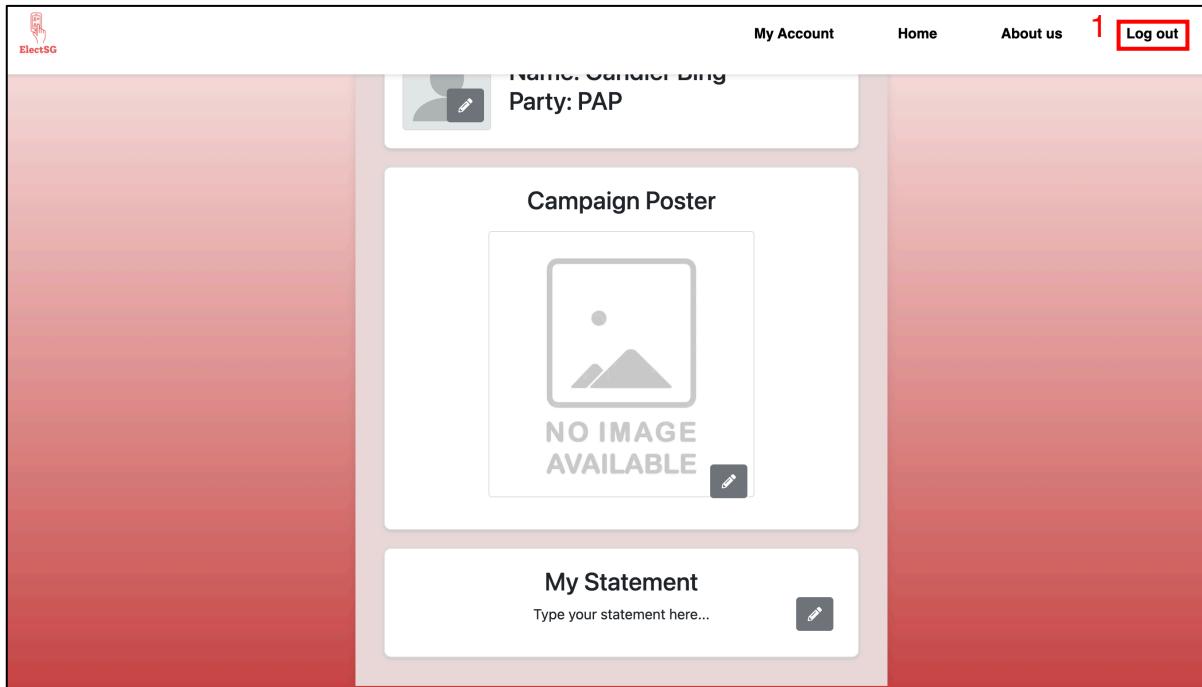


You will see that the profile picture has been deleted.

