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TITLE

E_Voting for University Scientific Councils: A Digital Solution

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Abstract

Although traditional voting is widely adopted for its simplicity and apparent transparency, it presents several limitations, including the high cost of organization, the time required for vote counting, the risks of human error, and accessibility difficulties for some voters. With the evolution of digital technologies, these constraints have encouraged the search for more modern and efficient solutions, such as electronic voting.

This dissertation presents the design and development of a secure electronic voting platform intended for university environments, particularly for scientific council elections, with teachers as the main users.

The proposed solution was modeled using several UML diagrams in order to clearly represent the architecture and overall functioning of the system. The implementation was carried out as an Android mobile application developed using Android Studio. Firebase was used as a real-time cloud database to ensure instant data synchronization and authentication management, while the PBKDF2 algorithm was adopted to enhance security through password hashing and encryption of sensitive information.

The platform also integrates several features aimed at improving the user experience, including theme customization and multilingual support, making the application more flexible, accessible, and user-friendly.

The obtained results demonstrate that electronic voting represents an effective alternative to traditional voting methods, thus providing a reliable, secure, and easy-to-use solution for organizing remote university elections while ensuring the integrity, confidentiality, and speed of the electoral process.

Keywords: E-voting, Android, Firebase, UML, PBKDF2, Security, University Scientific Committee.

الملخص

على الرغم من أن التصويت التقليدي يُعتمد على نطاق واسع بسبب بساطته وشفافيته الظاهرية، إلا أنه يواجه العديد من القيود، من بينها التكلفة المرتفعة للتنظيم، والوقت اللازم لفرز الأصوات، ومخاطر الأخطاء البشرية، بالإضافة إلى صعوبة الوصول بالنسبة لبعض الناخبين. ومع التطور المتسارع للتقنيات الرقمية، شجعت هذه القيود على البحث عن حلول أكثر حداثة وفعالية، مثل التصويت الإلكتروني.

تقدم هذه المذكرة تصميم وتطوير منصة تصويت إلكتروني آمنة موجهة للبيئات الجامعية، وخاصة لانتخابات المجالس العلمية، حيث يُعتبر الأساتذة المستخدمين الرئيسيين للنظام.

تمت نمذجة الحل المقترح باستخدام عدة مخططات UML بهدف توضيح بنية النظام وآلية عمله بشكل واضح. وقد تم تنفيذ النظام في شكل تطبيق محمول لنظام أندرويد باستخدام Android Studio. كما تم استخدام Firebase كقاعدة بيانات سحابية فورية لضمان المزامنة اللحظية للبيانات وإدارة المصادقة، في حين تم اعتماد خوارزمية PBKDF2 لتعزيز الأمان من خلال تجزئة كلمات المرور وتشفير المعلومات الحساسة.

تتضمن المنصة أيضًا عدة خصائص تهدف إلى تحسين تجربة المستخدم، من بينها تخصيص الواجهة ودعم تعدد اللغات، مما يجعل التطبيق أكثر مرونة وسهولة في الاستخدام والوصول.

وقد أظهرت النتائج المتحصل عليها أن التصويت الإلكتروني يُمثل بديلاً فعالاً لطرق التصويت التقليدية، حيث يوفر حلاً موثوقًا وآمنًا وسهل الاستخدام لتنظيم الانتخابات الجامعية عن بُعد، مع ضمان سلامة العملية الانتخابية وسريتها وسرعتها.

General Introduction

The voting process is a fundamental aspect of decision-making within both public and private institutions; however, traditional voting methods continue to consume significant time and resources and pose a major challenge in today's world. These challenges require solutions that rely on more efficient and effective technology.

Electronic voting (E-voting) offers a practical technological alternative by making it possible to conduct elections remotely in a secure and fast environment. This project focuses on building, designing, and developing an electronic voting platform specifically tailored to the university-level educational environment, targeting all ranks of teachers as primary users. The suggested electronic system consists of two main actors: the administrator, who manages the electoral process, and the regular user (the teacher), who participates in voting or running for office.

The system was designed using several UML diagrams and was built and developed as an Android application using Android Studio as the development environment, while Firebase provides real-time cloud database services. Security is ensured through PBKDF2 hashing and encryption mechanisms. Additional features include theme customization and multilingual support.

This thesis consists of the following chapters: Chapter 1 provides an overview of traditional voting and its alternative, electronic voting. Chapter 2 describes the UML modeling of the system. Chapter 3 details the software development process, covering Android Studio, the database, and security. The thesis closes with a conclusion offering perspectives on future improvements.

Chapter 1

Electronic Voting

1.1 Introduction

Electronic voting is a modern alternative to traditional paper voting systems. It aims to simplify the electoral process by saving time, reducing costs, and improving accessibility while ensuring transparency and security.

1.2 Classic Voting (Traditional Paper-Based Voting)



Figure 1.1: Classic Voting

1.2.1 Definition

Traditional voting is an election based on using papers in the electoral process, where voters cast their votes on ballot papers and place them in secure ballot boxes. Once voters have cast their votes, the votes are counted manually and then verified by election officials (7).

1.2.2 Historical Development

The concept of voting is closely associated with the notion of democracy. In ancient city-states like Athens in Greece, approximately 508 B.C. in Ancient Greece, the term election has evolved from the Greek word *eklektos* meaning 'picked out/chosen/selected' (7).

In the 18th and 19th centuries, when rulers became accountable to the people through councils of elected representatives, the right to vote was usually restricted to men who had reached a certain age and owned property, who constituted a small segment of the population (6).

The chronology varies between countries, but the common pattern is that property requirements were abandoned first, and gender inequality was abolished later. For example, in

New Zealand, universal suffrage for men was established in 1879, while women's suffrage was established in 1893, making it the first country to implement universal suffrage (6).

1.2.3 Voting Operational Framework

The traditional voting process typically includes:

1. Voter registration and identity verification
2. Issuance of a paper ballot
3. Private choice of the voter
4. Deposit into sealed ballot box
5. Manual counting and public observation

1.2.3.1 Advantages

- High transparency through public oversight
- Low technical requirements
- Physical record for review
- Less exposure to cyber threats

1.2.3.2 Challenges

- Time-consuming counting procedures
- Substantial costs for logistics and administration
- Human errors in counting
- Risk of vote fraud or physical vote tampering

1.3 Electronic Voting (E-Voting)

1.3.1 Definition

E-voting refers to the casting, recording, and/or counting of votes using an electronic system. These systems cover the use of remote e-voting (ability to vote from anywhere using internet technologies from a phone or computer), and the use of electronic voting machines and notably Direct Recording Electronic voting machines (also known as "DRE") (26).



Figure 1.2: Electronic Voting

1.3.2 Historical Development

The E-voting machine was introduced in the middle of the 20th century, but it began to be widely used in the early 2000s. The United States adopted different direct electronic recording (DRE) systems after the passage of the Help America Vote Act (2002) (29).

Brazil has implemented electronic voting machines at the national level to reduce voter fraud and accelerate vote counting (10).

A significant development took place in 2005 when Estonia became the first country to conduct a legally binding nationwide online vote in a parliamentary election (30).

1.3.3 Types of Electronic Voting Systems

- Direct Recording Electronic (DRE) machines
- Scan-based systems (paper ballots that are scanned)
- Internet voting (electronic voting via an electronic platform)

1.3.4 Advantages

- Fast tallying of results
- Reduction of human counting errors
- Improved accessibility for absentee voters or voters with special needs

- Possible long-term cost benefits

1.3.5 Challenges

Despite its advantages, electronic voting raises significant technical and security concerns (28):

- Exposure to cyberattacks
- Software manipulations or bugs
- Lack of transparency in monopolistic systems
- Digital divide issues
- Decreased public trust in non-transparent systems

1.4 Modern Technological Solutions for E-voting

1.4.1 Blockchain

Blockchain technology is based on a distributed and immutable ledger where each vote is recorded as a transaction. It is considered a promising solution to strengthen transparency and traceability in elections (23).

- **Advantages**: Data integrity, transparency, elimination of central authority.
- **Applications**: Independent audits, vote traceability, national experiments in Estonia and Switzerland (**?**).

1.4.2 Artificial Intelligence (AI)

Artificial Intelligence can be used to enhance security and improve user experience. It enables anomaly and fraud detection in real time, which is essential to maintain voter trust (24).

- Detection of anomalies and fraud in real time.
- Predictive analysis to anticipate technical problems.
- Assistance to voters through chatbots, voice recognition, and automatic translation.

1.4.3 Combination of Blockchain and AI

The combination of both technologies provides a robust system:

- **Blockchain** ensures vote integrity and traceability (23).
- **AI** continuously monitors and analyzes to detect anomalies and attacks (24).
- Together, they reinforce trust, transparency, and reliability of the electoral process.

1.4.4 Future Perspectives

Beyond Blockchain and AI, other innovations can enrich e-voting:

- **Biometrics**: authentication through fingerprint or facial recognition.
- **Multi-factor authentication**: combining passwords, SMS codes, and digital certificates.
- **Open-source platforms**: publicly audited systems to increase voter confidence.

1.4.5 Comparison between Traditional Voting and E-voting

Traditional voting systems have been widely used for many years and are generally based on paper ballots and manual counting processes. Although these methods are considered simple and transparent, they require significant human effort, financial resources, and time to organize and manage elections (28).

In contrast, electronic voting (E-voting) systems use digital technologies to automate the electoral process, including voter registration, vote casting, vote counting, and result publication. E-voting systems aim to improve efficiency, accessibility, and speed while reducing operational costs and human errors (27).

One of the main advantages of traditional voting is its transparency and public trust, since physical ballots can be manually verified and recounted when necessary. However, traditional elections often suffer from long waiting times, logistical difficulties, paper waste, and delays in announcing results (26).

On the other hand, E-voting systems provide rapid vote counting, real-time result processing, and easier participation for voters, especially in remote areas or during exceptional situations such as pandemics. In addition, electronic systems can reduce the need for large administrative staff and physical polling infrastructure (30).

Despite these advantages, E-voting introduces several security and privacy challenges. Electronic systems may become targets for cyberattacks, unauthorized access, malware, or data manipulation if appropriate security mechanisms are not implemented. Therefore, strong cryptographic techniques, secure authentication, and transparent auditing mechanisms are required to ensure election integrity and voter confidence (29; 31).

Table 1.1 summarizes the main differences between traditional voting and electronic voting systems.

Table 1.1: Comparison between Traditional Voting and E-voting

Criteria	**Traditional Voting**	**Electronic Voting**
Voting Method	Paper ballots	Digital interface
Vote Counting	Manual counting	Automatic counting
Result Publication	Slow	Fast and real-time
Operational Cost	High	Relatively lower
Accessibility	Limited by location	Remote access possible
Human Errors	More frequent	Reduced
Transparency	High physical traceability	Requires digital auditing
Security Risks	Ballot manipulation	Cybersecurity threats
Environmental Impact	High paper consumption	Reduced paper usage

Overall, both traditional voting and electronic voting systems have advantages and limitations. While traditional voting offers familiarity and transparency, E-voting provides speed, flexibility, and modernization. The success of an electronic voting system depends largely on its security, reliability, and the trust it can establish among voters.

1.4.5.1 Security: Hashing and Encryption using PBKDF2

PBKDF2 (Password-Based Key Derivation Function 2) is a widely used cryptographic algorithm designed to enhance password security by generating strong derived keys from user passwords. It is part of the PKCS #5 standard published by RSA Laboratories and standardized in RFC 8018 (22).

The main objective of PBKDF2 is to protect passwords against brute-force and dictionary attacks. Instead of storing passwords directly, the algorithm transforms the original password into a secure cryptographic hash using a combination of a pseudorandom function, a cryptographic salt, and a large number of iterations.

The PBKDF2 function is defined as follows:

$$DK = PBKDF2(PRF, Password, Salt, c, dkLen)$$

Where:

- **PRF**: Pseudorandom Function, usually HMAC-SHA256 or HMAC-SHA512.
- **Password**: The original user password.
- **Salt**: A random cryptographic value added to strengthen security.

- **c**: Number of iterations used to increase computational complexity.
- **dkLen**: Desired length of the derived key.
- **DK**: Final generated derived key.

The use of a cryptographic salt ensures that identical passwords produce different hashes, preventing rainbow table attacks. In addition, the high number of iterations significantly slows down password cracking attempts by increasing the computational cost required for each guess.

In the proposed electronic voting system, PBKDF2 is used to secure user authentication credentials before storing them in the Firebase database. This mechanism contributes to preserving confidentiality, integrity, and resistance against unauthorized access. Consequently, even if the database is compromised, recovering the original passwords remains extremely difficult.

PBKDF2 is considered a reliable and efficient solution for password protection in modern applications due to its simplicity, compatibility, and strong resistance to offline attacks.

1.5 The Department's Scientific Committee

1.5.1 Definition

The department's scientific committee is an elected or appointed academic body (usually comprising 7-9 members) responsible for managing scientific and pedagogical affairs within the educational department (12).

1.5.2 Authority of the Department's Scientific Committee

The Scientific Committee of the Department is responsible for the following:

- Proposing the organization and content of education
- Expressing its opinion on the distribution of pedagogical tasks
- Expressing its opinion on the results of pedagogical and scientific work
- Proposing research programs
- Proposing the opening, extension, or closure of postgraduate programs and determining the number of positions to be filled
- Expressing its opinion on research topics for postgraduate students

1.5.3 Meetings of the Department's Scientific Committee

The department's scientific committee meets periodically to discuss scientific and pedagogical topics, particularly scientific events, the approval of master's students' topics, the scientific registration of doctoral students, the appointment of experts for course publications, promotions, short-term internships abroad for professors and outstanding students, etc.

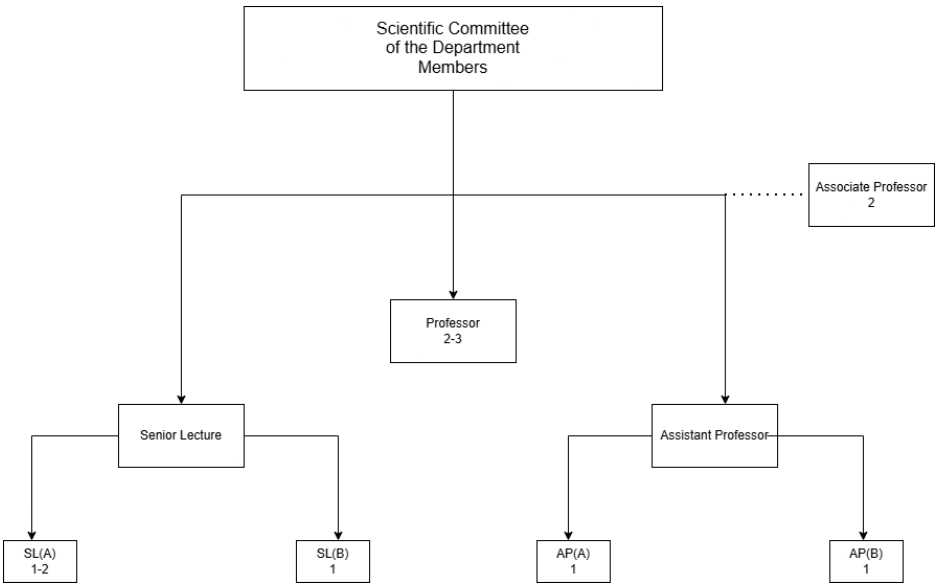

Figure 1.3: Composition of the Department's Scientific Committee

1.6 Conclusion

In this chapter, we explored the fundamentals of electronic voting and highlighted its importance in modern electoral votes. Despite the challenges related to security and reliability, electronic voting remains a promising solution capable of improving the efficiency, accessibility, and transparency of elections.

Chapter 2

Conception and Modeling (UML)



Figure 2.1: UML

2.1 Introduction

Design and modeling play a crucial role in software development by providing a clear representation of the system's structure and behavior before implementation. In this chapter, UML diagrams are used to analyze and model the proposed electronic voting system, including its features, interactions, and architecture.

2.2 Conception

2.2.1 What is the problem?

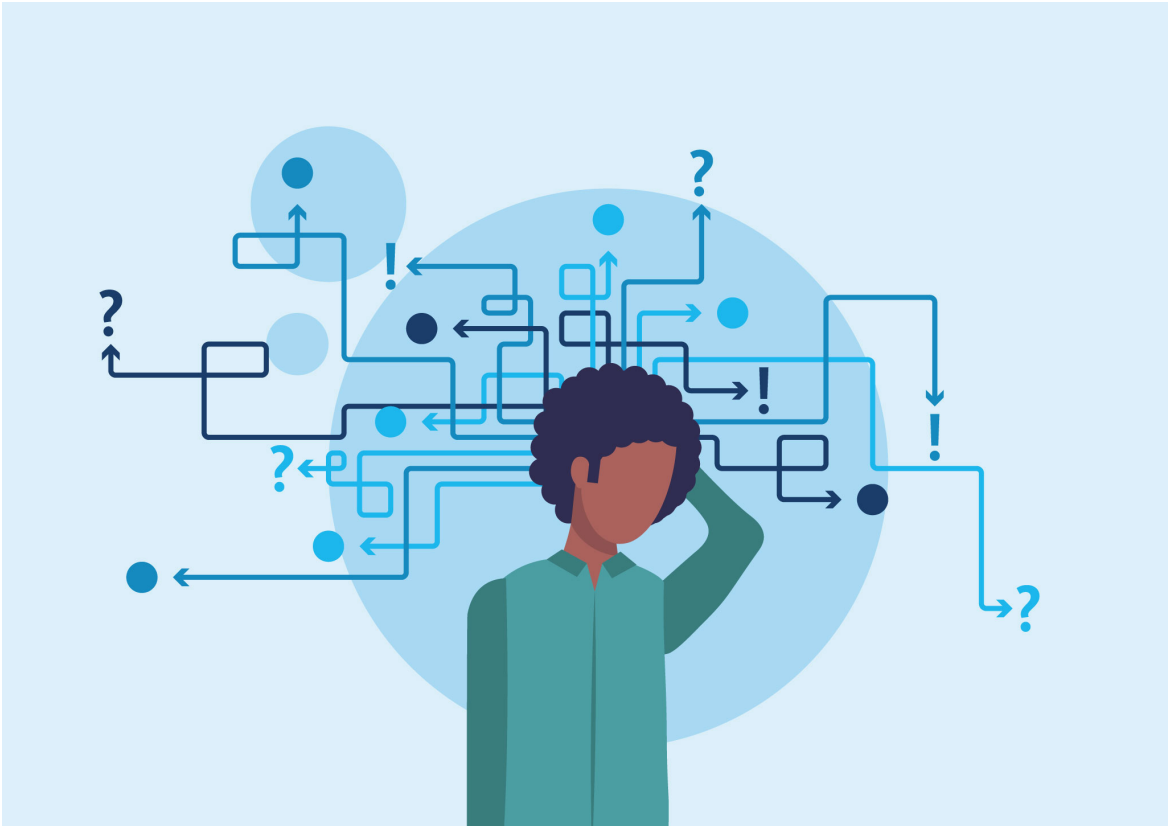

Figure 2.2: What is the problem?

As is well known, the electoral process requires significant resources and preparation, and takes a long time to organize from setting dates and managing candidate nominations to determining polling locations. This causes some disruption and wasted time, which is considered a problem in the modern era.

2.2.2 What is the solution of the problem?

However, thanks to technology and scientific advancements, traditional voting has become a thing of the past. This is due to the ability to build a remote voting platform using modern

technological resources, which is considered the ideal solution. This is the concept of E-voting.

2.3 UML (The Unified Modeling Language)

2.3.1 UML Definition

Unified Modeling Language (UML) is a visual language consisting of a set of diagrams, each offering a different view of a project to be carried out. These diagrams are used to represent the system to be developed, including its operation, structure, data, startup, and actions that can be performed by the system (13).

The creation of these diagrams is predicated on the modeling of the requirements of the system to be developed.

2.3.2 UML: The Different Types of Diagrams

The development of a system, computer application, or set of applications is based on several diagrams (or views). UML has 14 ”official” diagrams (14).

Two main categories:

- Diagrams of structure
- Diagrams of behavior

2.3.2.1 Diagrams of Structure

- **Diagram of classes:** Represents the static structure in terms of classes and relations
- **Diagram of objects:** Represents objects and their relationships
- **Component diagram:** Represents the software components of an application
- **Deployment diagram:** Represents the deployment of components on physical devices
- **Diagram of composite structures:** Shows the links between the class diagram and the component diagram.
- **Profile Diagram:** allows for custom stereotypes and properties for specific domains
- **Package diagram:** Organizes system elements into high-level groups (packages) to manage complexity.

2.3.2.2 Diagrams of Behavior

- **Activity Diagram:** Describes behavior in terms of actions and flows
- **Use Case Diagram:** Represents system functions from the user's perspective (functional requirements)
- **State Transition Diagram:** Represents the behavior of elements in terms of states and state transitions
- **Sequence Diagram:** Provides a temporal representation of objects and their interactions
- **Communication Diagram:** Provides a spatial representation of objects, links, and interactions
- **Timing Diagram:** Describes temporal specifications (for real-time systems)
- **Global Interaction Diagram:** A simplified version of the activity diagram that focuses on the elements involved in performing an activity rather than on its steps.

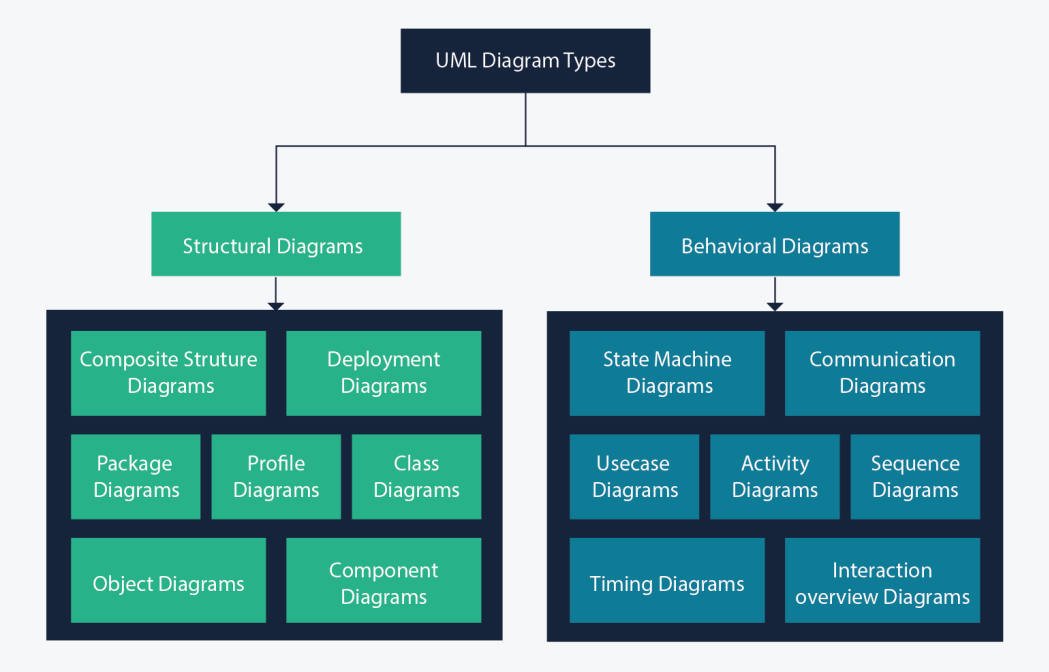

Figure 2.3: UML Diagrams Overview

2.4 E-vote Models and Diagrams

Electronic voting can be considered a software system with all the features that entails, and it can be represented and simplified through various diagrams and schematics to illustrate how the system works using UML diagrams. To accomplish this task, a modeling software program such as Modelio is required (15).