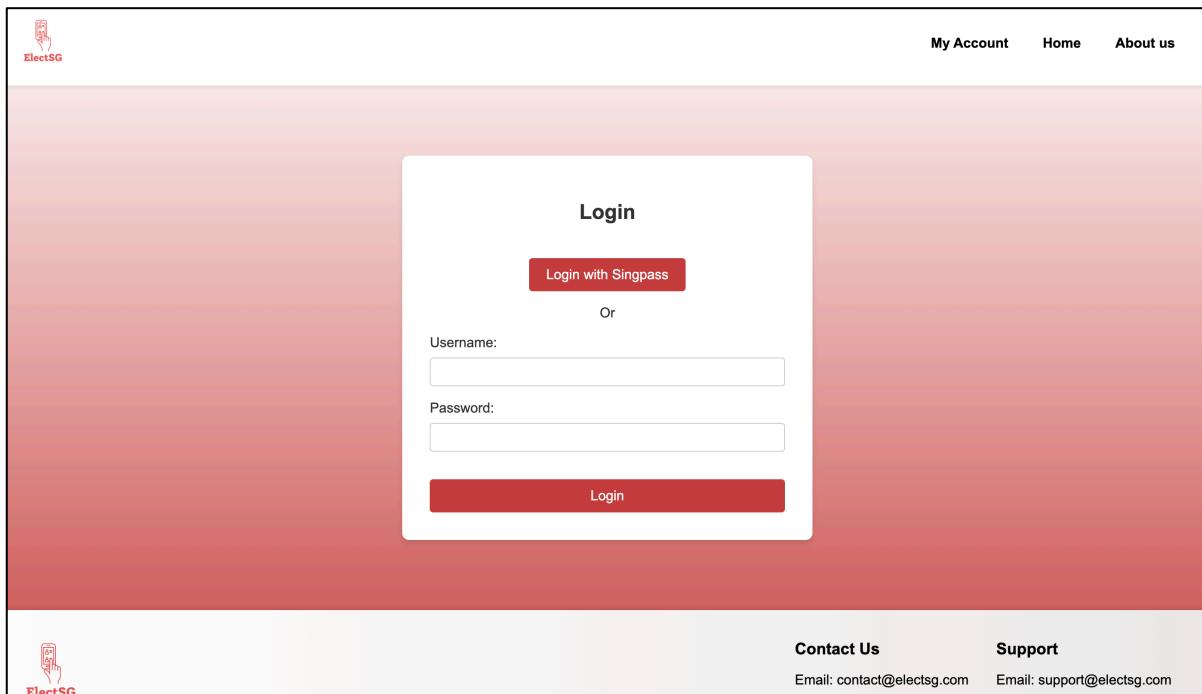


9.9 Candidate Log out

1. Click “Log out”.



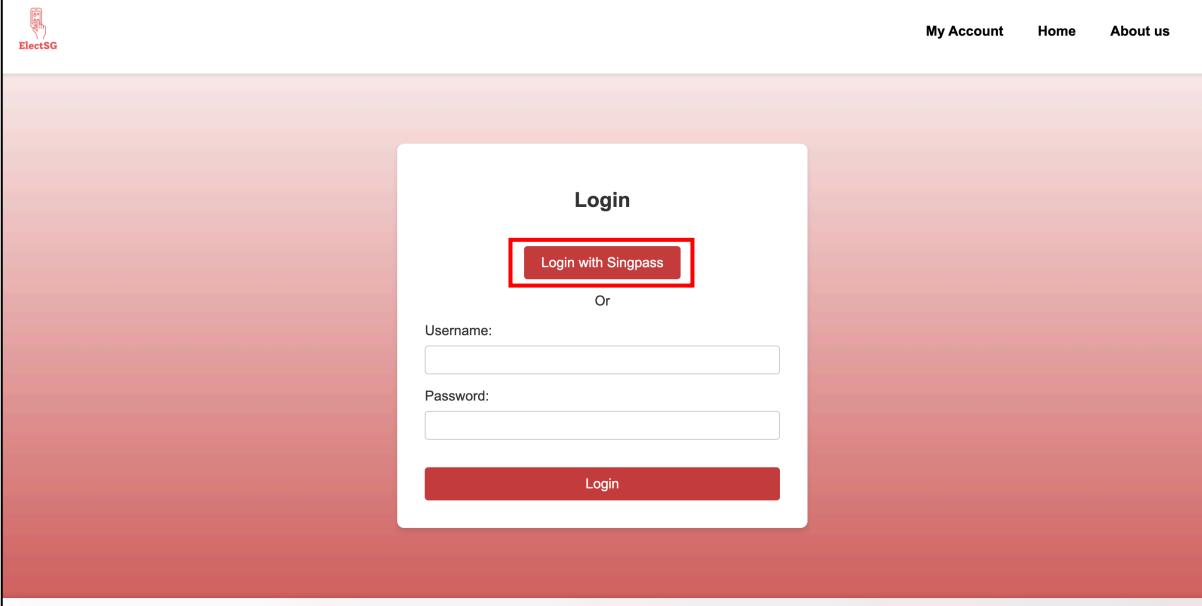
User will be redirected to log in page.



10. Using ElectSG as Voter

10.1 Voter Log in

1. Click the “Log in with Singpass” button.



The screenshot shows the ElectSG voter login interface. At the top right, there are links for "My Account", "Home", and "About us". On the left, there's a small logo with the text "ElectSG". The main area is titled "Login" and contains two login methods: "Login with Singpass" (which is highlighted with a red box) and "Or" followed by a standard "Username:" and "Password:" input fields, and a "Login" button.

ElectSG

My Account Home About us

Login

Login with Singpass

Or

Username:

Password:

Login

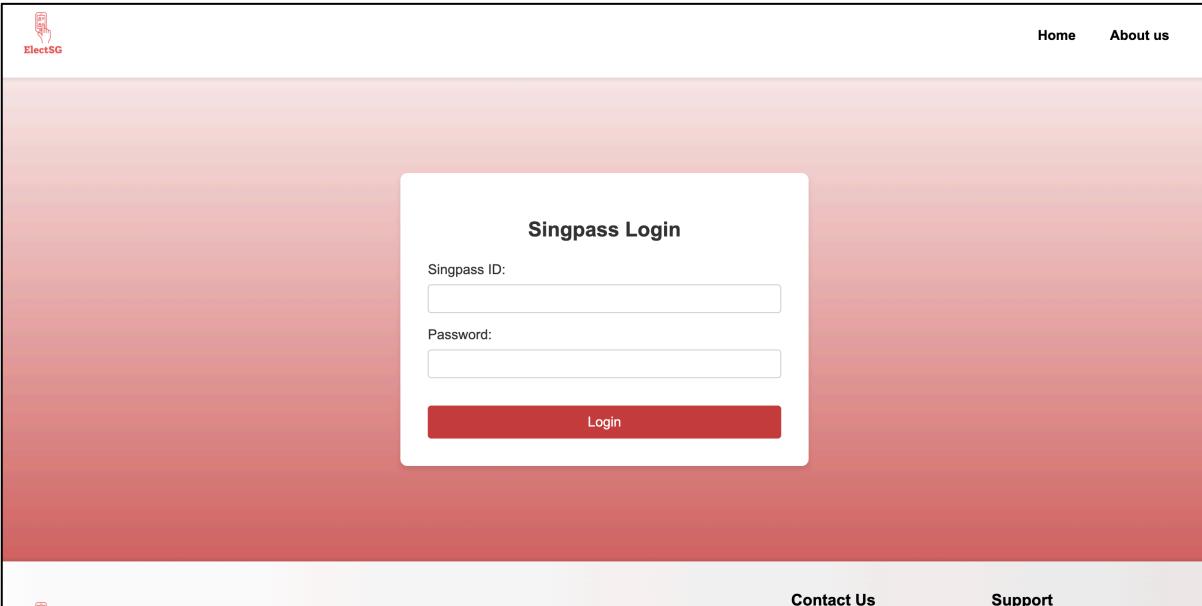
Contact Us Email: contact@electsg.com

Support Email: support@electsg.com

ElectSG

2. Fill in the Singpass ID and Password.

3. Click “Login”



The screenshot shows the "Singpass Login" form within the ElectSG voter login interface. It features "Singpass ID:" and "Password:" input fields, and a "Login" button. At the bottom right, there are "Contact Us" and "Support" links with their respective email and phone numbers.

ElectSG

Home About us

Singpass Login

Singpass ID:

Password:

Login

Contact Us Email: contact@electsg.com
Phone: +65 80656786

Support Email: support@electsg.com
Phone: +65 87666543

ElectSG

10.2 Voter Interface

1. This is Voter Homepage that voter will see after logging in.

The screenshot shows a voter homepage with a red gradient background. At the top right are links for "Home", "About us", and "Log out". On the left is the ElectSG logo. The top center displays "District: CLEMENTI". Below this, the text "Voting Status: Haven't Voted" is shown. A grid of five candidate cards is displayed in two rows: three cards in the first row and two cards in the second row. Each card contains a placeholder user icon, the candidate's name, and their party affiliation. A "Vote" button is located at the bottom center.