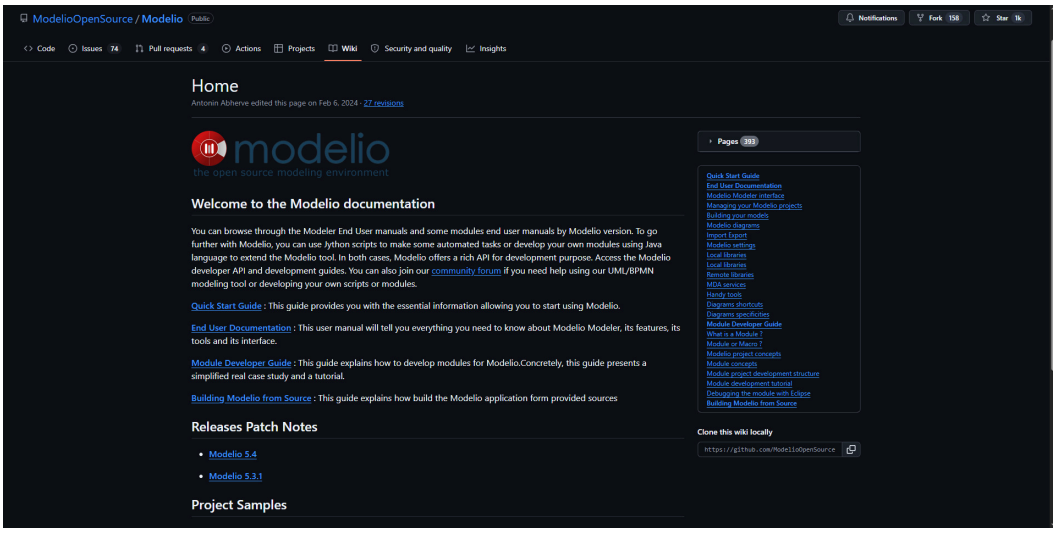

Figure 2.4: Modelio GitHub Repository

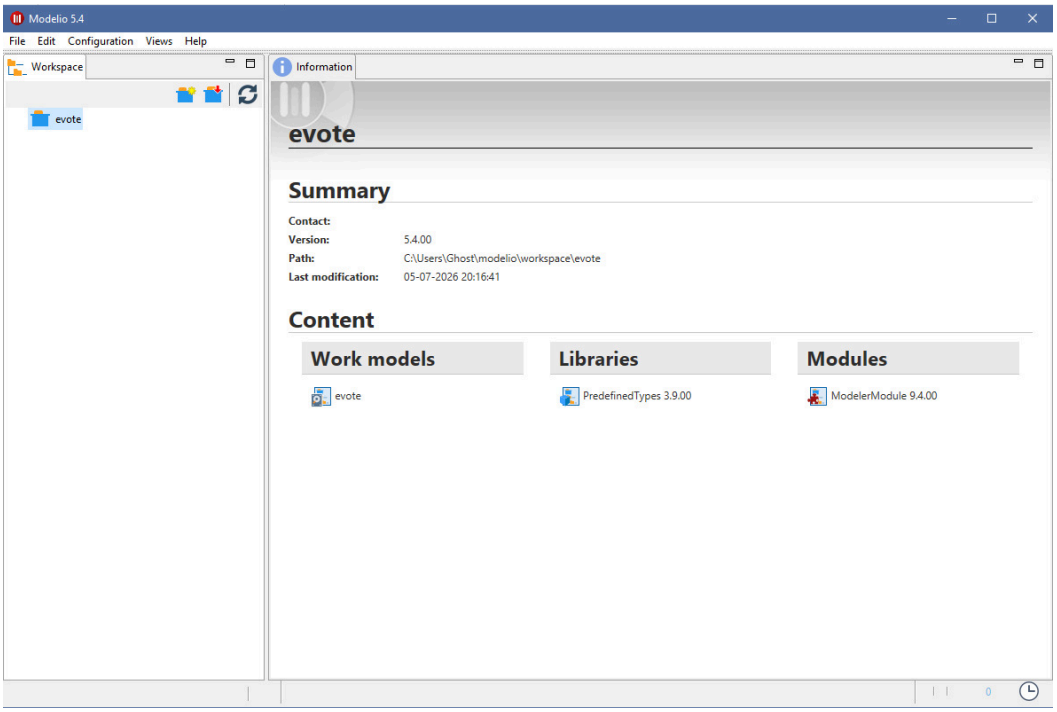

Figure 2.5: Modelio Software Interface

2.4.1 E-vote Use Case

The use case diagram for electronic voting provides a simple and concise overview of all the system's functions and users.

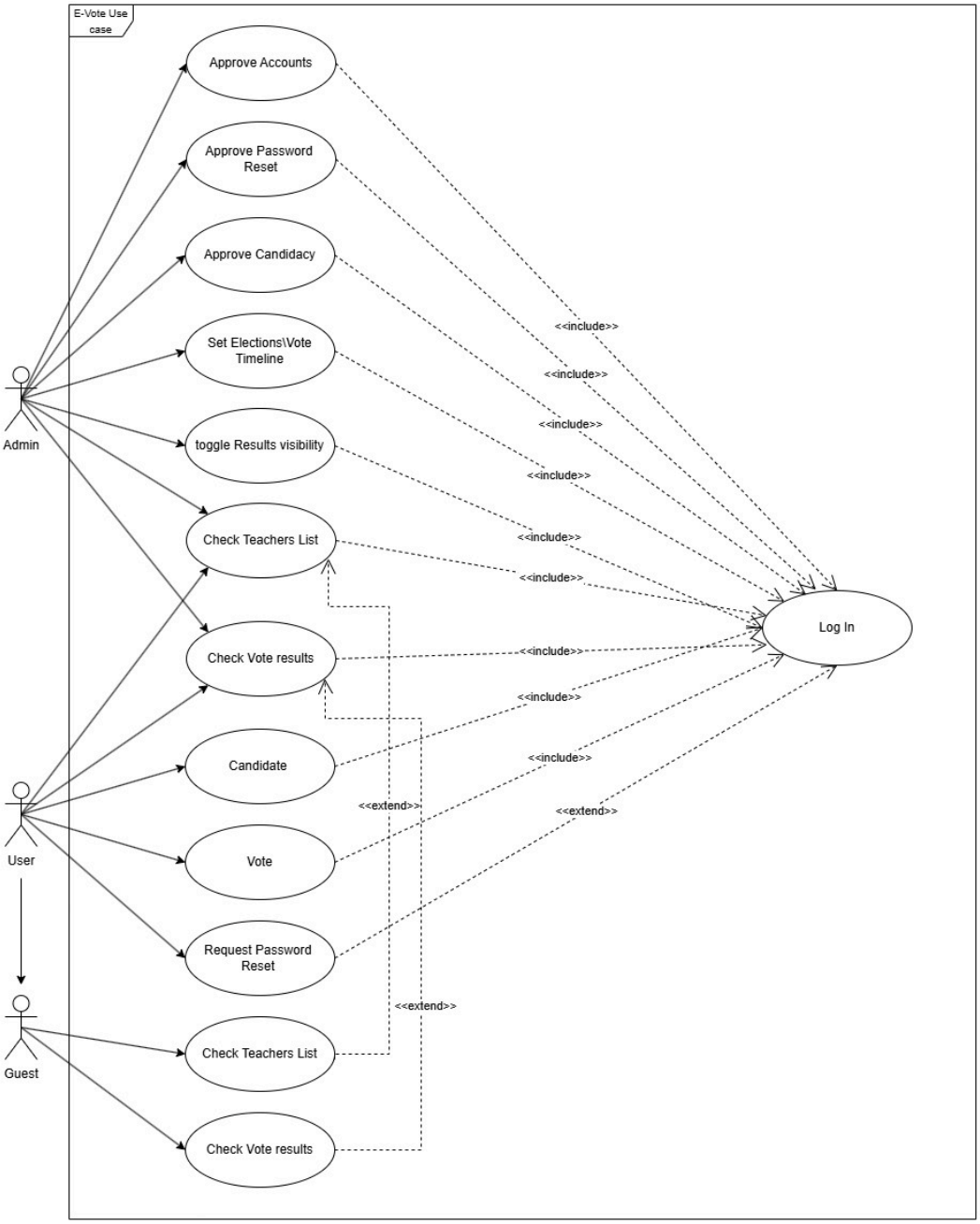

Figure 2.6: E-vote Use Case Diagram

2.4.2 E-vote State Diagram

The state diagram for the E-vote system represents the behaviors of actors with regard to states and state transitions, depending on whether the actor is an administrator or a regular user.

2.4.2.1 Admin State Diagram

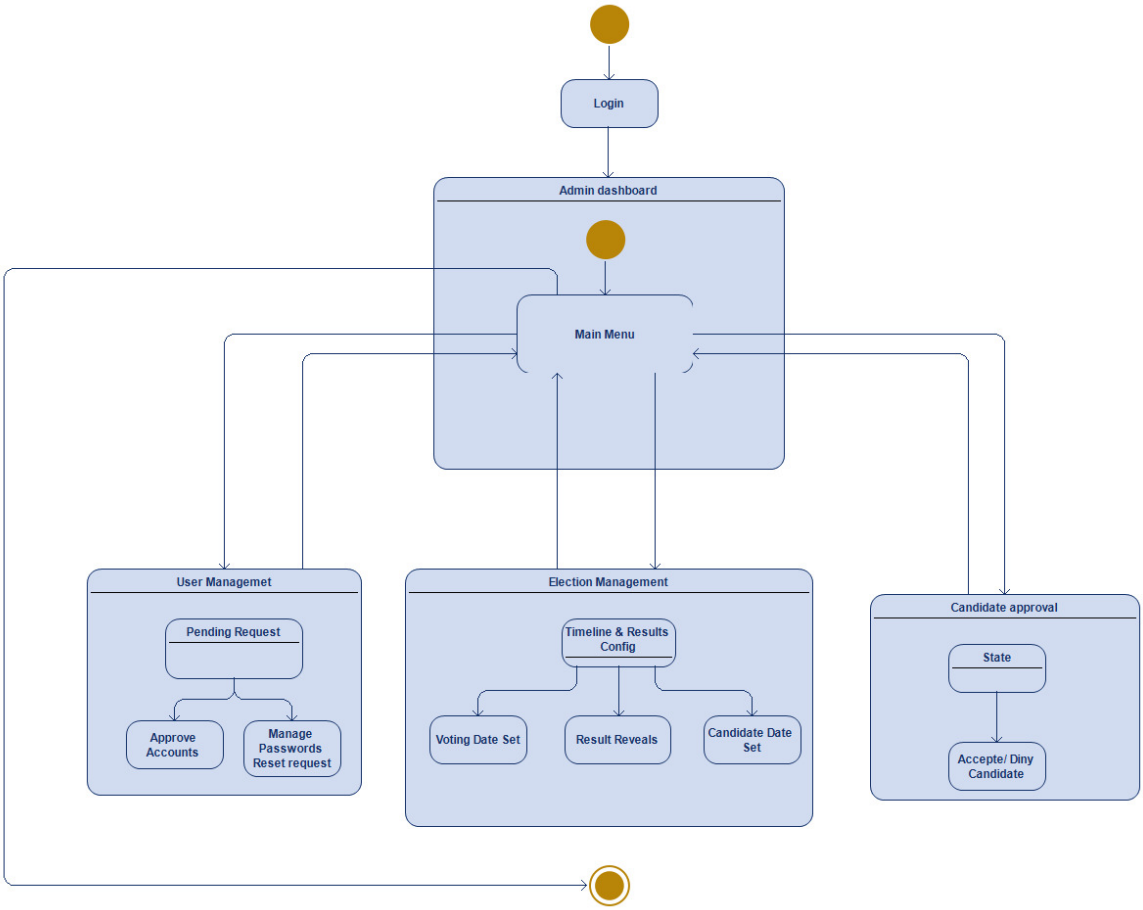

Figure 2.7: Admin State Diagram

2.4.2.2 Basic User State Diagram

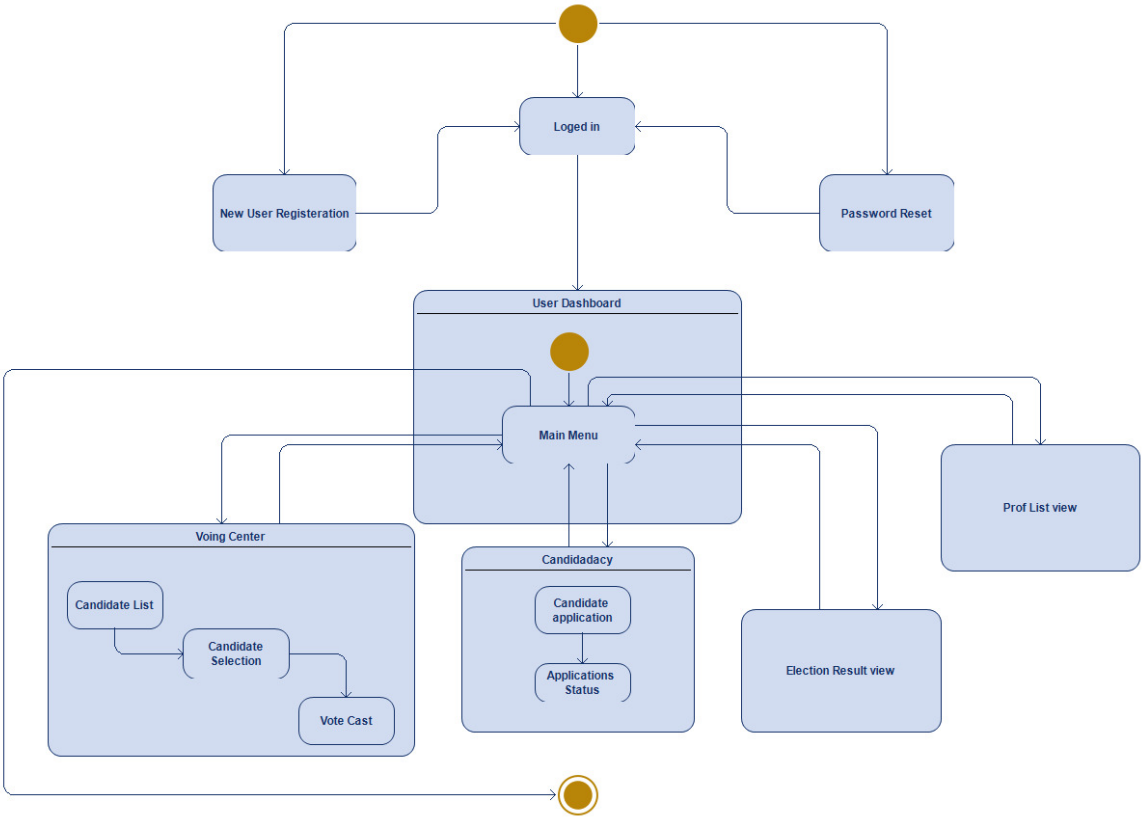

Figure 2.8: Basic User State Diagram

2.4.3 E-vote Class Diagram

The E-vote class diagram represents the solid structure in terms of classes and the role of users in all system operation.

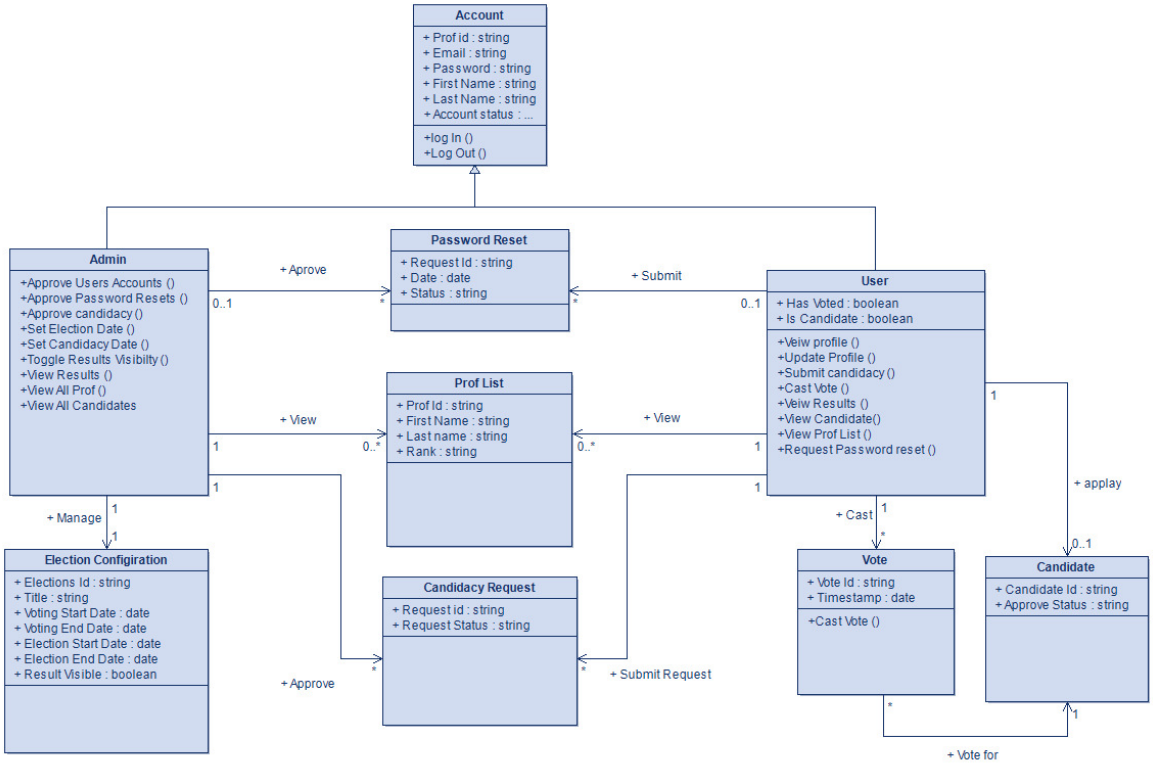

Figure 2.9: E-vote Class Diagram

2.4.4 E-vote Object Diagram

The E-vote object diagram mimics the objects and the relationships between them within the system and workflow.

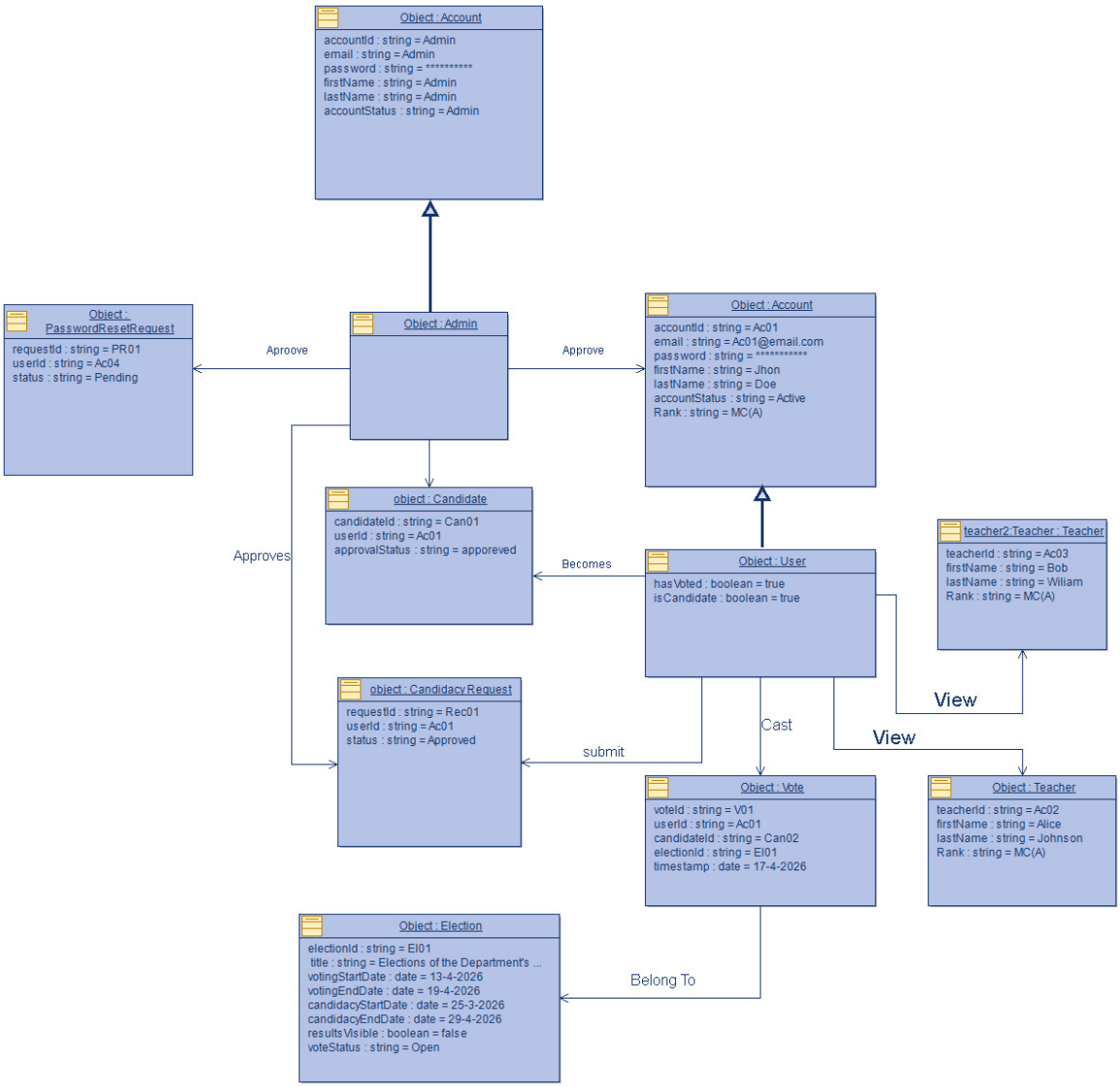

Figure 2.10: E-vote Object Diagram

2.5 Conclusion

In this chapter, we presented the different UML diagrams used to model the electronic voting system. These diagrams helped to provide a better understanding of the system requirements, components, and interactions. These diagrams serve as a solid foundation for the implementation phase.

Chapter 3

Software Development

3.1 Introduction

After completing the analysis and modeling phase, we implement the proposed system. This chapter describes the development tools, technologies, and methodologies used to build the electronic voting application. We will also present a simulation of an electronic voting operation carried out by our system.

3.2 E-vote Platform: Android Application

3.2.1 Why Android Application?

In this modern age, internet use has become widespread and dominant around the world, thanks to the proliferation of devices such as televisions and personal computers; however, one device in particular dominates the current technological era: the smartphone (especially Android devices). By early 2026, the number of smartphone users will reach between 5.65 billion and 6.92 billion (16). For this reason, the smartphone is considered an ideal platform for developing an electronic voting system.

Figure 3.1: Modern Platforms

3.2.2 Android System: Overview

Android is an operating system proprietary to Google, built on a modded version of the Linux kernel and other freeware and open-source software, and primarily designed for touchscreen mobile devices such as smartphones and tablets. Android was historically developed by a consortium of developers known as the Open Handset Alliance, but the most widely used version is primarily developed by Google. Android was first introduced in 2008 and is the most widely used operating system in the world; it is also the most widely used operating system for smartphones (16).