District: CLEMENTI		
Bryan Tate Party: DAP	Charles Ellis Party: DAP	Veronica Hanson Party: PAP
Vote		

10.3 Viewing Candidates

You can see the district voter belongs to, voting status, and all the candidates in your district in the home page after logging in.

This screenshot is identical to the one above, showing the Voter Homepage for District CLEMENTI. It features the same layout with the ElectSG logo, navigation links, and the "Voting Status: Haven't Voted" message. The candidate grid and the "Vote" button are also present, indicating no changes from the previous screenshot.

District: CLEMENTI		
Bryan Tate Party: DAP	Charles Ellis Party: DAP	Veronica Hanson Party: PAP
Vote		

10.4 View Candidate's poster and statement

1. Click the candidate you want to view.

The screenshot shows a web-based voting interface. At the top right are links for "Home", "About us", and "Log out". Below this, the text "Voting Status: Haven't Voted" and "District: CLEMENTI" are displayed. A green rectangular box highlights the first candidate profile. The profiles for four candidates are shown in a grid:

- Bryan Tate** (Party: DAP)
- Charles Ellis** (Party: DAP)
- Veronica Hanson** (Party: PAP)
- (Two more candidates are partially visible below)

A "Vote" button is located at the bottom center of the screen.

You can see all the candidates profile, poster and statement.

The screenshot shows a detailed candidate profile for Bryan Tate. At the top right are links for "Home", "About us", and "Log out". The candidate's profile picture and name ("Name: Bryan Tate, Party: DAP") are displayed. Below this, there is a section for the "Campaign Poster" which shows a placeholder message: "NO IMAGE AVAILABLE". At the bottom, there is a section for "My Statement" with the placeholder text "Type your statement here...".

10.5 Casting Vote

1. Click “Vote”.

Voting Status: Haven't Voted

District: CLEMENTI

Bryan Tate Party: DAP	Charles Ellis Party: DAP	Veronica Hanson Party: PAP
<input style="border: 2px solid yellow;" type="button" value="Vote"/> 1		

2. Choose Candidate to vote.

3. Click “Submit”.

Lisa Marisol (DAP)	<input type="checkbox"/>
Thomas Page (DAP)	<input type="checkbox"/>
Kathleen Reyes (PAP)	<input type="checkbox"/>
Alicia Sanford (PAP)	<input type="checkbox"/>
Christina Griffin (PAP)	<input type="checkbox"/>

3

You can see Voting Status changed to Voted.