3.2.3 Features of Android Operating System

The Android platform offers a wide set of features that meet the needs of both users and developers. Among the main features of the Android Operating System:

- **Open-source platform:** Android is based on an open-source Linux kernel, allowing devs to access, modify, and contribute to the source code. This openness encourages innovation and collaboration within the Android ecosystem.
- **Personalizable user interface:** Android gives user the ability to adjust the user experience on their device, including wallpapers, themes, widgets, and apps. Users can

customize their devices to match their preferences and style.

- **Multitasking:** Android is designed to support multitasking, allowing users to run several apps at once, switch between them fluently, and perform different tasks simultaneously. Users can also use split-screen mode to view two apps side by side.
- **Google Play Store:** Android users have access to the Google Play Store, which offers a wide selection of apps, games, movies, music, books, and more. The Play Store offers users a central platform to discover, download, and install content on their devices.
- **Security Features:** The Android system includes various security features to protect users' data and confidentiality. These features include app sandboxing, secure boot, cryptographic file systems, Google Play Protection, and regular security updates from device manufacturing companies.
- **Accessibility:** Android includes a wide variety of accessibility capabilities to meet the needs of users with disabilities or specialized needs. These features include screen readers, zoom gestures, color inversion, text-to-speech, and more.
- **Development Tools and Support:** Android provides developers with a comprehensive set of development tools, including Android Studio, the officially supported integrated development environment (IDE) for Android app development. Developers also have access to comprehensive documentation, application programming interfaces (APIs), libraries, and resources to create high-quality apps for Android devices.



Figure 3.2: Android Features

3.3 Integrated Development Environment: Android Studio

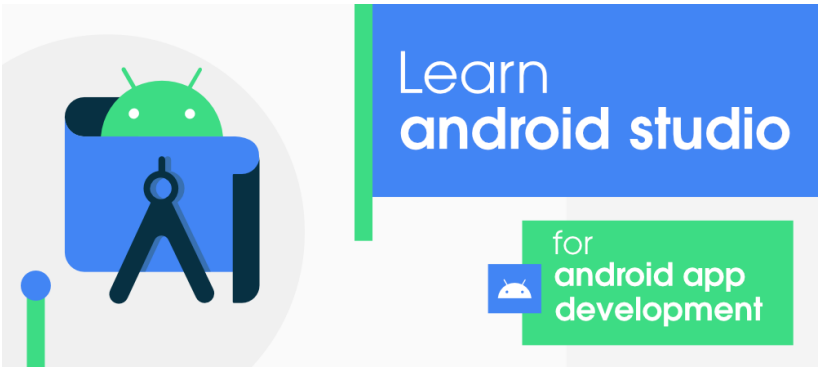

Figure 3.3: Android Studio

3.3.1 Android Studio: Introduction

Android Studio is the official integrated development environment (IDE) for Android app development (17). Based on the coding editor and powerful developer tools of IntelliJ IDEA, Android Studio offers more features that improve your app development productivity, such as:

- A flexible Gradle-based build framework
- A fast, rich-featured emulator
- A unified development environment that lets you develop for all Android devices
- Live Edit for real-time updates to components in emulators and physical devices
- Code templates and GitHub integration to help you create common app features and import code samples
- Comprehensive testing tools and frameworks
- Lint tools to detect performance, usability, version compatibility, and other issues
- Support for C++ and the NDK

3.3.2 Android Studio: Project Structure

Every Project in Android Studio includes one or more modules containing source code and resource files (17). Module types include:

- Android application modules

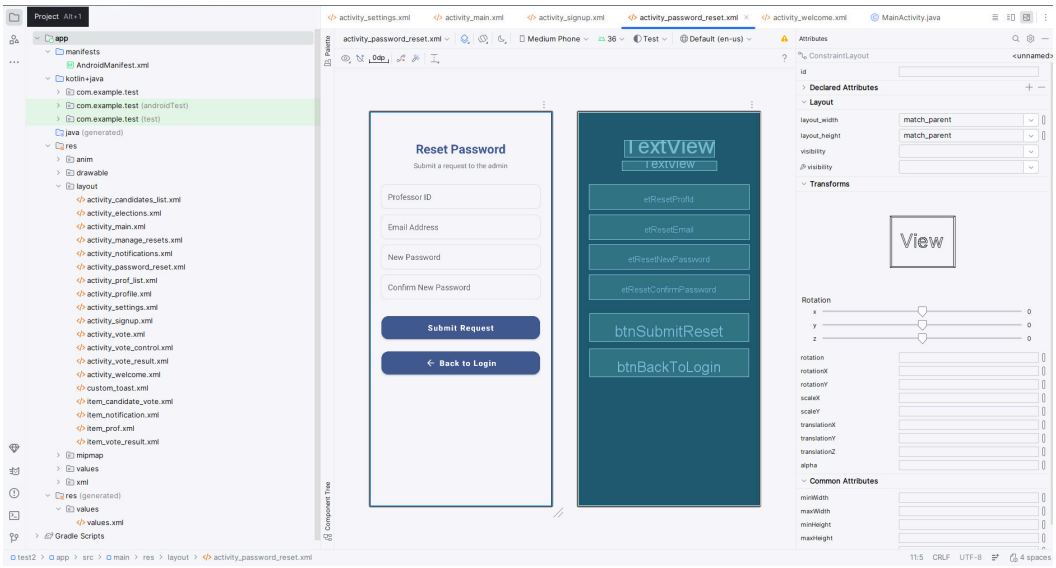

Figure 3.4: Android Studio IDE

- Library modules
- Google App Engine modules

By default, Android Studio displays your project files in Android View, this view is structured by modules to provide quick access to your project's main source files. All build files are displayed at the top level, under Gradle Build Scripts.

Each app module contains the following folders:

- **manifests:** Contains the AndroidManifest.xml file.
- **java:** Contains Kotlin and Java source code files, including JUnit test code.
- **res:** Contains all non-code resources such as UI strings and bitmap images.

The structure of an Android project on disk differs from this flat view. To see the actual file structure of the project, select ”Project” instead of ”Android” from the ”Project” menu.

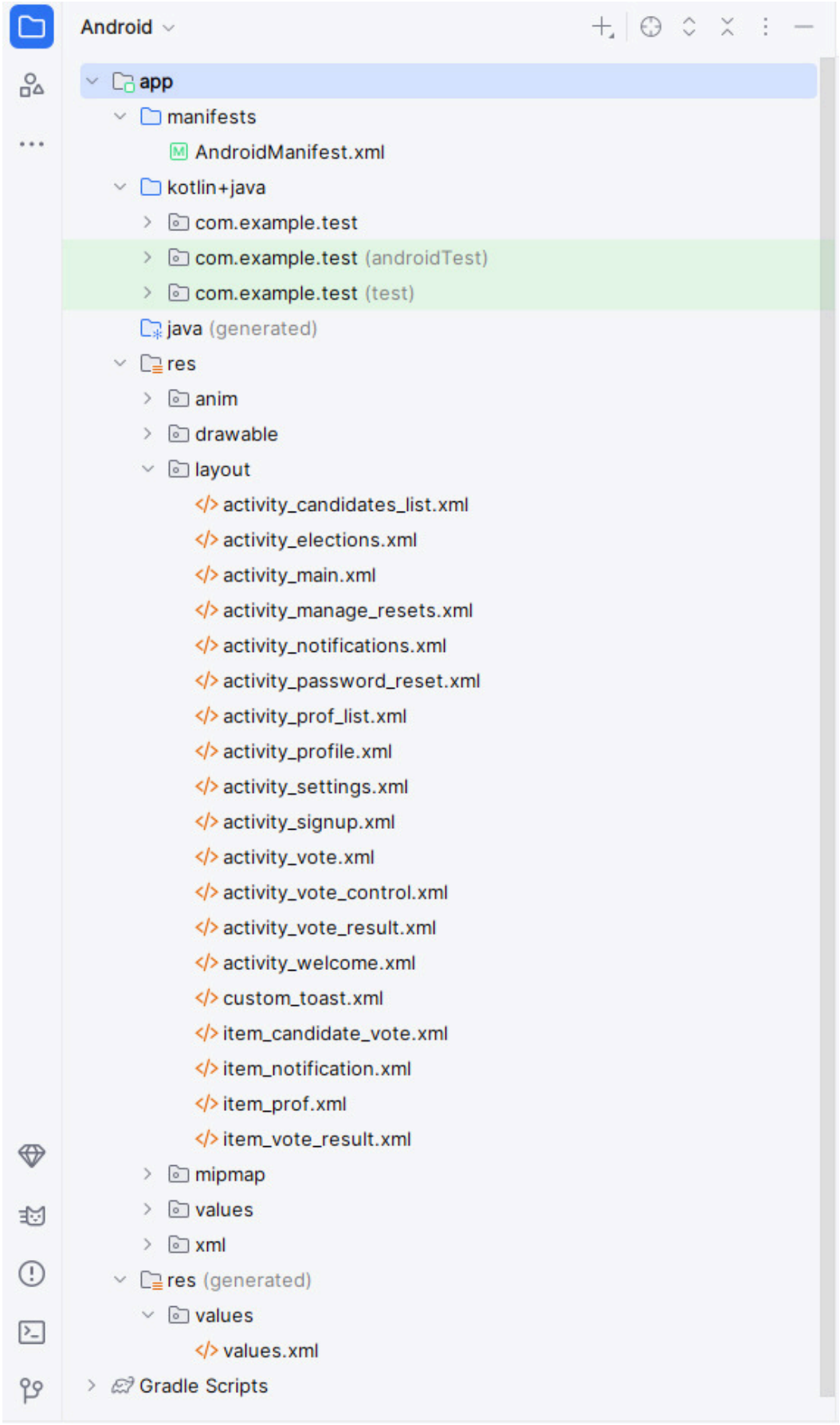

Figure 3.5: Android Project Structure

3.4 E-vote System: Android Platform

3.4.1 Platform Overview

On this election platform, there are two main parties that can interact with it: the administrator, who has higher privileges, and the regular user—that is, the teacher—who represents the target audience. The system interface is separated into the user front-end and the admin front-end (layout-animations-icons).

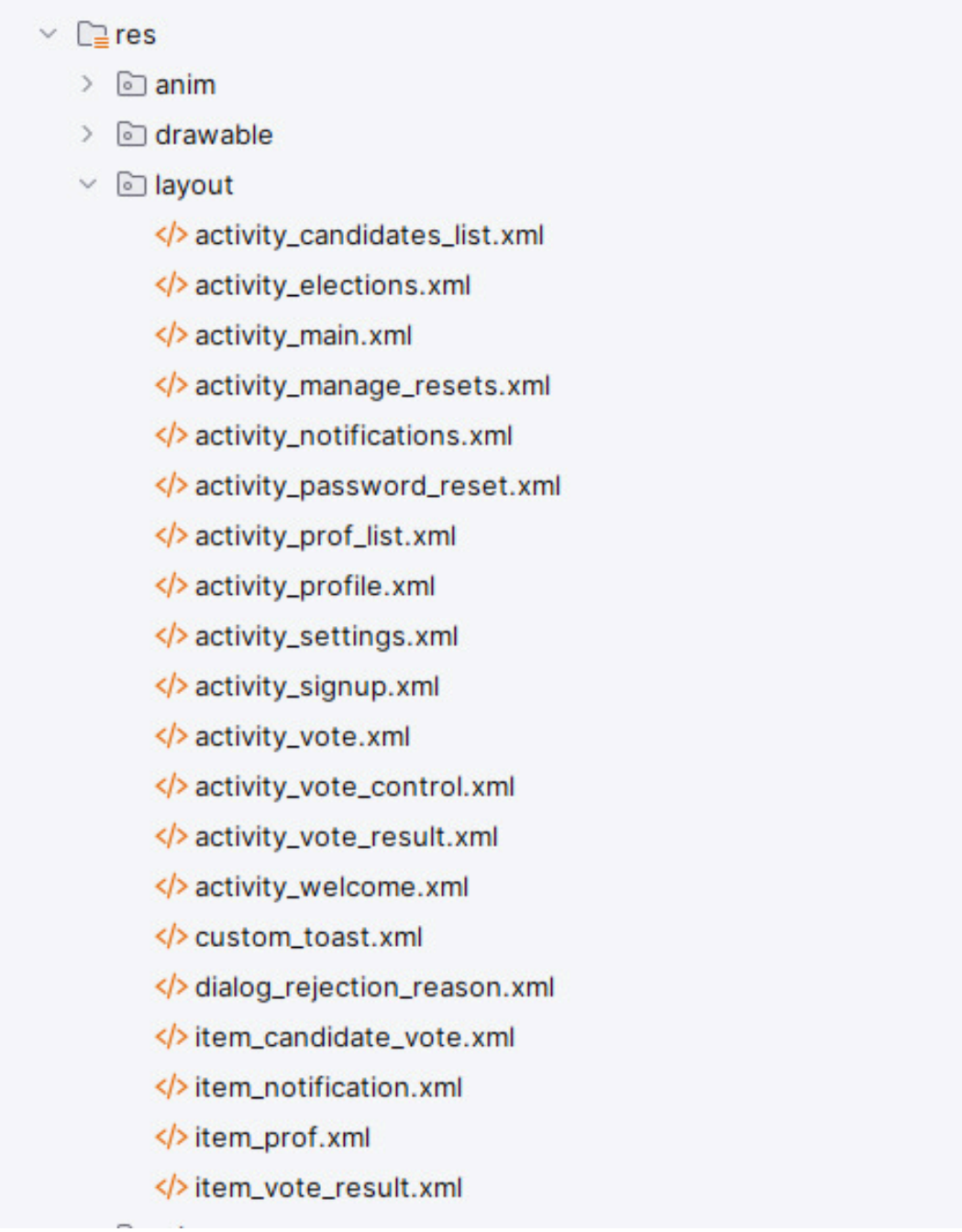

Figure 3.6: Project Interface Overview

3.4.1.1 User Front-end

The user interface includes many of the designs and features offered by the app:

Log In This is the initial screen that appears when starting the app and includes several functions:

- Log In
- Sign Up
- Log in as Guest
- Settings
- Reset Password

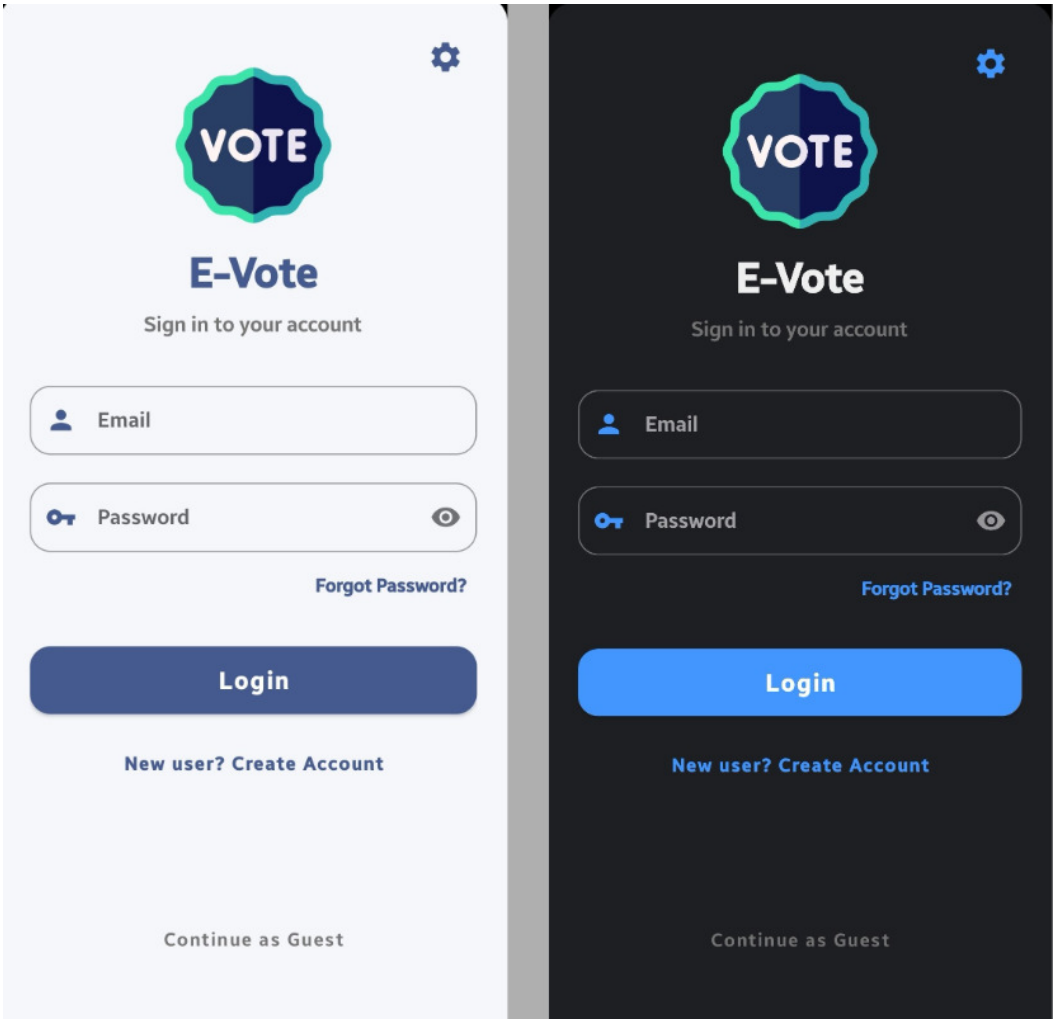

Figure 3.7: Log In Interface

Sign Up This window allows the user to create an account by entering certain information (first name, last name, email address, teacher ID, and password). Once the form is filled out, the user can return to the login page and log in after the administrator approves the account.

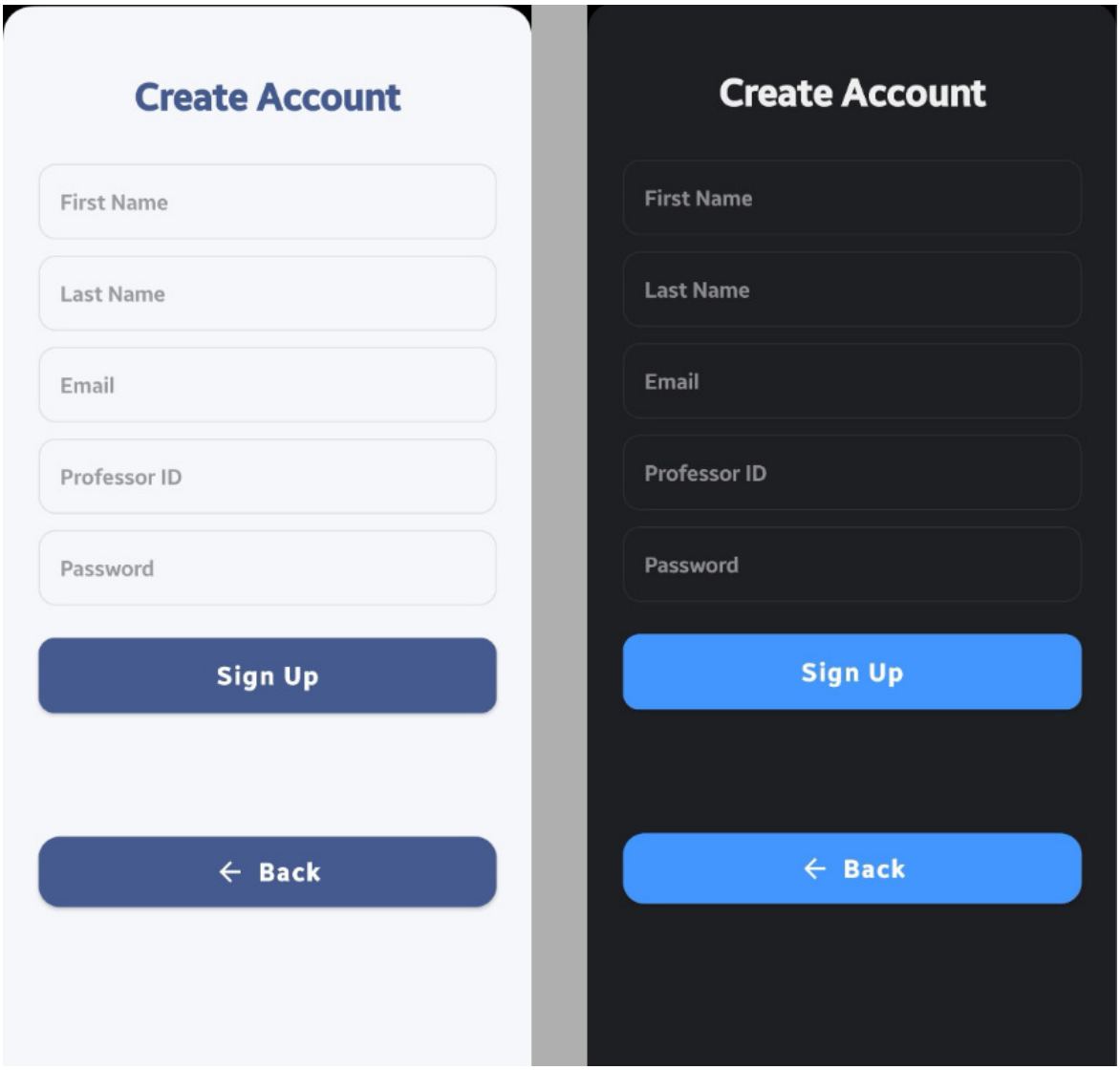

Figure 3.8: Sign Up Interface

Log in as Guest This window allows users to log in as guests and view voting results and the list of candidates (limited access).