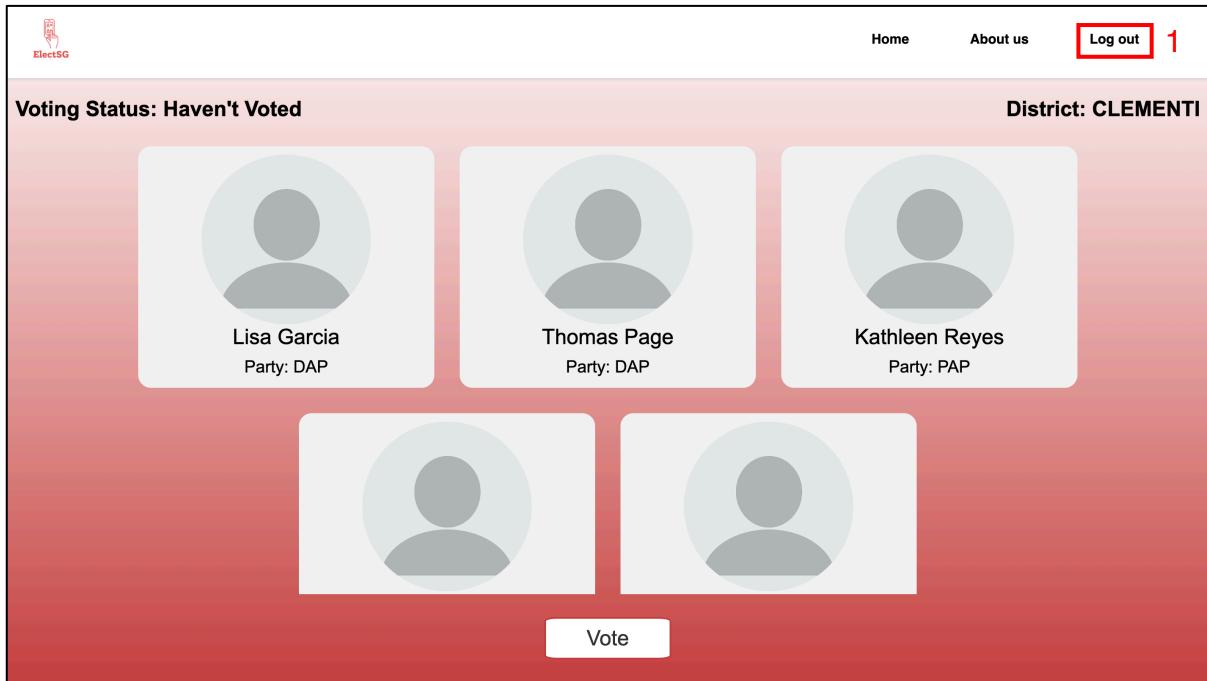
The screenshot shows a web-based voting application. At the top right, there are links for "Home", "About us", and "Log out". On the left, there is a small logo for "ElectSG". In the center, the text "Voting Status: Voted" is displayed, with the word "Voted" highlighted by a red rectangular box. To the right of this, it says "District: CLEMENTI". Below this, there is a grid of five candidate profiles. The first three profiles are fully visible, while the last two are partially visible at the bottom. Each profile includes a placeholder user icon, the candidate's name, and their party affiliation. A "Vote" button is located at the bottom center of the grid.

Voting Status: Voted		District: CLEMENTI
Bryan Tate Party: DAP	Charles Ellis Party: DAP	Veronica Hanson Party: PAP