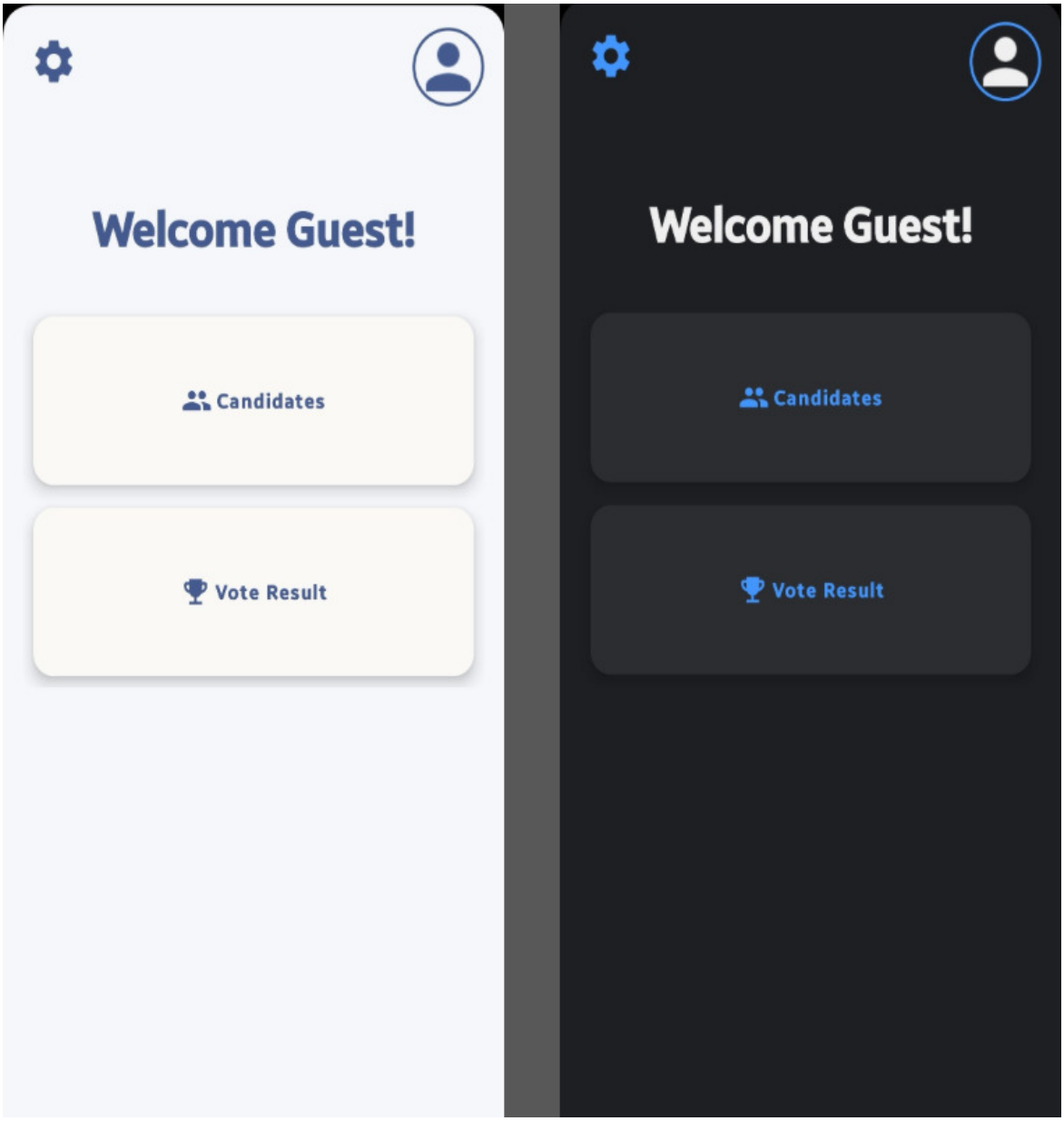

Figure 3.9: Guest Login Interface

Password Reset This window allows users to submit a request to the administrator to approve a new account password if the user has forgotten their password.

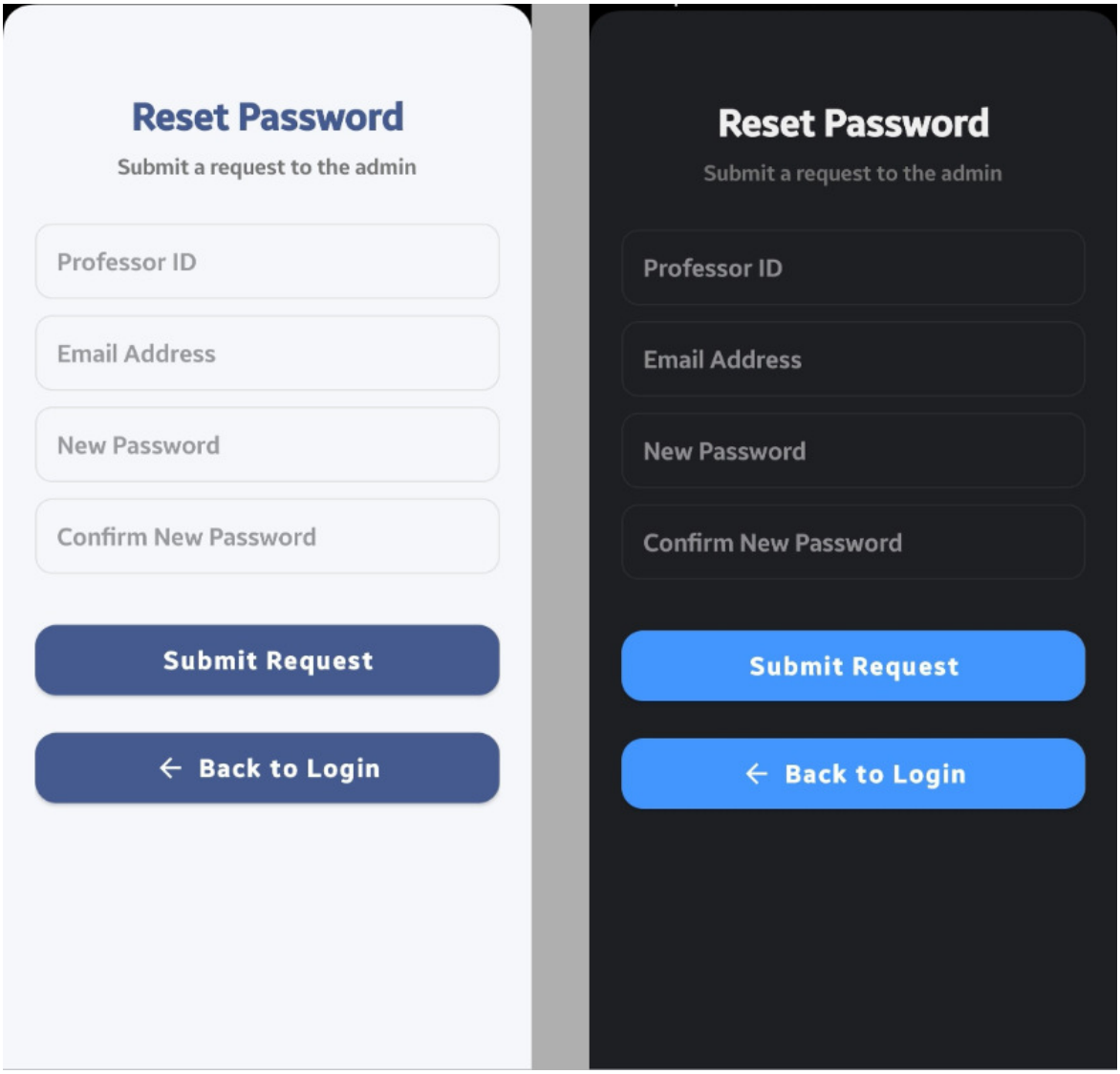

Figure 3.10: Password Reset Interface

Welcome Screen This window is the welcome screen that displays after a successful login, and it includes a range of features and functions:

- Profile
- Teacher List
- Candidate List
- Notifications
- Voting (if available)
- Candidate (if available)
- View Results (if available)
- Settings

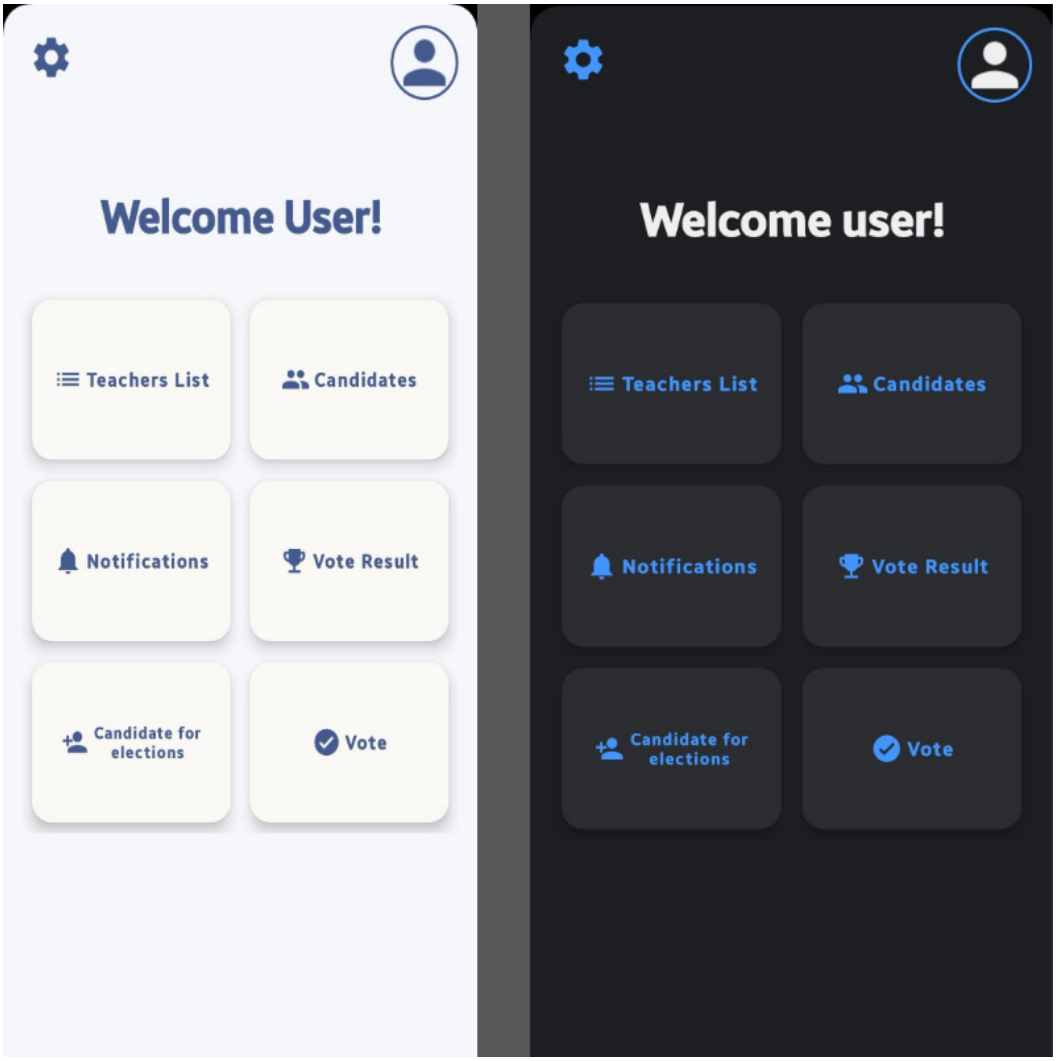

Figure 3.11: Welcome Screen Interface

User Profile This window is the user's profile page, where they can add a profile picture, view their information, and log out.

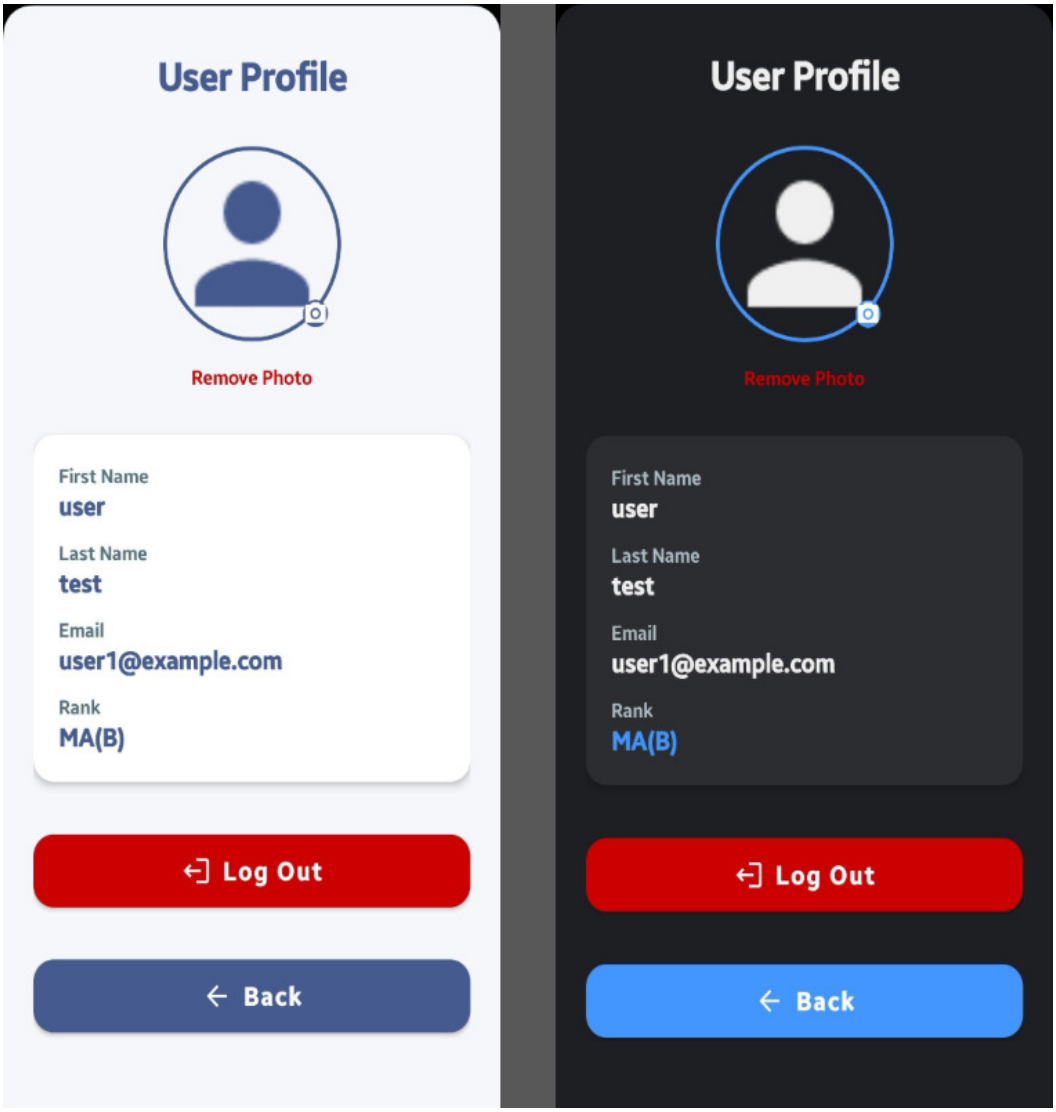

Figure 3.12: User Profile Interface

Teacher List This window allows the user to browse the list of assigned teachers, search by name, or use the rank filter.

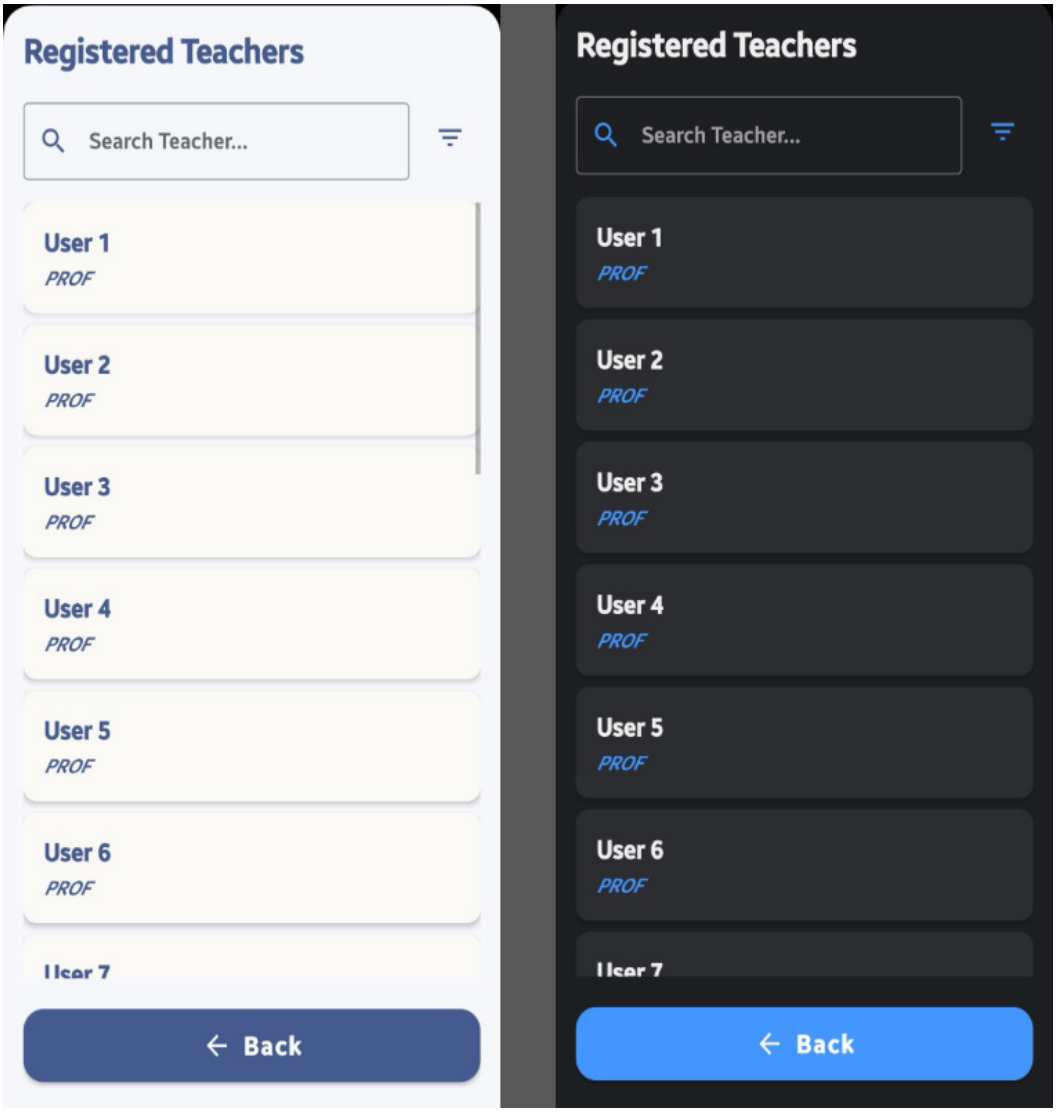

Figure 3.13: Teacher List Interface

Candidate List This window allows users to browse the list of candidate teachers, search by name, or use the rank filter.

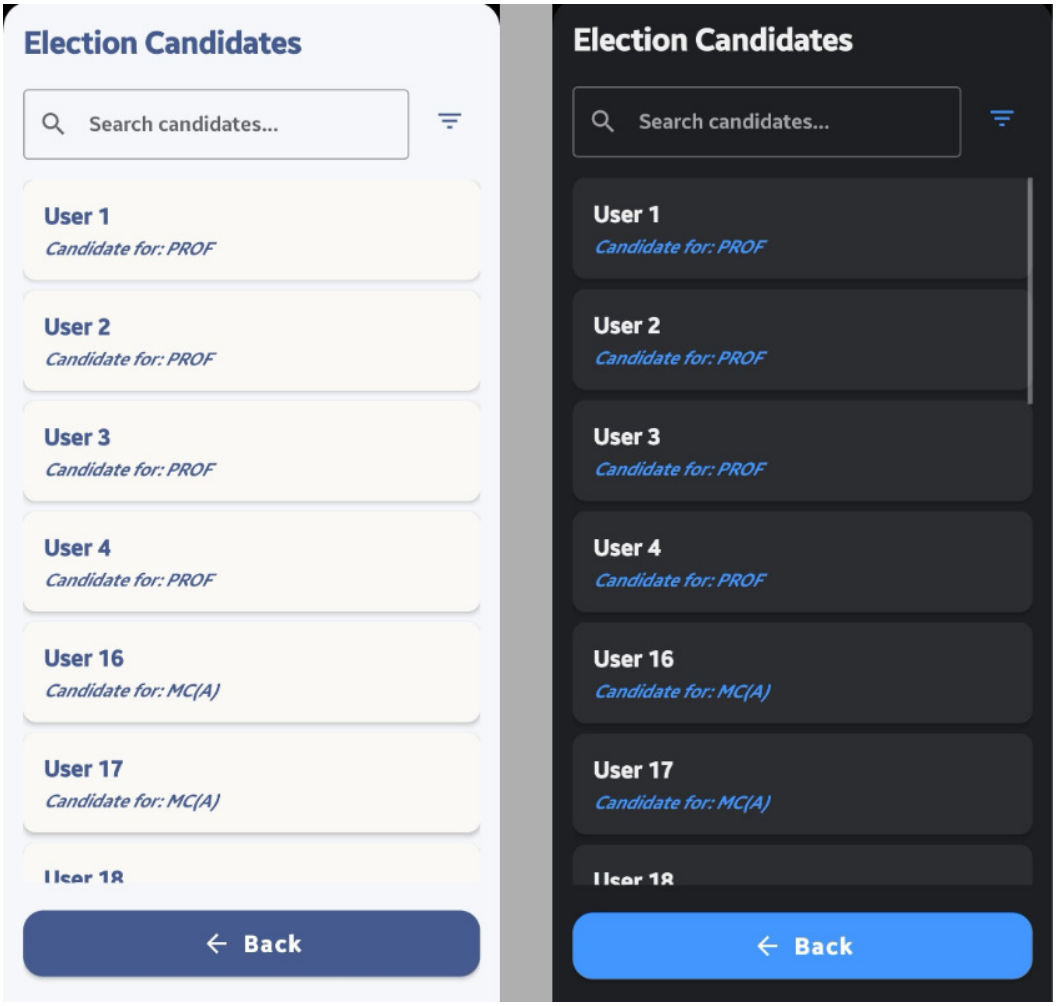

Figure 3.14: Candidate List Interface

Notifications This window allows users to check their notifications.

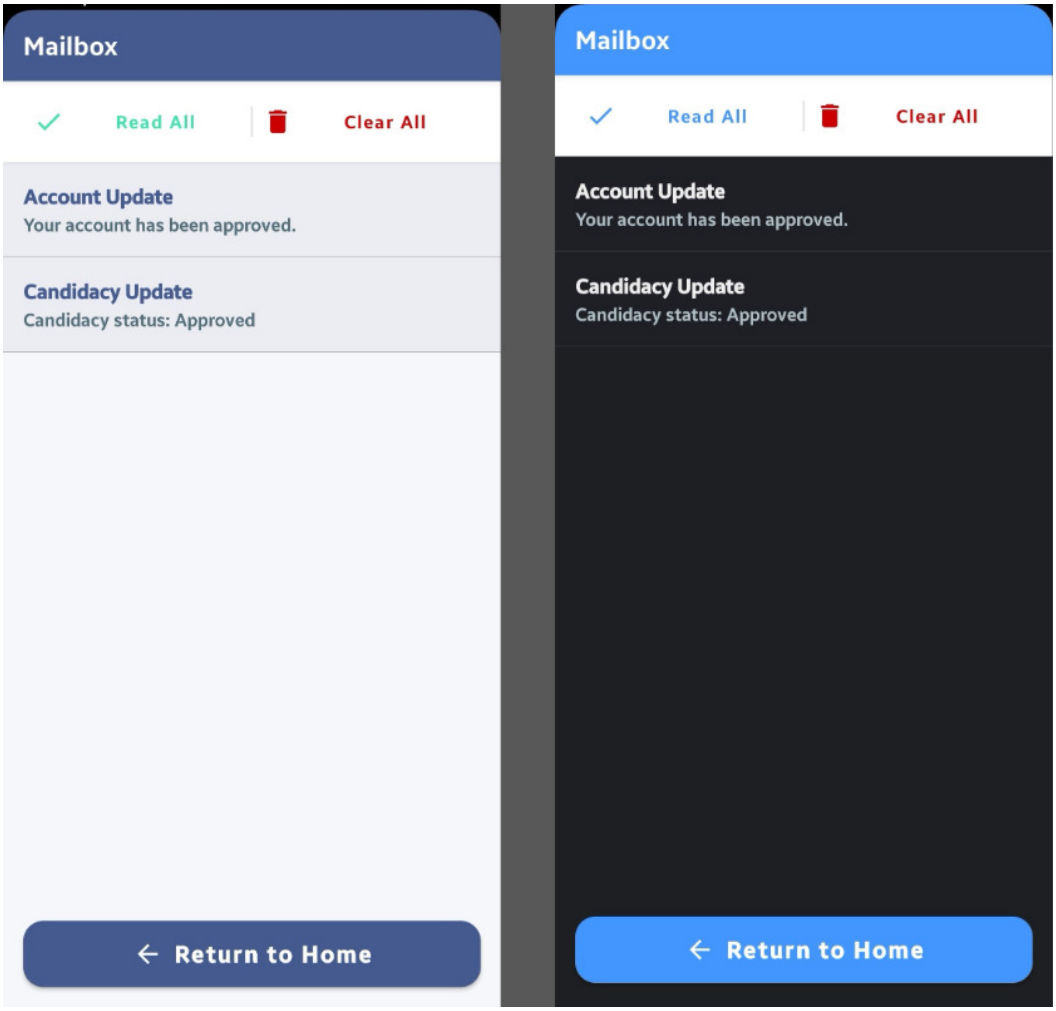

Figure 3.15: User Notifications Interface

Candidate for Elections This window allows user to submit a referral request to the administrator.