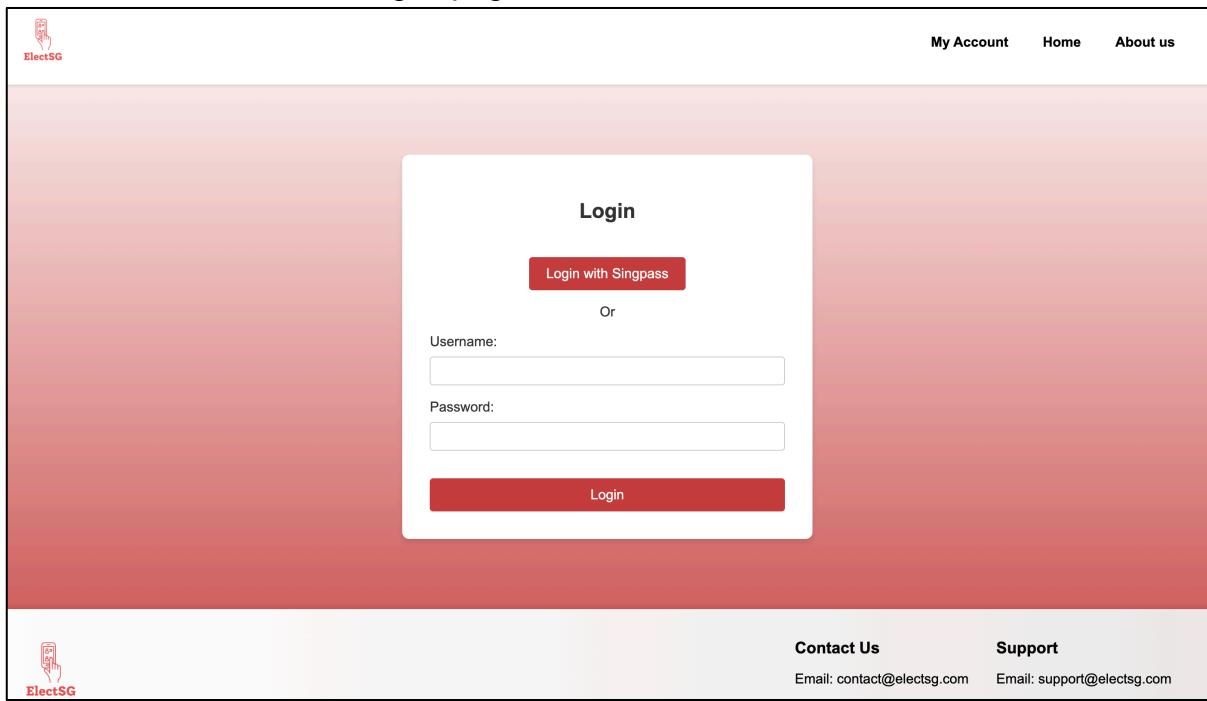
Vote

10.6 Voter Log out

1. Click “Log out”.



User will be redirected to log in page.



11. Admin Startup Guide

Below is a structured startup guide for the application, ElectSG, specifically tailored for system administrators managing an e-voting platform, ElectSG general election system. This guide includes steps for setting up the application with three admin accounts and registering each with a FIDO2-certified device.

11.1 Startup Guide for ElectSG

11.1.1 Application Hosting and Handover

- Application is fully hosted on a secure server.
- The application is handed over to designated election admins.

11.1.2 Admin Account Setup

- Pre-configured Admin Accounts: The application comes with three pre-configured admin accounts. The usernames and passwords for Admin 1, Admin 2, and Admin 3 are as follows:
 - username: [admin1], Password: [Admin1Password\$!]
 - username: [admin2], Password: [Admin2Password\$!]
 - username: [admin3], Password: [Admin3Password\$!]

11.1.3 FIDO2 Device Registration for WebAuthn

- a. Device Requirements:
 - Hardware Security Keys: USB, NFC, or Bluetooth Low Energy (BLE) keys that are FIDO2 certified.
 - Built-in Authenticators: Compatible devices include Windows Hello, Touch ID, Face ID, and Android biometric sensors.
- b. Browser Support:
 - Chrome: Fully supported since version 67
 - Firefox: Fully supported since version 60
 - Safari: Supported since version 13
 - Edge: Fully supported since version 18
 - Opera: Supported since version 54
- c. Registration Process:
 - Each admin must register their account using a FIDO2-certified device. Refer to section 8.4 in the user manual for detailed registration steps.
 - It is recommended that each admin registers one master device to ensure account access in case of loss of a non-master device.

11.1.4 Managing WebAuthn Devices

- Device Limits: Admins can register up to two devices (regardless of master and non-master, the total is two). If more than two devices are registered and the admin would like to update the WebAuthn device, the admin must:
 - Remove all WebAuthn credentials (this includes master and non-master device) from the "View Account" page.
 - Alternatively, remove non-master WebAuthn credentials from the "My Account" page.

11.1.5 Security and Best Practices

- Storage of master device: Ideally store master device in a vault.
- Loss of WebAuthn Device: Immediately remove the WebAuthn credential with the master device login.

This guide provides a comprehensive overview of the initial setup and security practices for the election system application, ensuring a secure and efficient administration process.

12. Appendix: Vote Record

```
{
  "key_image": "91f09342984e426815cd04d4b8a533bd67ead77dbe9d9015ba1cdbe1f9b4b7e1",
  "rG": "40fea28a21106e3c63e3f969e272cc6057f7ef336808c7f733c7820a22cfa298",
  "blsagSig": {
    "c": "8d6203471ab99fc1a09c4fd9b7cd9281f33b95cc605cd5512d092fe960a9f0a",
    "m": "57c7966ae1bf93599e812c29b722d54cc1c3bb30095166227cf3d1ce3aa55031",
    "r": [
      "202aaedb0cf9316fcebd5d5ef51141fd0b3265b9a902e1ca69f921dc0bc501",
      "6ebb18fbe7101f17ce69167c359cf39f454f57560b0bf29846bba6201e5950c",
      "a8ef4e76b6d086ed327f4e10ab0a857f028d6910bf5a57aa9a6add1a0c220c0d",
      "d8489ff373af5bdb367c338e80da87ad4eed761940e5702cd5c25c4b0499210f",
      "289379de5cc5025a623707843914c2be6b2f0957aa366521b20439cc76585b01",
      "e520d63e608c0d63286f0bf1f29f33561878c082c19f6291002be2857b7680b",
      "2be4dc045a86f2fc34945a42f9bc985d1578b3a4047350f28736b6a6ebe0580e",
      "444e223cb1bc77df6cb385337cf615524e57a7cd8e3335ae11cb3a755226d0d",
      "2fcb7ae968ffad8223e5d62cf5a60bf02c5a945a667b9cfca393204ed7ab6d01",
      "505d85d03e62cc4ddac8ee5026c196898b1103d17e43e5e1dfb61c5752f9320f",
      "f6d1cdaeac157a5f4a97df30843d1a608443f9802d4130fa374c8b8114e4f603"
    ],
    "members": [
      "ae9170e30e8729516fa13a52e00d700dbf9f070132f5ad7e5a1f07190adeebf1",
      "010e3ff4cdfdb2c2ebbacb9db41d283a9446ef06feb53714d8818ea4913814ae",
      "7e4e3f197d852e74ad2853d8414450a73211f137ccb1b4733eb4acf586791e92",
      "eb9f39a3aca86dd63b7ebc1500ce252138dbf8c4a5ce605d38521c0e28f034d6",
      "10095e142995a429b9dd64ecf033ba84524c5e67a4d4a4e42f241f91e1edaf5d",
      "e59c8dbb8b1a28c2030bb37d12a4466b3de867087108fc889693bc063348f887",
      "3bf6f84e9b8a584323ccb4c44103f6431b970af1852005ff23cab6624a2073fe",
      "69a90e27b7faeb1366f5be3e4e4ef9e379b1ee7b80fd4b39a6e9b96944e79782",
      "96c5b056eb357dc50afbc87f455a22662c180e951b624947a628edd7a7586117",
      "11c9c814bcc5f16eb8e021b1593933a0f1227e70bb43bf2f59b2a51a89ee761",
      "14925d36688023b35a32fb11d9c0a3df475ee4cf59fc58c9c116aae191ea9f26"
    ],
    "commitment": {
      "amount_mask": "250ce2271b6897d9",
      "output_commitment": "f0776579336357f8f5bd18c9daf00a6082fdःaa254863fb1d16d8c0ec7251e913",
      "pseudoout_commitment": "f0776579336357f8f5bd18c9daf00a6082fdःaa254863fb1d16d8c0ec7251e913"
    },
    "rangeproof": {
      "C1": [
        "7866728ddefecfcf7bc224545a3d6cdc7e73a38e328d81d06a49634c3a767bbf",
        ...
      ]
    }
  }
}
```

```

.....
"7a39d3c2e97c3e299cc23e67b20eac3eea0103fc23b740fdbdfed7c660a287b8",
"20a733943c1604f4ba9b8d6303f830caf0c80a6d3456c82886ef04b64fd686a7",
"32debff55b819c41d3cf755582572ec6953252de8296c76aeee535ba52db24780",
"4ed80e14b350c2fbdede80ebd4f1f8f1ab4bc187818a4b3567f3add78dd589ab",
"cddb1ca1b9f92d44f4594f92386d216f7d1af384181bbeb8197c5d67d2e8573d",
"96c1da05103fc2f3e5dec3413d5416af787b14cb96c15e52e4782a8c16bd1bea",
"33fbacd6dc9d699b38c57cb8377b3fab9290c481b624e082e343c7230dc6d6ae"