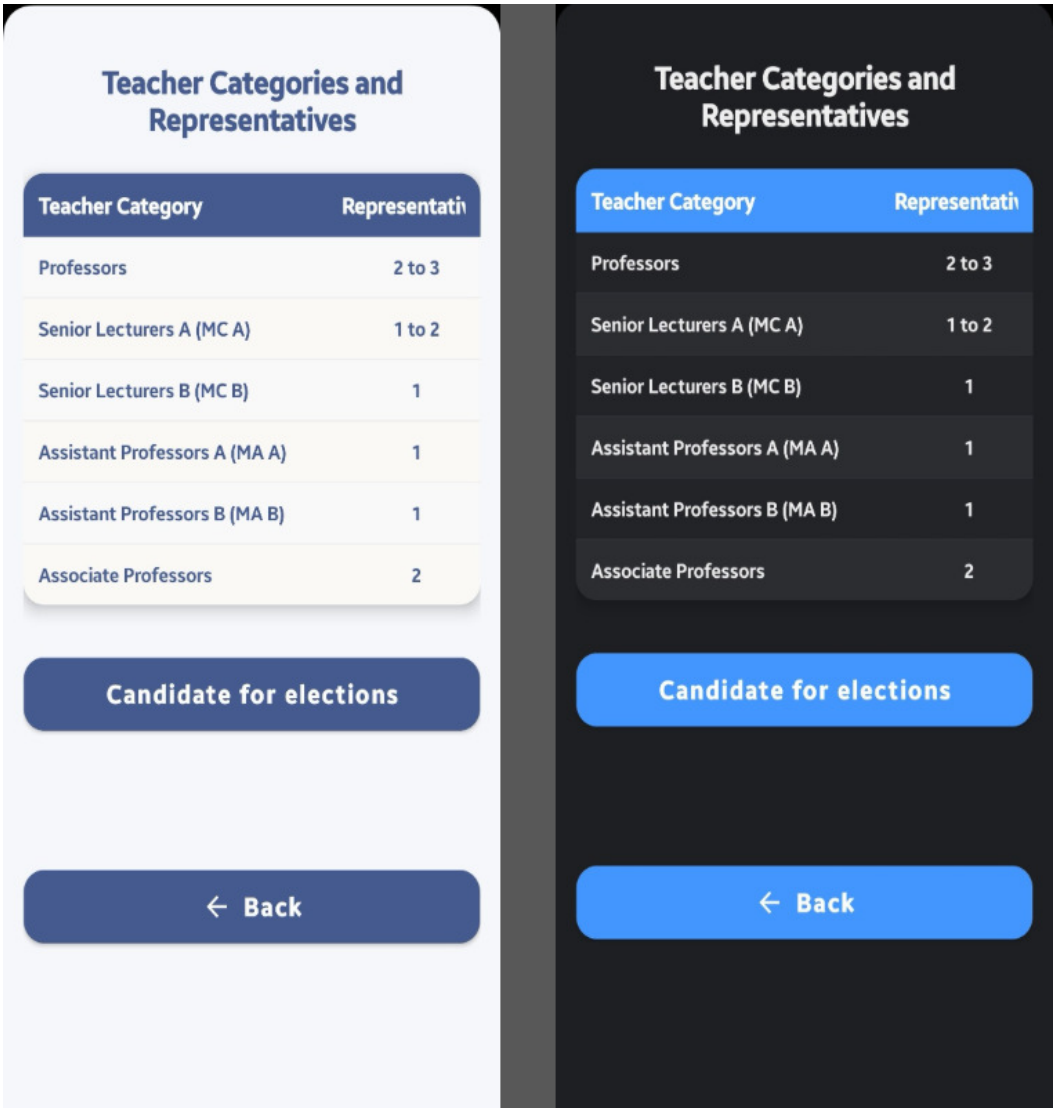

Figure 3.16: Candidate Request Interface

Cast Vote This window allows users to select any candidate from the list and vote for them.

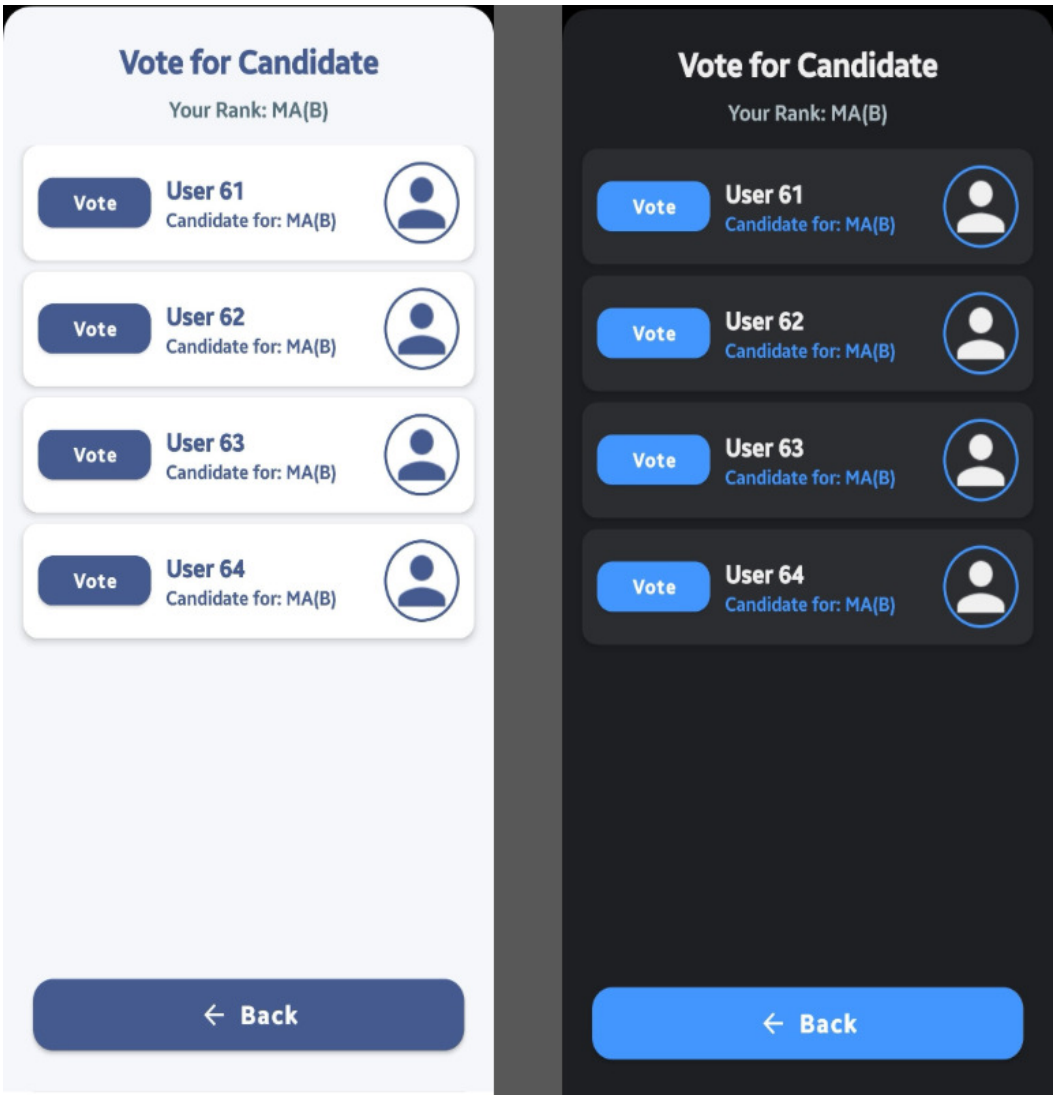

Figure 3.17: Cast Vote Interface

Vote Result This window allows users to view election results and filter them by rank.

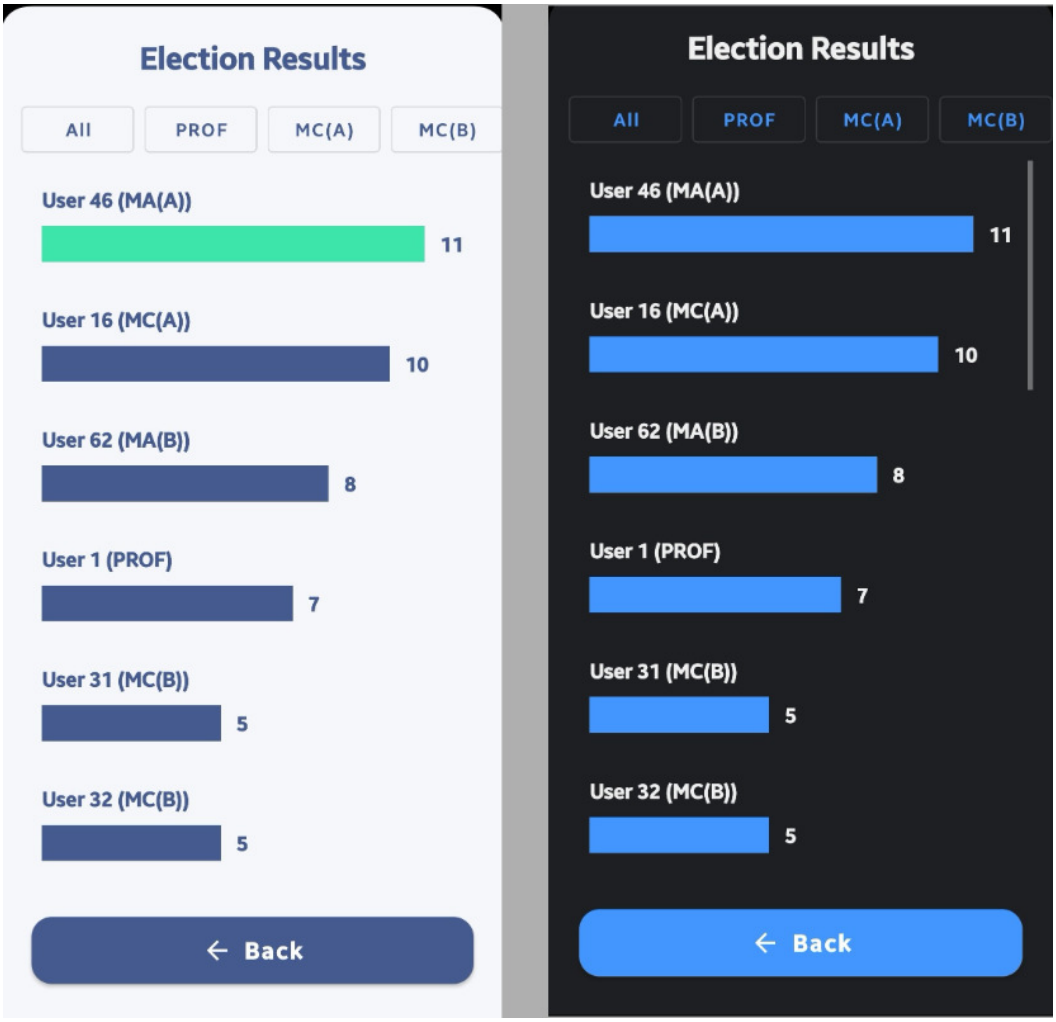

Figure 3.18: Vote Results Interface

3.4.1.2 Admin Front-end

The administrator interface provides advanced management and control features for the election platform.

Welcome Screen This window is the welcome screen that displays after a successful login, and it includes a range of features and functions:

- Admin panel
- Candidate Panel
- Notifications
- View Results
- Vote Control Panel

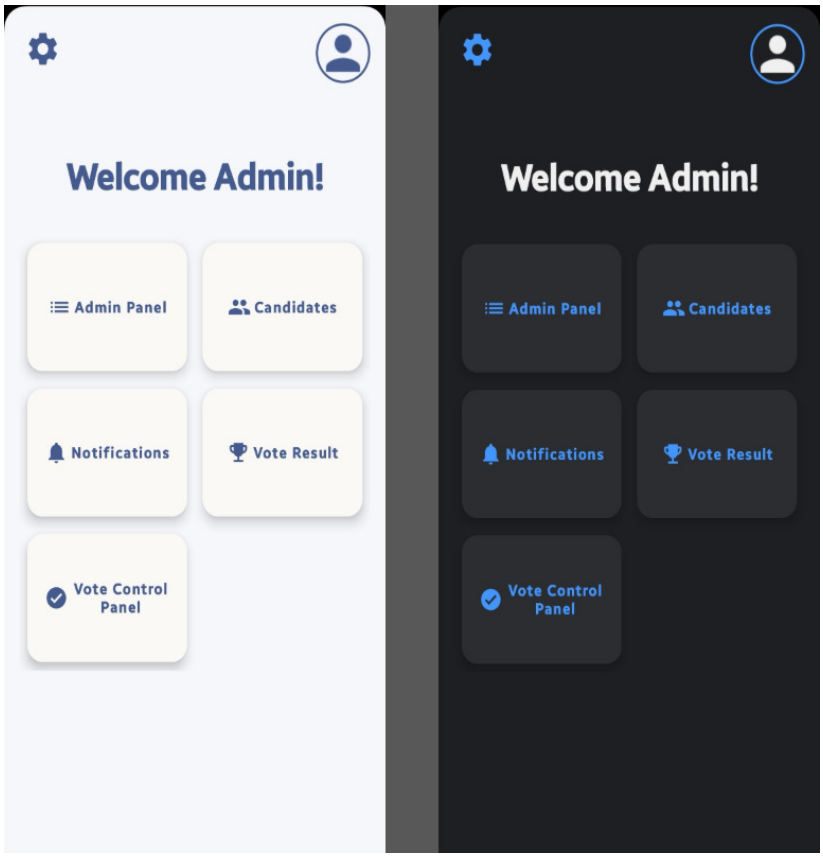

Figure 3.19: Admin Welcome Screen

Admin Panel This window allows the administrator to approve all new user accounts, set their rank, and approve password resets.

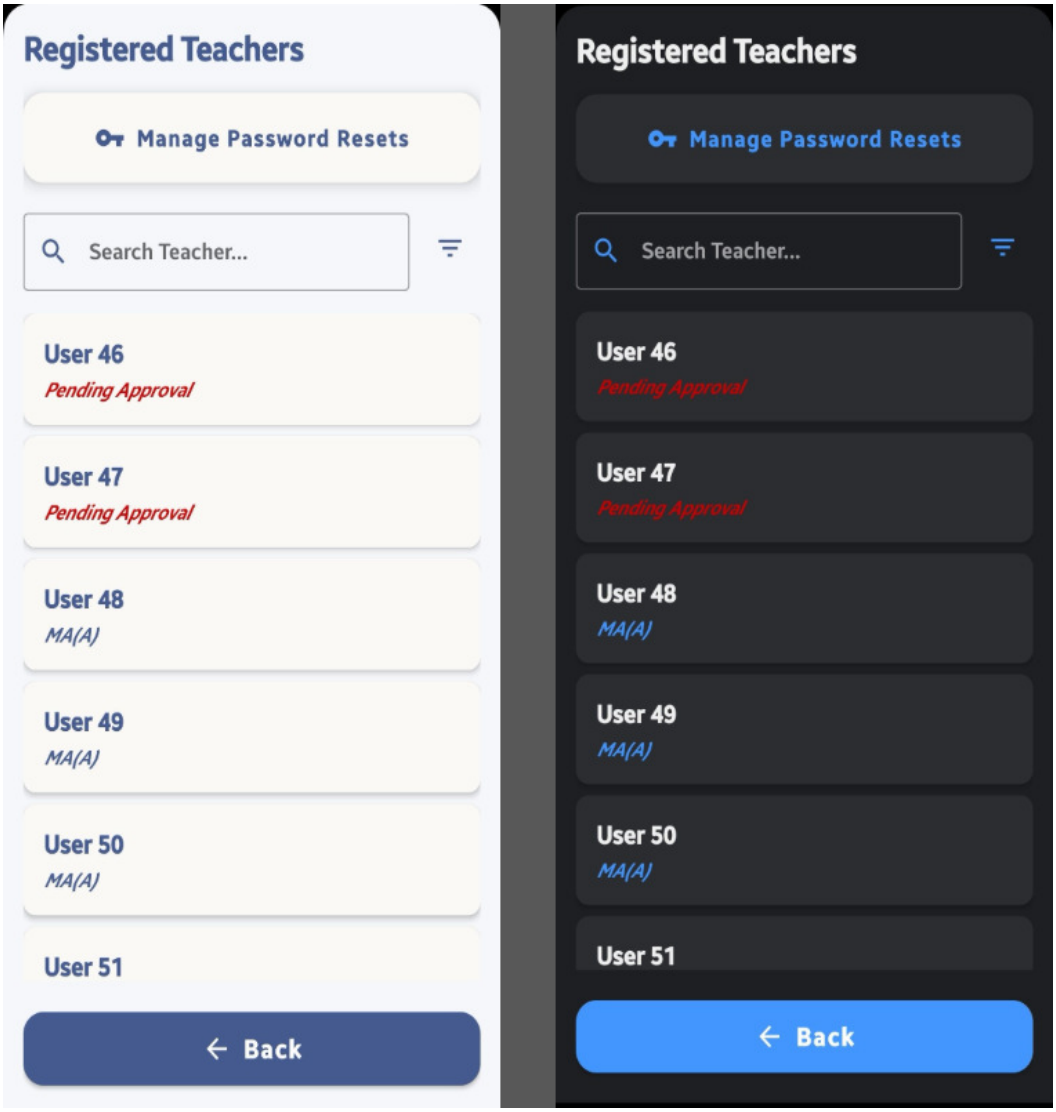

Figure 3.20: Admin Panel Interface

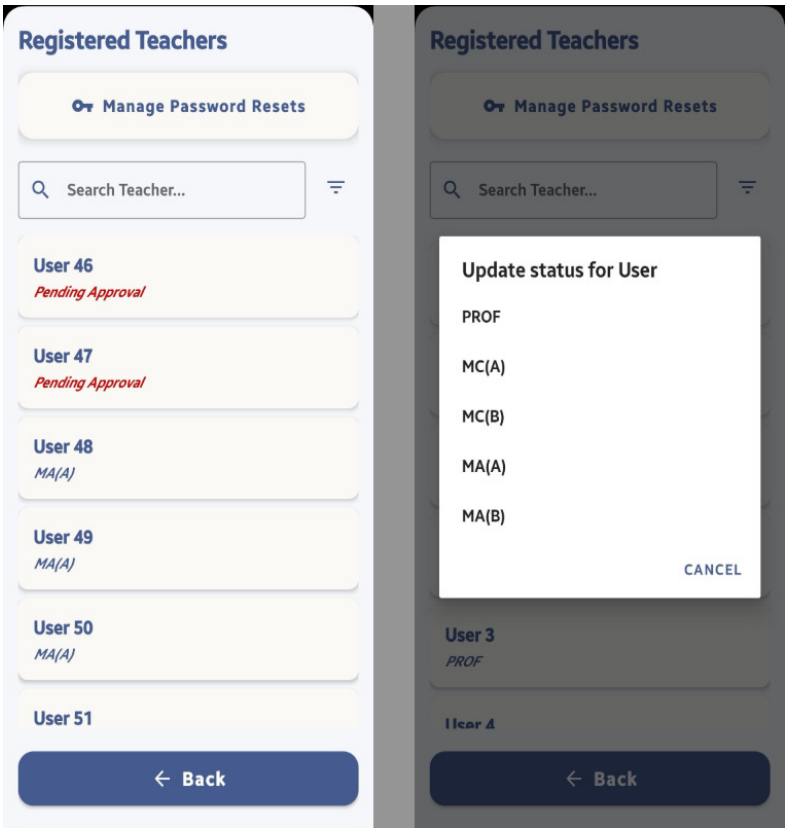

Figure 3.21: User Approval Interface

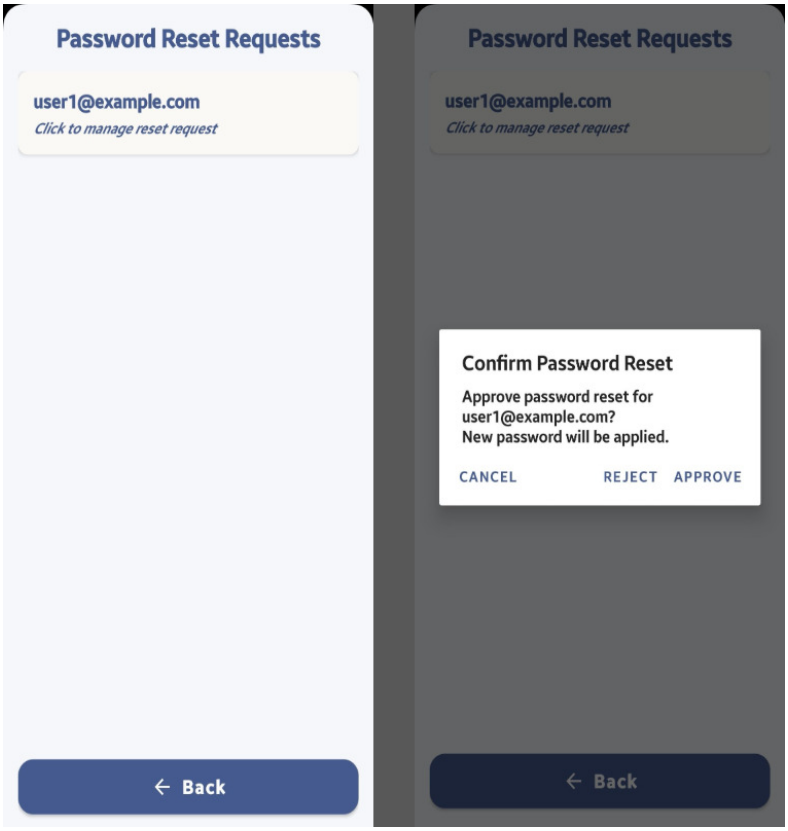

Figure 3.22: Password Reset Approval Interface

Candidates Panel This window allows the administrator to approve or reject (with reason submitted) all new candidates.