],
"C2": [
  "d3036a4935fd31ef165156d3b8660d710d6a935e9ba5cc7de2f6947d596b827b",
  "760bc7bba50a5f4c810b0225d5a512f8764e484278ddc51bf3cd522602a16b95",
  "d0605fdadbc7eadb1e06f631f49226498713b9ba691c4046c3385b25f68eec26",
  "7d9c7302e7ed226b9c6cb96e3e311064e2a3aa16a4a4441f81a5ca515d26cba7",
  "56cec730a25a48917c47d9832d299aac3242daffe5a595dc1b7e593e1b801c98",
  "5e909f986dfdc799b28ae93a8766f38ede31fa156e5c0265ae98756216eba00f",
  "12d024c0488241462fce803478bcc3a90eeaf12d91950da42dd7c484631cbbd9",
  "5915133f8645588c376fcfd0061954ecc6ab4378e04c2b7e887842f8a7c617b6"
],
"bbe": "398e9ef79fbcdc2e3b61078577caa302c8f49e2c071b2d51e519d5beddba4c02",
"bbs0": [
  "abfc0c578558b3a733fd3522b762ebc5c0871fd7c3d30de434f16a80d2bbde02",
  "42ac0fc925f3aaeadcf7757732c662d35789305767230c1c0ccb57250eea0a",
  "81cdfc7a481ae696c7913fcc60455d5b7354af32ef3e6037df311de9b309904",
  "d7f156f254dc34a0ced20d7179cdc7750e25f48e289bd2e20ede6654ee819b07",
  "cc7a7a7eb4d878d95c1e687329ad4effd98791895ee8ae7ac035074ee8f0ef02",
  "6c701d1ca6b90259ddbfe95bfc752438e84505b5dcce30b0212bf32a9e3ce0e",
  "e3d885e0ff506775ddefa499184b3041521c5261c69e8f33e600d3ed827cbe0b",
  "8cf0cf2226d445371b2bb05df37ebf0603e42562d8b3147384e78ed7d87bc401"
],
"bbs1": [
  "3f249907b66500888c9aa4cfbec166f8814bcde723b95739caca5cc9eb32601",
  "f94178daa257788b9a4279eb5db5d621ae37505b16d18e782d261c81e7481207",
  "2b979f339489dd3881352da98676291fc593efe6085ddb7123eeeca1ffe2eb206",
  "86cebc2453ea7d99bb6c06b4f3642e2e2b04970942c30a31bbb524183fc04",
  "692a4bb33c0552e16610b5b6032069eff6761dd39a19e35e0a474d57d3d4de09",
  "720236313d5454fbec5f4a0f0985023306e99d059c26e09de6c8f8e7eec0b10c",
  "70c6c7514e2999924b287b70195d521a078480f0723ad9313588f358d6e0d809",
  "2f2c55b155e154f67f61cc696ef9541f619b4e7af9bf3d3f6a2a4c6ac122e607"
]
},
"stealth_address": "b6a13435e84ab8bd488ae658e9097536ada1bdf7cce6b0afe508fba2c08ec74d"
}

```

- key_image: A unique identifier for each transaction, preventing double voting by linking multiple votes from the same source.
- rG: A cryptographic value used in the signature process.
- blsagSig: Contains the components of the bLSAG signature.
- c: Challenge value in the signature.
- m: Message hash related to the signature.
- r: Array of response values for each ring member.
- members: List of public keys forming the ring, including decoys and the real signer.
- commitment: Ensures the integrity of the transaction.
- amount_mask: A mask applied to conceal the transaction amount.
- output_commitment: Represents the concealed output value.
- pseudoout_commitment: Used to obfuscate the actual output.
- rangeproof: Verifies that the transaction amount is within a valid range without revealing it.
- C1, C2: Arrays of cryptographic commitments.
- bbee, bbs0, bbs1: Additional cryptographic components ensuring validity.
- stealth_address: A unique, one-time address that conceals the recipient's identity in the transaction.