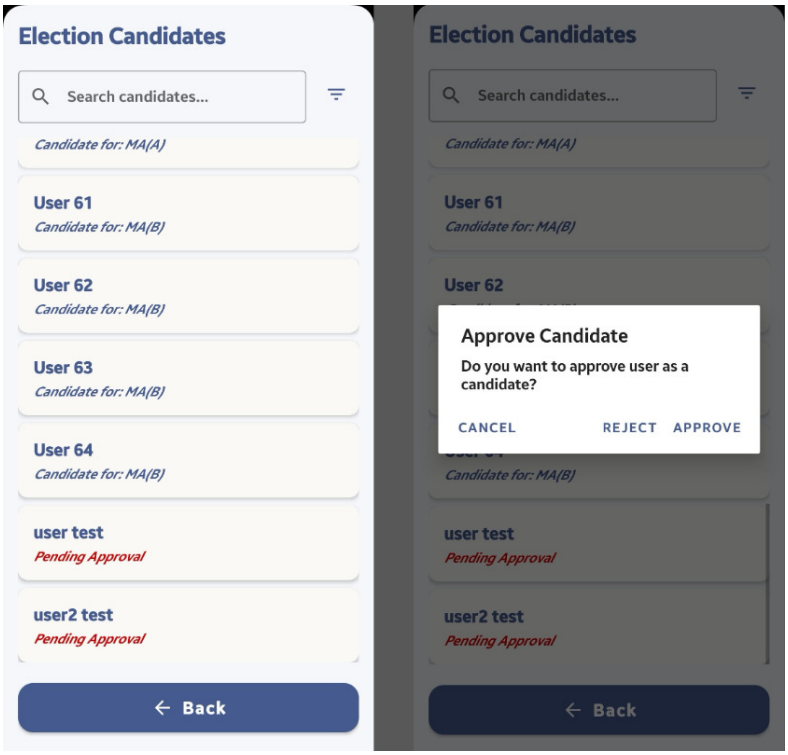

Figure 3.23: Candidate Panel Interface

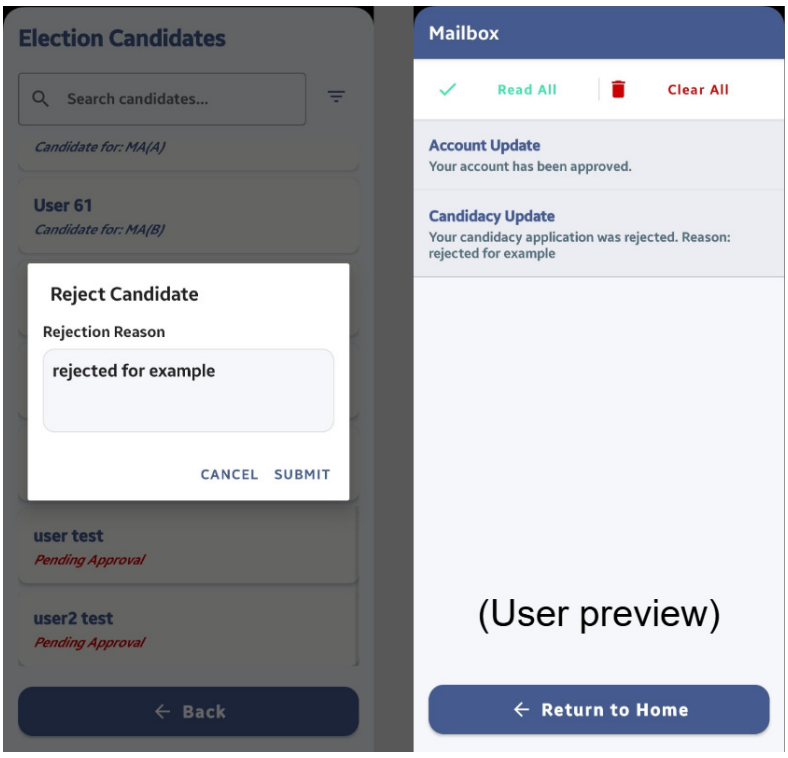

Figure 3.24: Candidate Rejected Interface

Vote Control Panel This window allows the administrator to set the nomination date and the voting date and duration, as well as view the results.

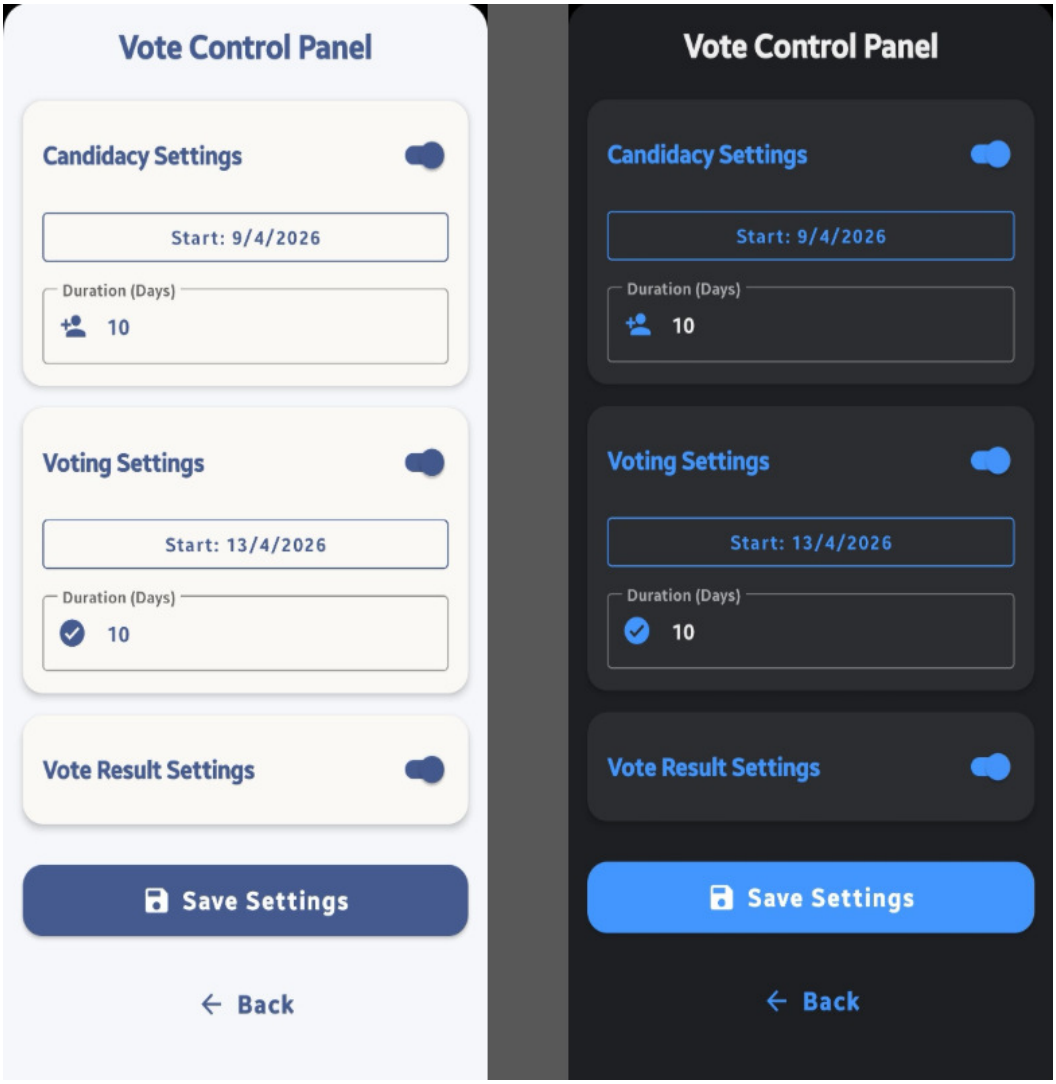

Figure 3.25: Vote Control Panel Interface

Notifications This window allows the administrator to check their notifications.

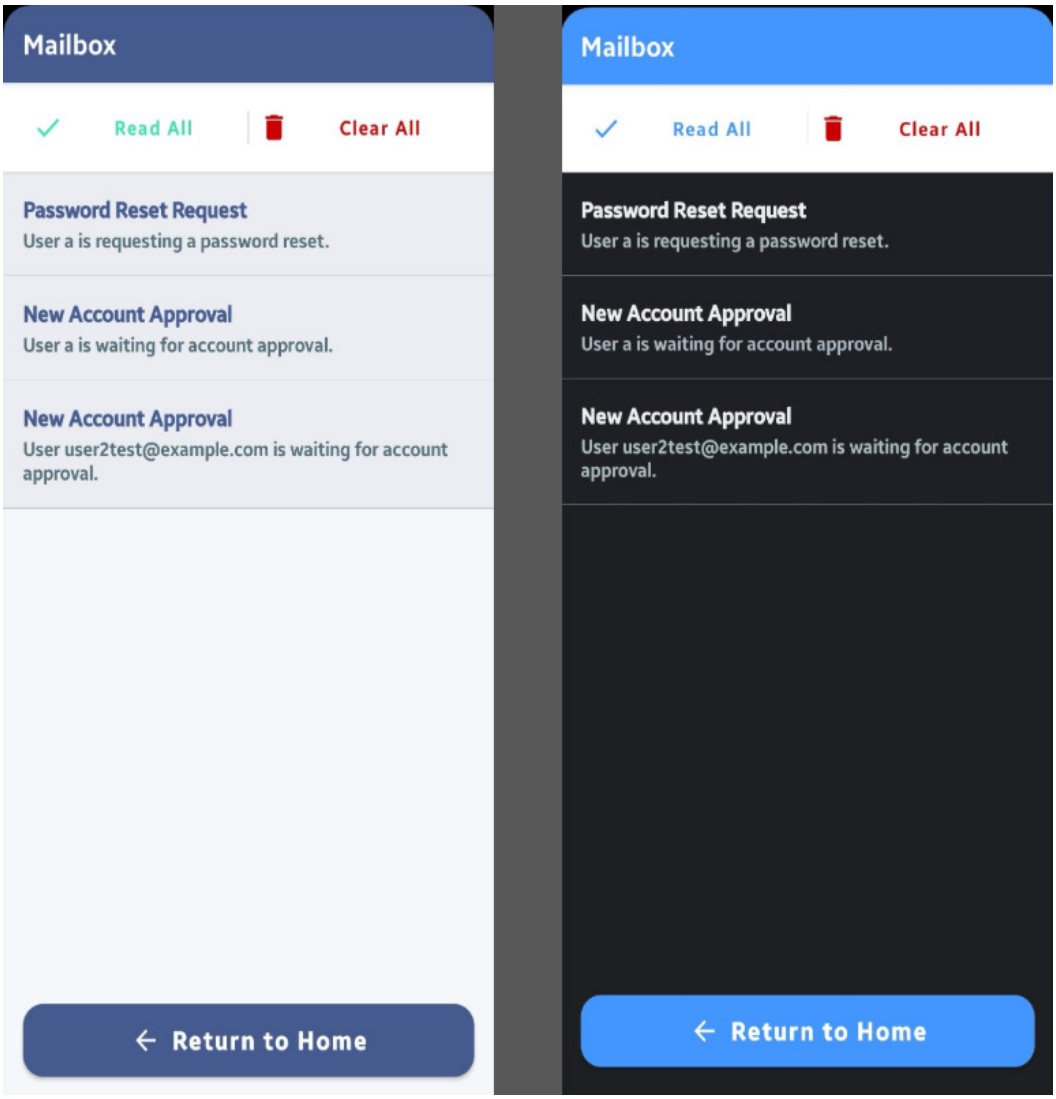

Figure 3.26: Admin Notifications Interface

3.4.1.3 General Front-end

The application provides universal features accessible to all users regardless of their role (administrator, regular user, or guest).

Application Theme This feature allows everyone to change the app's appearance to dark or light mode using the toggle switch in Settings.

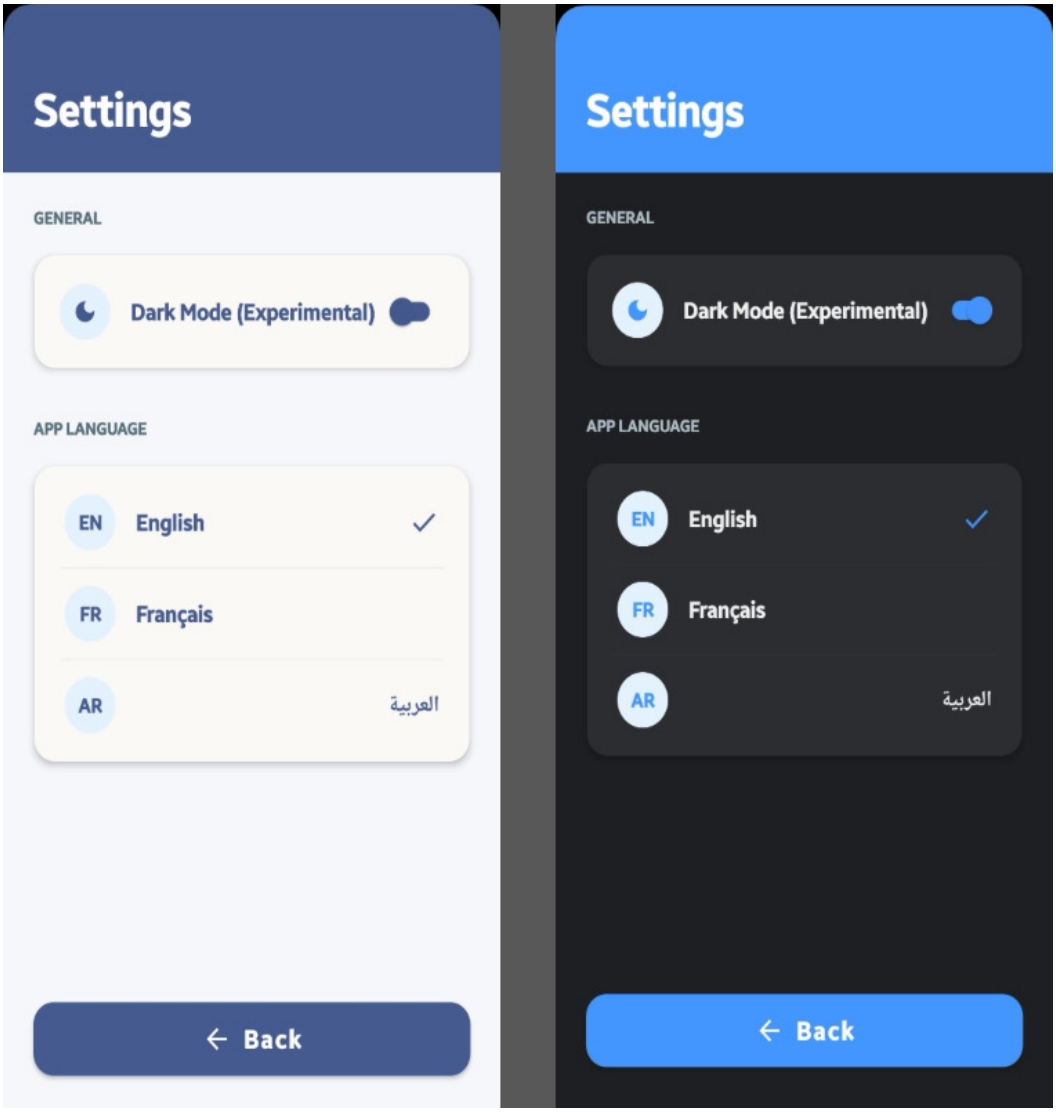

Figure 3.27: Settings Interface

Application Language This feature allows anyone to change the app's interface language to Arabic, English, or French through the settings.

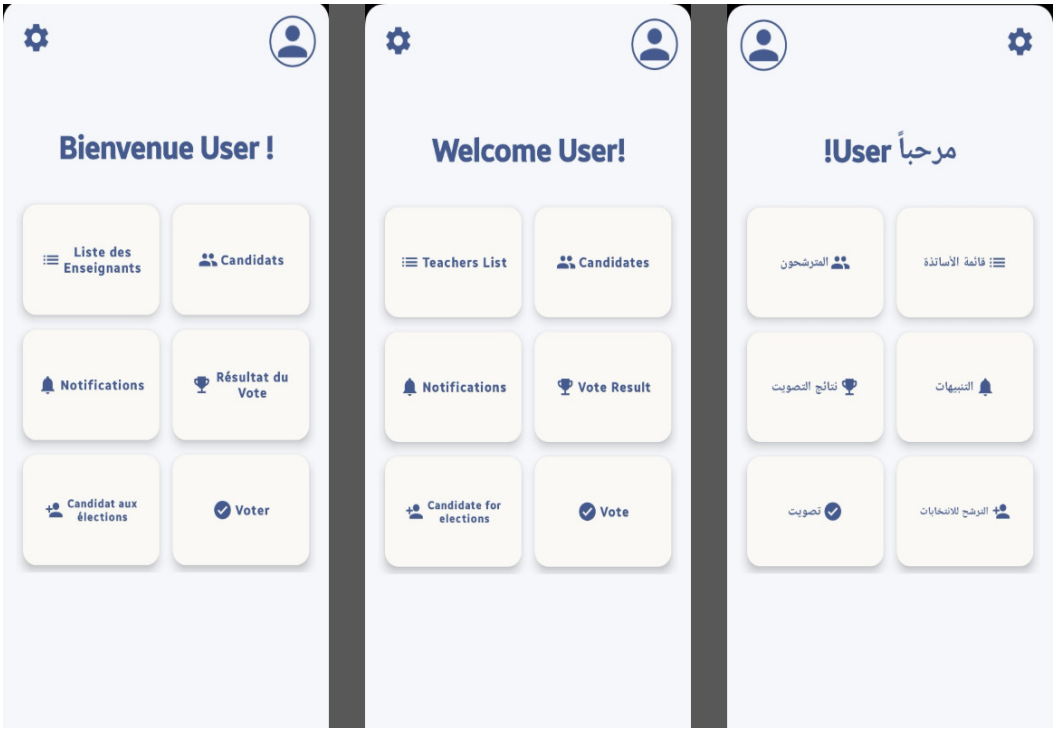

Figure 3.28: Application Language Interface

3.4.2 E-vote System: Host & Connection



Figure 3.29: Host & Connection

3.4.2.1 Database: Definition

A database is an organized collection of structured information, or data, that is commonly kept electronically in a computer system. A database is typically managed by a database management system (DBMS). The data and the database management system, along with their related applications, are collectively referred to as a ”database system,” which is often abbreviated to simply ”database” (18).

There are many types of databases. The choice of the most suitable database for a particular organization is based on how that company intends to use the data. So the existed types are:

- Relational databases
- Object-oriented databases
- Distributed databases
- Data warehouses
- No-SQL databases
- Graph databases
- OLTP databases
- Open source databases

- Cloud databases
- Multi-model database
- Document/JSON database
- Self-driving databases

3.4.2.2 Database: Firebase

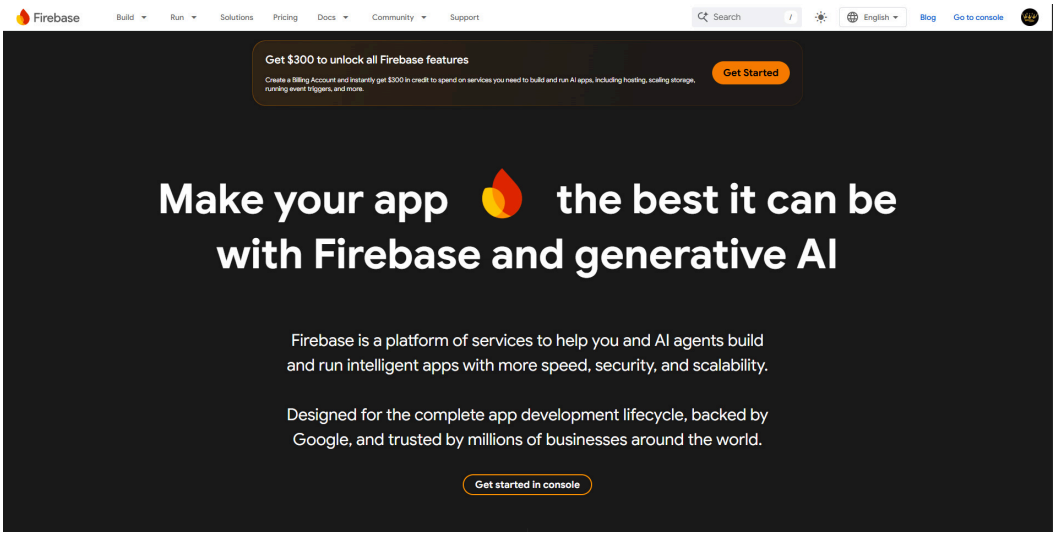

Figure 3.30: Firebase Web Console

Definition Firebase is a cloud-based development platform created for web and mobile apps that simplifies the development process. It offers a set of tools designed to help achieve four key goals: development, growth, monetization, and analytics (19).

Why Firebase?

1. Firebase is a platform offered by Google for developing both mobile and web applications, providing authentication and storage services.
2. It enables the development of mobile and desktop applications with the help of the Firebase platform. It offers a variety of tools and features to develop high-quality applications more efficiently.
3. Firebase consists of a variety of features such as authentication, real-time database (NoSQL), cloud functions, hosting, storage, and many more.
4. It is an easy and straightforward option for connecting an Android project to Firebase thanks to Firebase's integration with Android Studio.

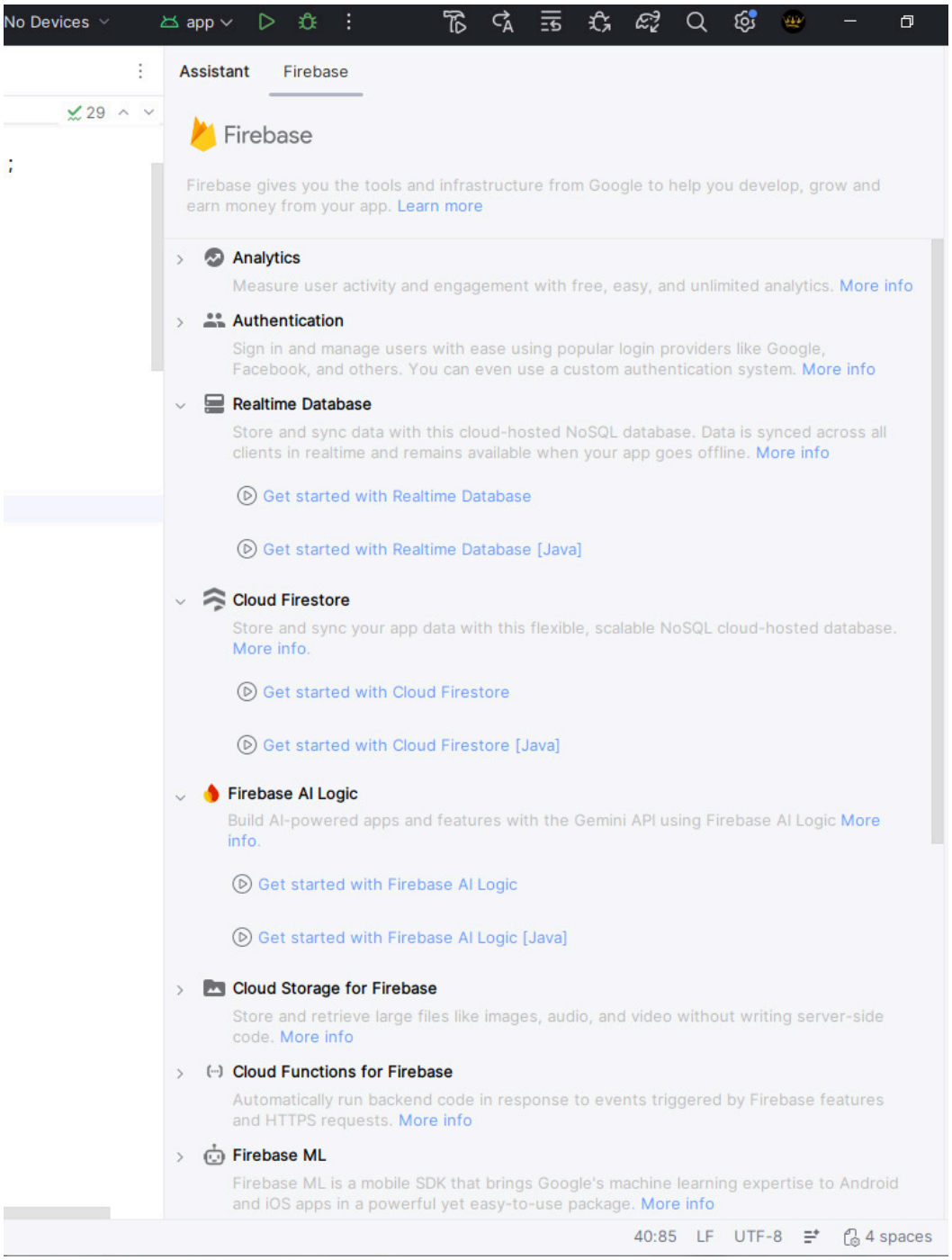

Figure 3.31: Android Studio with Firebase Integration

Firebase: Real-Time Database The Firebase Real-time Database is a database hosted in the cloud. Data is stored in JSON format and synchronized in real time with every connected client (20). When you build multi-platform apps using our Apple, Android, and JavaScript SDKs, all users share a single instance of the Real-time Database and automatically receive updates with the latest data.

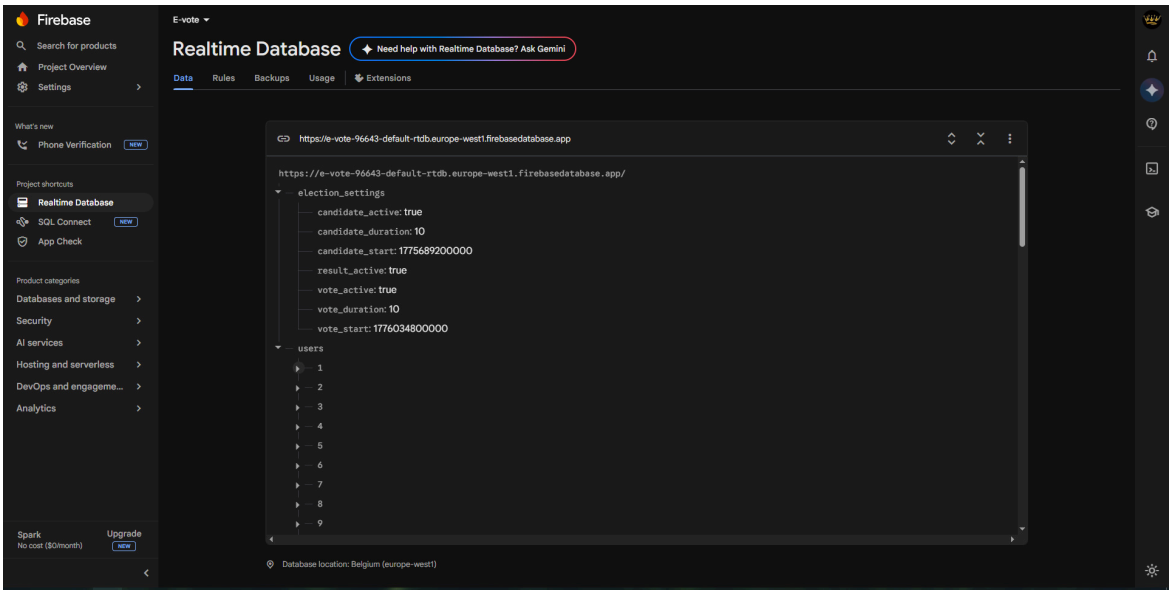

Figure 3.32: Firebase Real-Time Database

3.4.3 E-vote System: Security & Privacy

3.4.3.1 Security

Definition Online security covers all measures taken to protect data from unauthorized access, including by hackers or anyone other than those with whom the data is shared (21).

Security: Hash and Encryption (PBKDF2) PBKDF2 is part of RSA Laboratories' Public-Key Cryptography Standards (PKCS) series, specifically PKCS #5 v2.0, also published as Internet Engineering Task Force's RFC 2898 (22). It supersedes PBKDF1, which could only produce derived keys up to 160 bits long. RFC 8018 (PKCS #5 v2.1), published in 2017, recommends PBKDF2 for password hashing.

PBKDF2 has five input parameters:

$$DK = PBKDF2(PRF, Password, Salt, c, dkLen)$$

where:

- **PRF** is a pseudorandom function of two parameters with output length hLen (e.g., a keyed HMAC)
- **Password** is the master password from which a derived key is generated
- **Salt** is a sequence of bits, known as a cryptographic salt
- **c** is the number of iterations desired

- **dkLen** is the desired bit-length of the derived key
- **DK** is the generated derived key

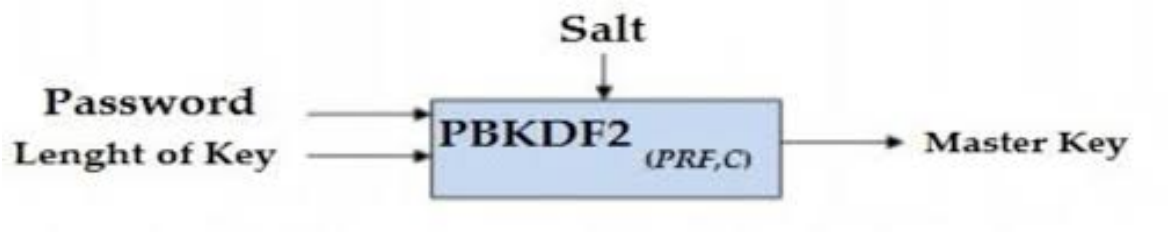

Figure 3.33: PBKDF2 Algorithm

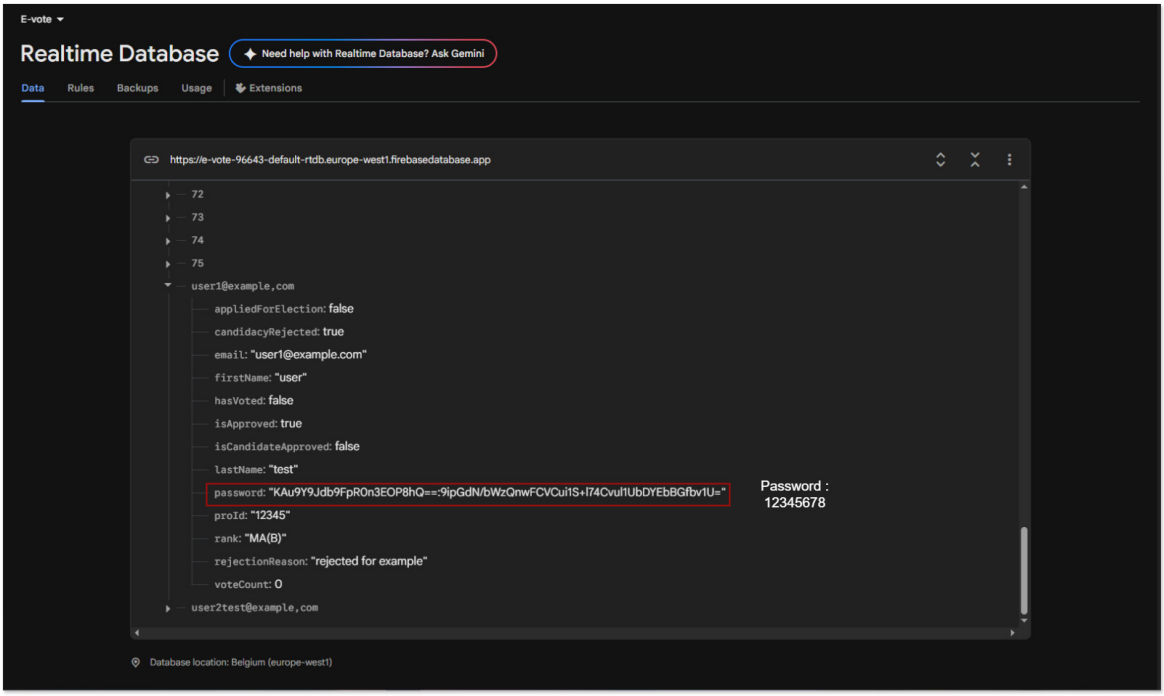

Figure 3.34: Firebase PBKDF2 Implementation

3.4.3.2 Privacy

Definition Online privacy (also referred to as data privacy) concerns control over how user information is collected, used, and shared. Privacy does not mean hiding users data completely, rather, it involves determining who can access user's data, under what circumstances, and for what purposes (21).

The e-voting platform does not handle sensitive data such as credit card information or personal details; the only data the platform requires is:

- First name
- Last name

- Email (university email)
- Teachers ID
- Password (hashed and secured)
- Profile picture (Optional)

3.5 Conclusion

In this chapter, we presented the implementation and development process of the electronic voting application. The use of Android Studio, Firebase, and PBKDF2 contributed to building a secure, reliable, and user-friendly system adapted to academic elections.

General Conclusion

Traditional voting methods present several limitations and weaknesses, as they are time-consuming and require significant effort and cost. These challenges have justified the need to find a reliable and practical alternative.

The objective of this research was to design, develop, and implement a secure electronic voting system adapted to the academic environment. The proposed solution adopted a structured methodology based on a set of UML (Unified Modeling Language) diagrams, including use case diagrams, state diagrams, class diagrams, and object diagrams, in order to provide an overview of the overall system structure through a clear visual representation.

We began our study by identifying the limitations and weaknesses of traditional voting methods in order to propose a secure electronic voting system using Android Studio as the development platform. Google Firebase was used as a real-time database for authentication and hosting, ensuring instant synchronization of data across all connected devices and units. The protection of all user credentials and sensitive information is ensured through the PBKDF2 hashing algorithm for encryption. Several improvements can be considered in order to further enhance the performance and reliability of the proposed system:

- Integrating advanced technologies such as blockchain to ensure greater transparency and traceability of votes.
- Adding biometric authentication to improve security and reduce the risk of identity fraud.
- Extending the proposed system to administrative or national elections, with a more advanced architecture capable of handling a large number of simultaneous users.
- Developing a cross-platform web version as well as a real-time statistical analysis system to improve accessibility and the exploitation of election results.
- Strengthening the proposed system through additional studies on its resistance to cyberattacks in order to further increase its level of security and reliability.

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الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي و البحث العلمي

جامعة محمد خيضر بسكرة.

عنوان المشروع:

منصة تصويت الكترونية للجنة العلمية للقسم

مشروع لنيل شهادة مؤسسة ناشئة في اطار القرار الوزاري 1275

الاسم التجاري	صورة العلامة التجارية

عنوان المشروع :

بطاقة معلومات:

حول فريق الاشراف وفريق العمل

1- فريق الاشراف:

فريق الاشراف	
المشرف الرئيسي (01):	التخصص: .....
المشرف الرئيسي (01):	التخصص: .....
المشرف المساعد:	التخصص: .....

2- فريق العمل:

فريق المشروع	التخصص	الكلية
الطالب:أمير علي محمد أمين	SIOD	كلية العلوم الدقيقة والطبيعة و الحياة

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

فهرس المحتويات

المحور الأول: تقديم المشروع

المحور الثاني: الجوانب الابتكارية

المحور الثالث: التحليل الاستراتيجي للسوق

المحور الرابع: خطة الإنتاج والتنظيم

المحور الخامس :الخطة المالية

المحور السادس : النموذج الاولي التجريبي

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

المحورالأول: تقديم المشروع

1. فكرة المشروع

- يتمثل مجال نشاطنا في الخدمات و المنصات الرقمية (منصة تصويت الكترونية)
- بدأت الفكرة من التحديات و الصعوبات التي تواجهها الجامعات الجزائرية عامة و جامعة محمد خيضر بسكرة خاصة في عملية انتخابات اللجنة العلمية للقسم , و جاءت فكرة بناء منصة انخابات للجنة العلمية للقسم كحل مبتكر يمكنه الحد من مشاكل الانتخابات التقليدية
- يهدف مشروعنا الى بناء منصة رقمية تتضمن:

1. امكانية الاساتدة من التسجيل في المنصة بطريقة سهلة و بسيطة خالية من التعقيد
2. بعد التسجيل , تسمح المنصة كافة المستخدمين الاطلاع على لائحة الاساتدة المسجلين فالمنصة
3. امكانية الترشح لمنصب في اللجنة العلمية فور انطلاق عملية الترشح
4. امكانية انتخاب اي مترشح وفق رتبة المستخدم المحددة
5. الاطلاع على نتائج الانتخبات و معرفة الفائز في التصويت حسب كل رتبة
6. توفر المنصة مساحة الزوار و دلك بالقدرة على الاطلاع على المترشحين و نتائج التصويت

2. القيم المقترحة

- الحداثة: المنصة ستكون عبارة عن تطبيق في الهواتف الدكية وفق نظام لاندرويد (11+)
- الاداء و المرونة: التأكد من ان المنصة تعمل بشكل سلس و اداء عالي خالي من العيوب التقنية و الخدماتية لضمان استحدام سهل و ثابت لجميع المستخدمين , و بالنسبة الى المرونة فان المنصة ستدعم كافة اجهزة الاندرويد اطلاقا من اندرويد 11 (2020)
- التصميم : انشاء منصة رقمية دات تصميم انيق و بسيط دون اي تعقيد لضمان سهولة التجول بين الحدمات داخل المنصة

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

- خفض التكلفة : نهدف ال توفير الوقت و الجهد في الاعداد للانتخبات ودلك باستعمال المنصة عن بعد دون الحاجة الى التنقل او اضاعة الوقت و الجهد
- إمكانيةالوصول: جعل المنصة تعمل وفق نظام الاندرويد كونه النظام الاكثر شيوعا و الاستهلاكا نسبيا في العالم و في الجزائر
- إنجاز المهام: مساعدة الاساتدة في إنجاز مهام محددة من خلال الخدمات التي توفرها المنصة (ترشح , انتخاب , الاطلاع على النتائج)

من خلال التركيز على هذه القيم ، يهدف المشروع إلى تقديم نظام معلوماتي متكامل يساهم في تشكيل اللجنة العلمية للقسم بطريقة جد سهلة و بسيطة

3. فريق العمل

الاسم و اللقب : أمير علي محمد أمين

المؤهلات و المهارات :

1. ليسانس في نظم معلوماتية كلية العلوم الدقيقة و الطبيعة و الحياة جامعة محمد خيضر بسكرة
2. ماستر 2 في أنظمة تكنولوجيا المعلومات، والتحسين، واتخاذ القرار كلية العلوم الدقيقة و الطبيعة و الحياة جامعة محمد خيضر بسكرة

المهام:

1. التخطيط و دراسة كل الخدمات اللازمة
2. تطوير البنية التحتية للمنصة
3. تطوير الواجهات الخاصة بالمنصة
4. ربط المنصة بقاعدة البيانات و ضمان الاتصال
5. ضمان الامن و الخصوصية في المنصة

4. أهداف المشروع

- دعم الرقمنة في الانتخبات : الحصول على الدعم و الاهتمام في مجال رقمنة الانتخابات لتسهيل علمية الاقتراع للاساتدة و المستخدمين

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

- التبني و الوعي : زيادة الوعي و الاعتماد على النظم المعلوماتية و الرقمنة في جامعة محمد خيضر بسكرة و سائر الجامعات الجزائرية
- رضا الاساتدة المستخدمين : ضمان مستويات عالية من رضا الاساتدة من خلال توفير حل موثوق و سهل الاستخدام في ممارسة الانتخابات للجنة العلمية لقسم
- قابلية التوسع : بعد الاعتماد على منصة التصويت الالكتوني على مستوى جامعة محمد خيضر نسعى للتوسع على مستوى مختلف الجامعات الجزائرية و حتى مختلف على مستوى المنظمات التي تحتوي على نشاط انتخابي
- الريادة : نسعى الى ان نصبح منصة رقمية دات كفاءة و مستوى عال على مستوى كامل التراب الوطني

5. جدول زمني لتحقيق المشروع :

المرحلة	النشاط و المهام	المدة الزمنية
الدراسة و التخطيط	دراسة حول اللجنة العلمية للقسم	1 اسبوع
	وضع اساسيات المنصة	1 اسبوع
التصميم و البرمجة	تصميم و برمجة المنصة	4 اسابيع
التطوير و الاختبار	تطوير المنصة و تصحيح الاخطاء	4 اسابيع
	الاختبار و التجربة	1 اسبوع
الاطلاق	حملة التسوقية و لاعلان	2 اسابيع
	الاطلاق الرسمي للمنصة	2 اسابيع
المتابعة	جمع الاراء و الملاحظات حول الاداء	مستمر
	طوير ميزات جديدة و اصلاح الاخطاء	مستمر

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

المحور الثاني: الجوانب الابتكارية

1. **طبيعة الابتكارات :**

- ابتكارات السوق: تتضمن تطوير منصة لسوق المنصات الرقمية على مستوى جامعة بسكرة و التي تضمن المصداقية و الامان و السرعة
- الابتكارات الجذرية: يمثل اعتماد على التحكم عن بعد في اتمام النشاط الانتخابي في ظرف قياسي
- الابتكارات التكنولوجية: يحتضن المشروع الابتكارات التكنولوجية عبر استغلال ادوات التطوير الخاصة باجهزة الاندرويد لضمان ادء عالي و اسقرار تام
- الابتكارات المتزايدة: تتضمن تحسين تصميم المنصة وترقيتها الى مستوى افضل عبر ملاحظات المستخدمين و توفير الدعم و التحسينات للمنصة

2. **مجالات الابتكار :**

- تتبع نشاط المستخدمين : دلك عبر مراقبة النشطات داخل المنصة من تسجيل حسابات دخول جديدة و ترشح المستخدمين و عملية الاقتراع
- الامان : تضمن المنصة للامان التام لكل مستخدميها و دلك لوجود نظام تشفير يعمل على ضمان حماية البيانات
- الخصوصية : تضمن المنصة ان خصوصية المستخدمين محفوظة لان المنصة لا تسعى لجمع الي معلومات حول ملفات مالية او ملفات خاصة
- الكفاءة : تضمن المنصة سهولة و سلاسة في الاستخدام عبر واجهة انيقة و بسيطة
- توفير التكاليف: تقيل التكاليف سيكون ملحوظ عبر استخدام المنصة ودلك عبر توفير الوقت و الجهد

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

المحور الثالث: التحليل الاستراتيجي للسوق

1. **عرض القطاع السوقي :**

- السوق المحتمل :

  كافة اقسام الكليات لجامعة محمد خيضر بسكرة دون استثناء

  كافة اقسام الكليات الجامعية على مستوى التراب الوطني

  المؤسسات التي تحتوي على نشاط انتخابي (حكومية او خاصة)

- الفئة المستهدفة : و هي قسم الاعلام الالي لكلية العلوم الدقيقة و الطبعية والحياة جامعة محمد خيضر خاصة و باقي الاقسام الجامعية عامة

  نحن نستهدف هده الفئة لكونها الواجهة الاساسية للرقمنة و تطوير مختلف المنصات و لانها تحتوي على كفاءات عالية من اساتدة و باحثين في المعلوماتية مما يتيح لنا فرصة في النمو و الازدهار في عالم المنصات الرقمية

2. **قياس شدة المنافسة :**

تعتبر المنافسة على مستوى قسم الاعلام الالى متوسطة الى عالية نسبيا و دلك باعتبار القسم مهدا لتطوير كافة البرمجيات و المنصات الرقمية و اما البنسبة الى باقي الاقسام فان المنافسة تعتبر متوسطة الى ضعيفة نسبيا

3. **الاستراتيجيات التسويقية :**

- استراتجية التميز : التركيز على تويفر كامل الخدمات الانتخابية بطريقة عصرية و منتظمة و الحفاظ على الخصوصية و الشفافية في المنصة

- استراتجية التركيز : التركيز على الفئة المستهدفة و بدل كل المجهودات و القدرات لبناء منصة انخابية رقمية ترتقي الى مستوى تطلعات المستخدمين

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

المحور الرابع :خطة الإنتاج والتنظيم

- **تتمثل خطة الانتاج فيما يلي :**

اختيار الموقع	- مكتب على مستوى الولاية
الموارد الاولية	- قاعدة بيانات - خادم (server)
الالات و المعدات	- 2 حاسوب محمول او مكتبي - - اتصال دائم بالانترنت
الاثاث	- 2 مكتب - مكيف هوائي
الموارد البشرية	- **خبير امن سيبراني** - **مبرمج تطبيقات للهواتف المحمولة** - **منسق من طرف الادارة**

- التنظيم الداخلي :

- مساحة للبحث و التطوير
- مساحة الفريق الفني و التقني
- مساحة الادارة
- مساحة فريق الامن السبيراني

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

المحور الخامس: الخطة المالية:

- **التكاليف و الاعباء:**

الاصول	التكلفة
الموقع	240.000 دج
الموارد الاولية	- الخادم = 85.000دج - قاعدة البيانتات = 60.000 دج
المعدات	- 2 حواسيب = 140,000 دج - الانترنت = 26,400 دج سنويا
الاثاث	- 2 مكاتب = 32.000 دج
الموارد البشرية	- مطورتطبيقات هو اتف ذكية= 420.000دج سنويا - خبيرأمن سيبر اني = 420.000دج سنويا
المجموع	142.3400 دج

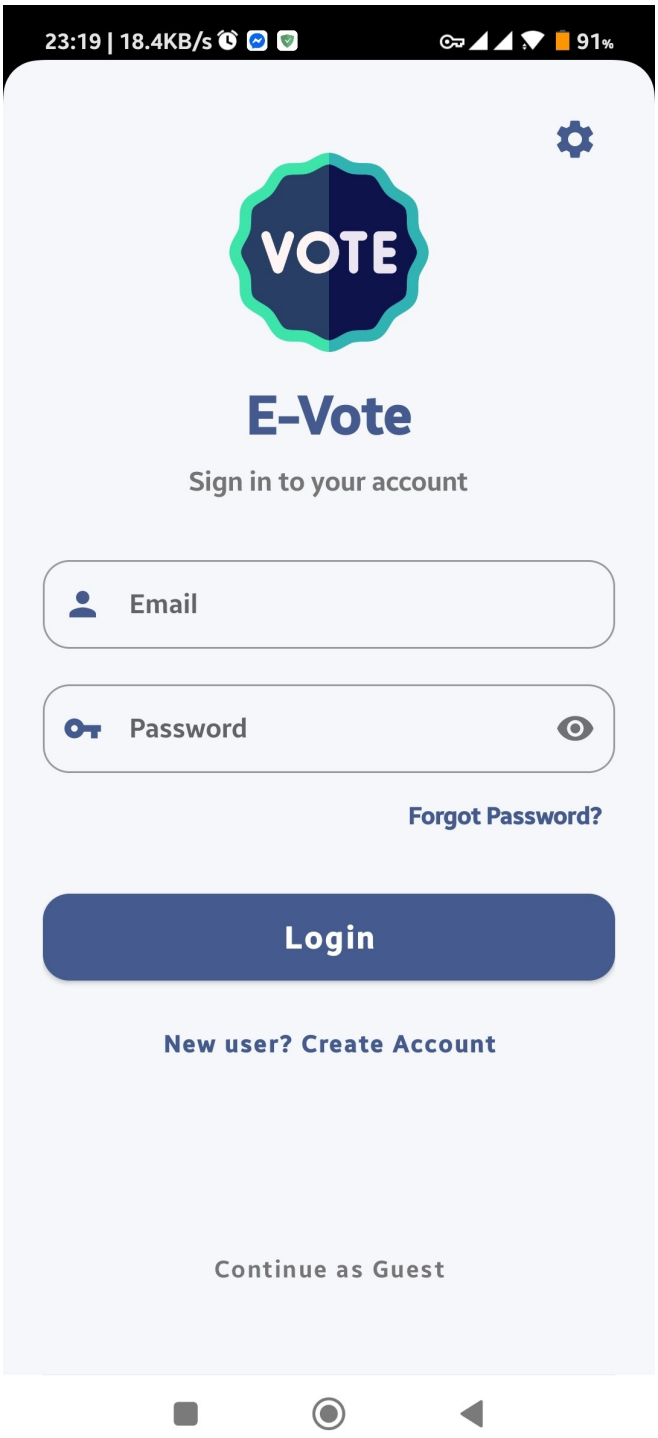
- **رقم الاعمال**

	REALISATION			PREVISION		
Produit A destiné Client	N -2	N - 1	N	N+1	N+2	N+3
Quantité produit A	0	0	1	1	3	7
Prix HT produit A	0	0	-	50.000000 دج	150.000000 دج	350.000000 دج
Ventes produit A	0	0	0	1	2	4
CHIFFRE D'AFFAIRES GLOBAL	-	-	-	50.000000	100.000000	200.000000

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم

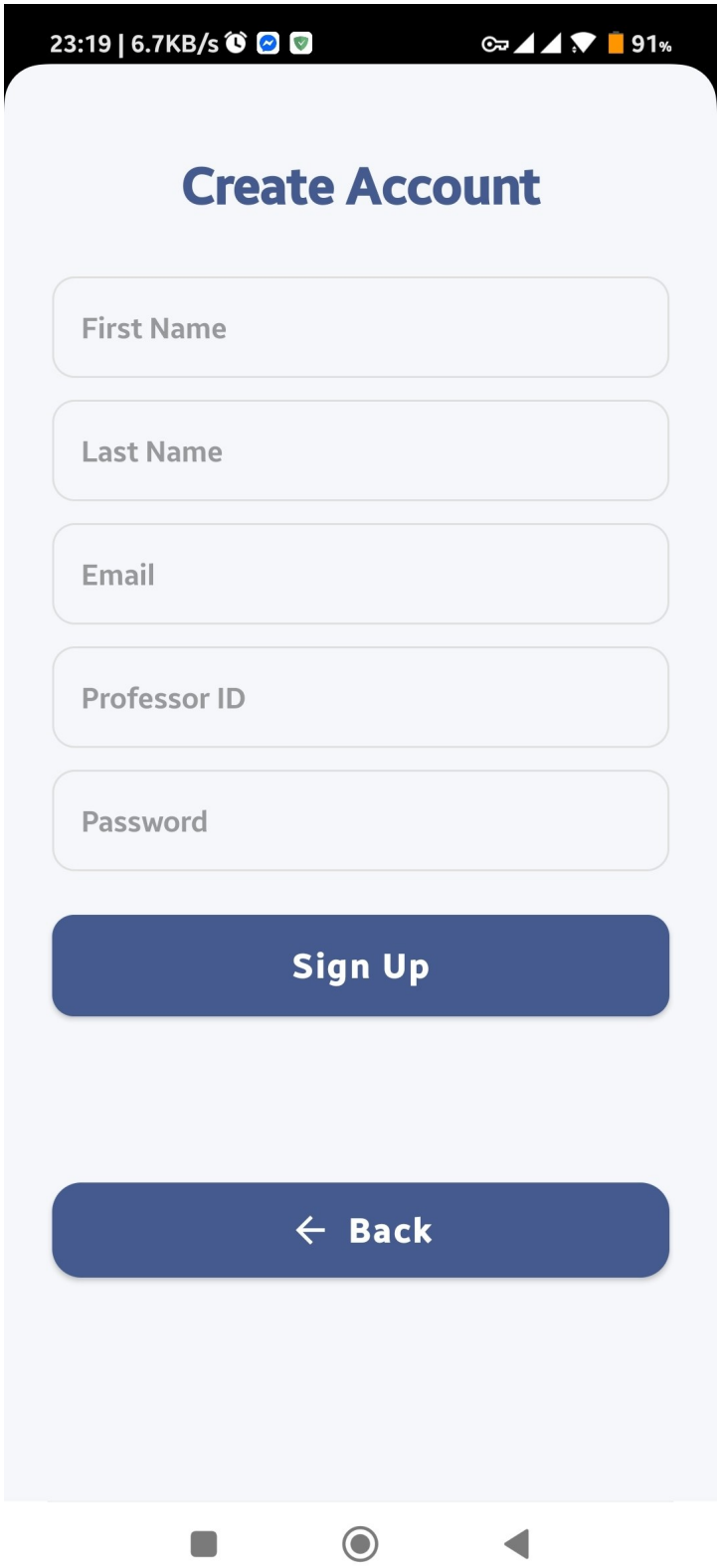
المحور السادس : النموذج الاولي التجريبي



الواجهة الاولى للمنصة

عنوان المشروع :

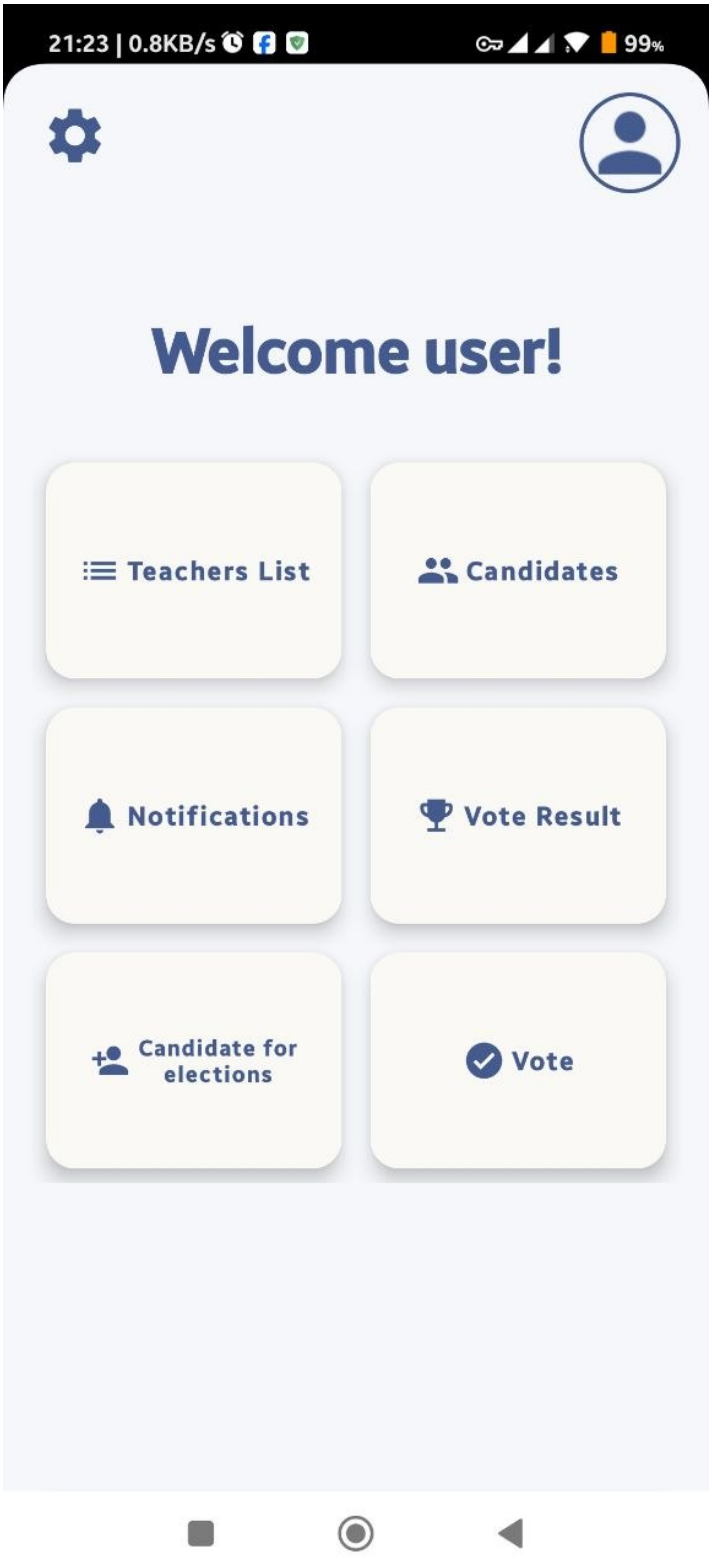
منصة تصويت الكترونية للجنة العلمية للقسم



انشاء حساب جديد

عنوان المشروع :

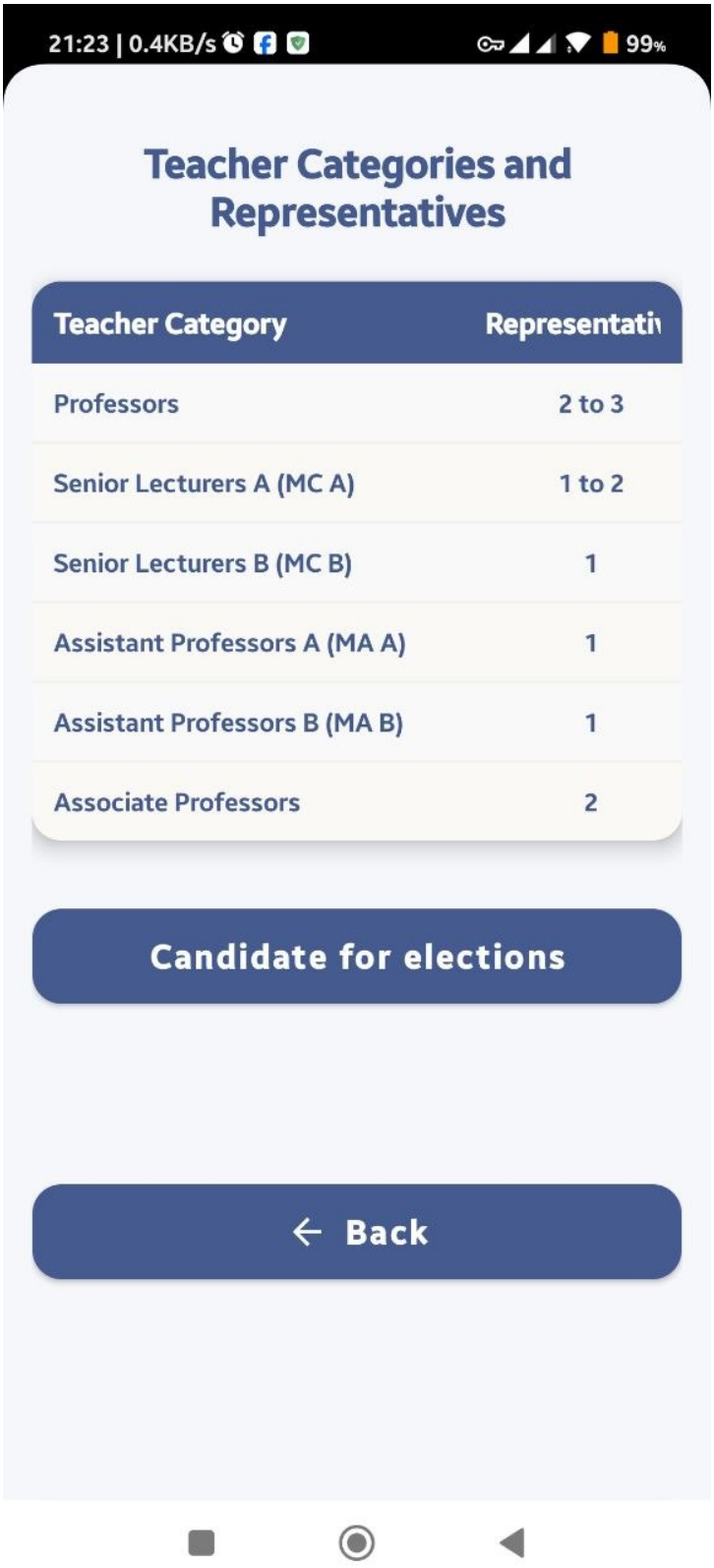
منصة تصويت الكترونية للجنة العلمية للقسم



واجهة الرئيسية للمنصة

عنوان المشروع :

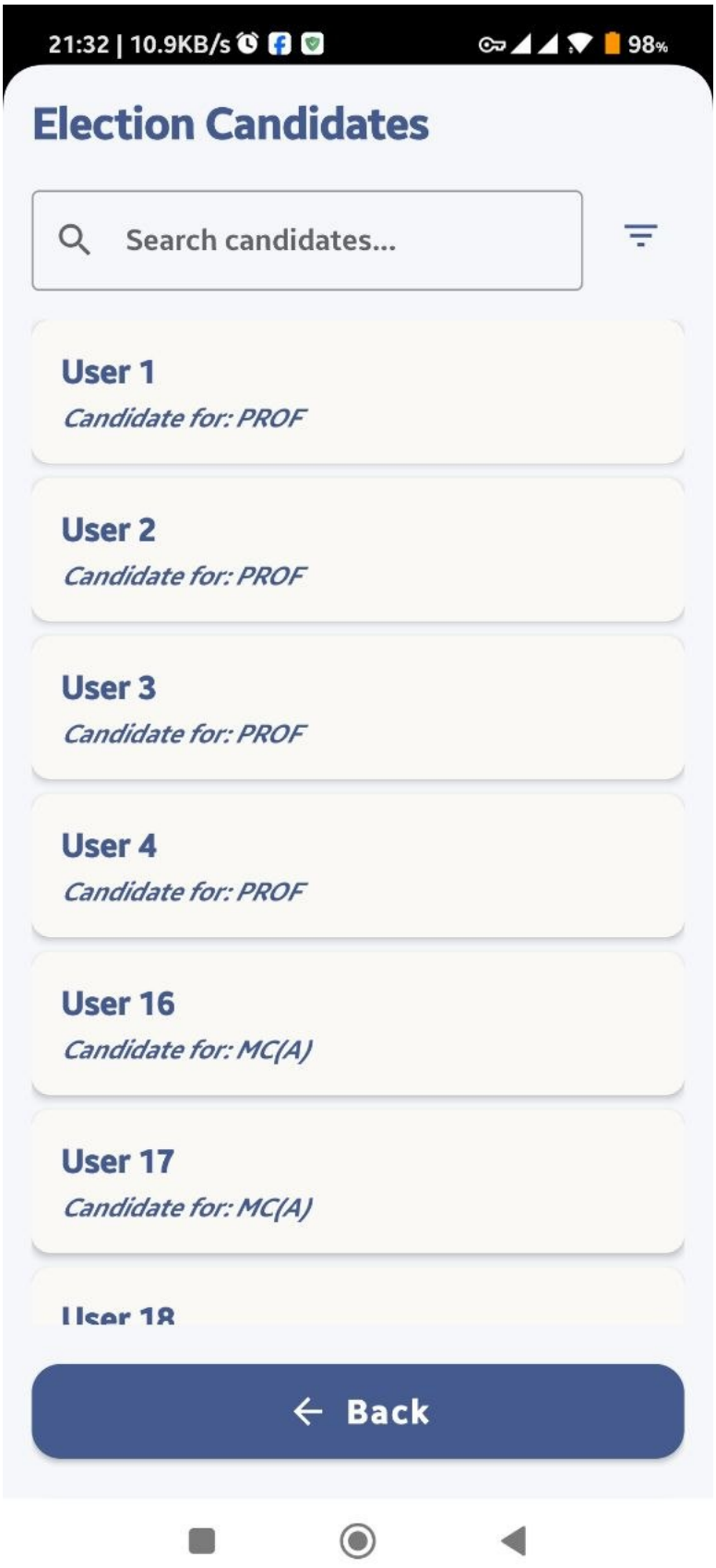
منصة تصويت الكترونية للجنة العلمية للقسم



واجهة الترشح للجنة العلمية

عنوان المشروع :

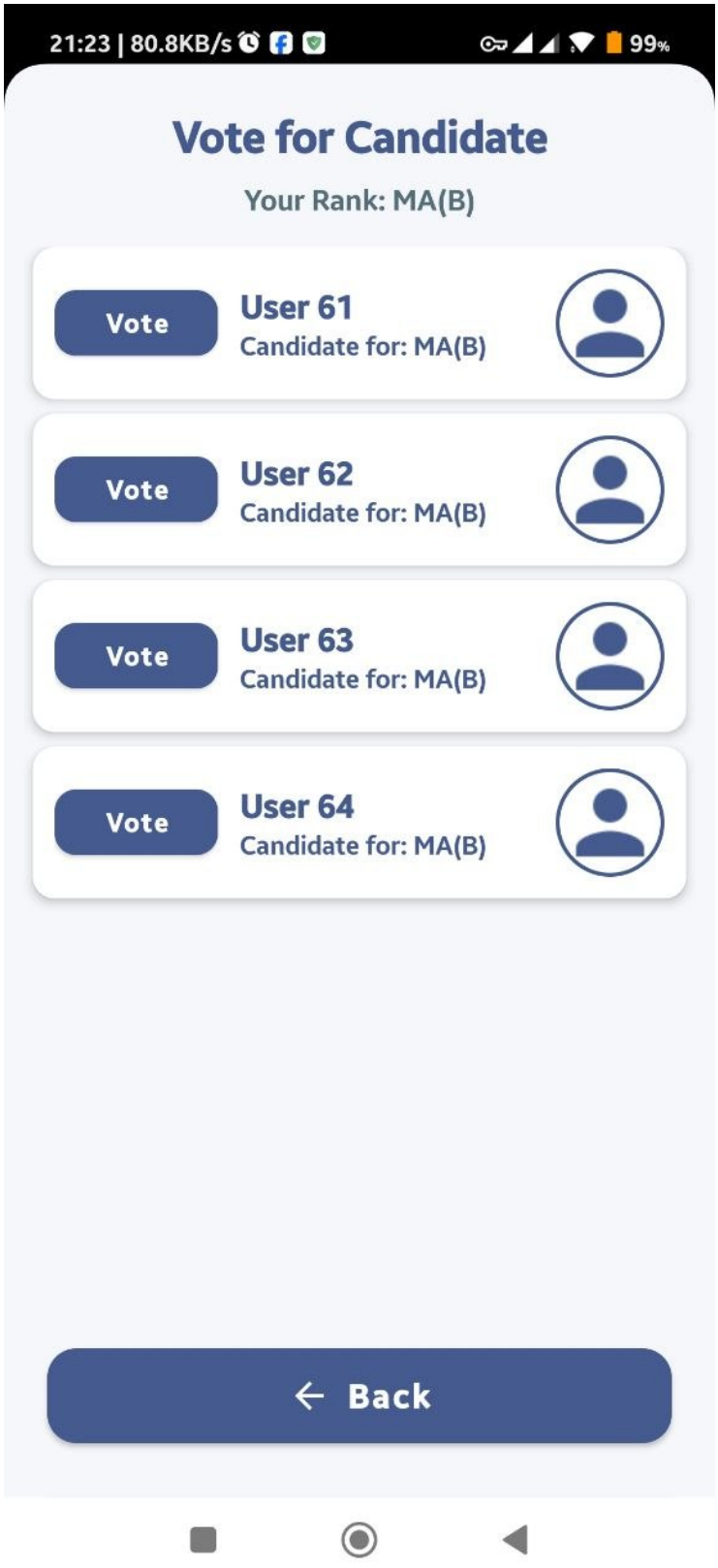
منصة تصويت الكترونية للجنة العلمية للقسم



واجهة لقائمة المرشحين للانتخبات

عنوان المشروع :

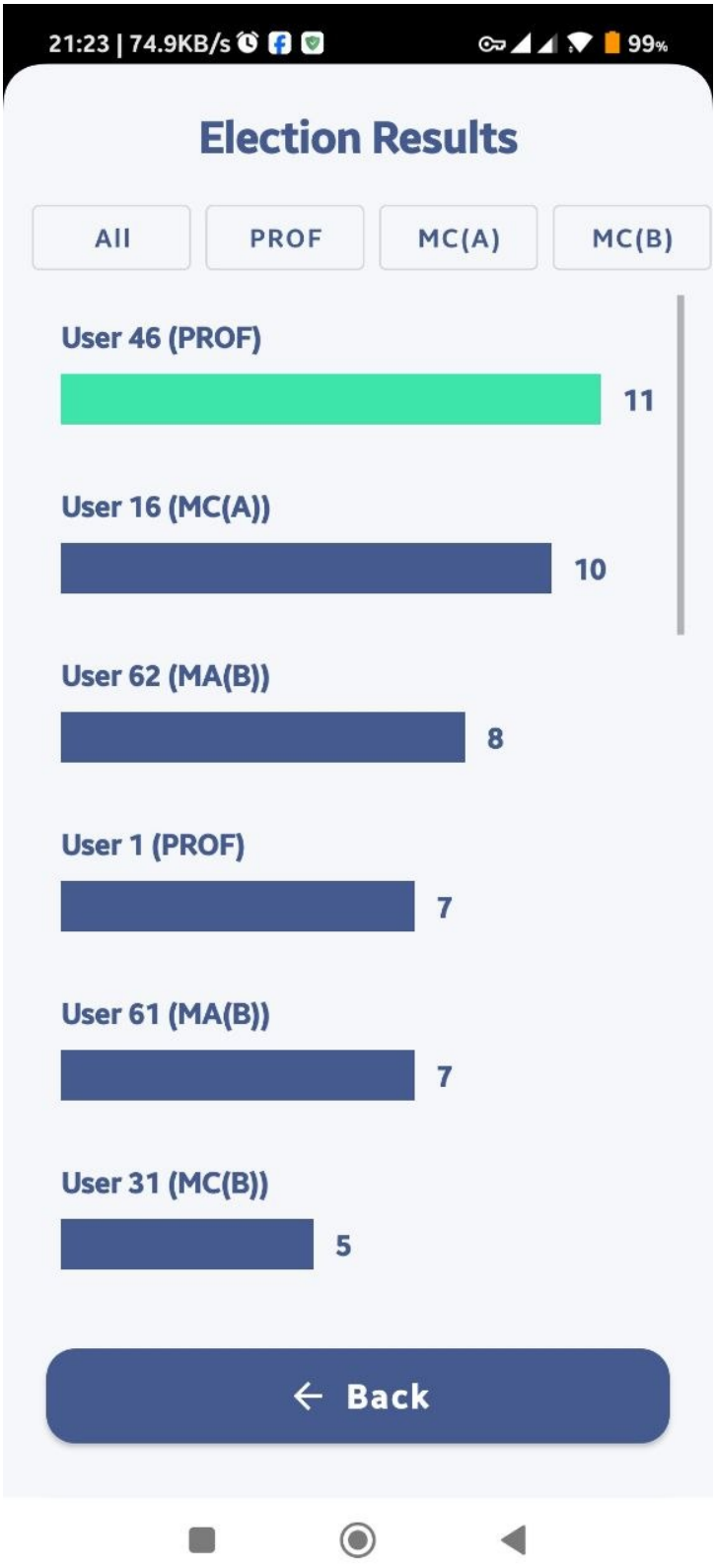
منصة تصويت الكترونية للجنة العلمية للقسم



واجهة الانتخاب للمنصة

عنوان المشروع :

منصة تصويت الكترونية للجنة العلمية للقسم



واجهة نتائج الانتخبات