Enhancing Student Service Efficiency Through a Smart Enrollment Queuing System for St. Clare College of Caloocan

Caranza, Aaron Christopher O.; Cortez, Christian Chilles G.; Da, Leo V.; Dela Cruz, Simon Andrei S.; Rapadas, Daniel M.; Santos, Miguel Nicolai M.; Jeanethjoy D. Naturales

Bachelor of Science in Computer Science, St. Clare College of Caloocan

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PROBLEM AND ITS BACKGROUND

Background of the Study

Enrollment is one of the most crucial processes in every academic institution, yet it often becomes stressful and time-consuming for both students and staff. At St. Clare College of Caloocan, students usually experience long queues during enrollment, especially when completing multiple steps such as submitting requirements, paying at the cashier, or verifying records. This traditional manual process often results in delays, overcrowding, and disorganized workflows that affect the overall student experience.

With the increasing use of digital systems in schools, the development of a Smart Enrollment Queuing System becomes an essential innovation. By adopting a system that allows enrollment staff to manage queues and provide real-time updates, waiting times can be minimized and services delivered more efficiently to students. The system will not only streamline enrollment procedures but will also help enrollment staff adapt to digital queue management systems, while students benefit indirectly through reduced waiting times and clearer processes, tools that are becoming common in companies, banks, and government agencies. Ultimately, this project aims to transform enrollment into a smoother, faster, and more organized process that benefits both students and the institution.

Statement of the Problem

The enrollment process at St. Clare College of Caloocan remains inefficient due to its reliance on traditional manual procedures. Students experience long queues, overlapping steps, and a lack of real-time updates, which result in wasted time, disorganized workflows, and unnecessary stress. These inefficiencies negatively affect both student satisfaction and productivity.

This study does not propose to replace the institution's enrollment system but rather to assist enrollment staff in streamlining queues and improving service delivery, which enhances student-side efficiency.

Specific Problems

- Long queues during enrollment cause wasted time and unnecessary stress for students.
- Lack of real-time updates leaves students unsure of their status in the process.
- Overlapping procedures often lead to confusion and slower service delivery.
- Students have limited opportunities to experience the benefits of digital queue systems, which are increasingly relevant in modern institutions.
- Enrollment staff face difficulty in managing queues manually, which leads to overlapping steps and slower service delivery.

These problems highlight the need for a digital solution that can organize the enrollment flow, reduce waiting times, and prepare students to get used to online platforms in the real world.

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Objective of the Study

General Objective

To develop a Smart Enrollment Queuing System as an assistive tool that enhances the efficiency of student services and improves the enrollment experience at St. Clare College of Caloocan.

Specific Objectives

The specific objectives are:

- To assist enrollment staff in minimizing long queues and overcrowding.
- To provide real-time queue tracking that staff can use to update students on their progress.
- To improve workflow organization by enabling staff to schedule and manage enrollment procedures efficiently.
- To familiarize staff with digital queue management systems, preparing them for future institutional digitalization.

This system aims to ensure that the enrollment process becomes more organized, convenient, and efficient, ultimately creating a better experience for students, by assisting staff in managing queues more effectively.

Significance of the Study

This study contributes to enrollment service efficiency by acting as a supplementary tool for staff, indirectly improving the student experience. It enhances the student experience indirectly by reducing waiting times and improving clarity, while directly assisting enrollment staff with structured queue management.

The Smart Enrollment Queuing System is intended as an assistive tool that enhances student service efficiency without altering or replacing the institution's existing enrollment procedures.

Scope and Delimitation of the Study

Scope

This study focuses on assessing how a Smart Enrollment Queuing System can improve student service efficiency at St. Clare College of Caloocan. It covers:

- Organization of student queues during enrollment
- Real-time tracking of student progress
- Digital ticketing (virtual queue numbers, screen-based display)
- Workflow streamlining for enrollment staff handling student steps (submission, verification, approval).
- Staff-side dashboard for managing queues, calling next students, and updating enrollment status.
- Usability testing and evaluation based on student feedback
- Deployment and monitoring of the system during enrollment periods

The system acts only as a supportive mechanism to streamline Enrollment Queuing System, not a replacement for EduSuite.

Delimitations

- Limited to tertiary student enrollment only
- Excludes cashiering, registrar services outside enrollment, library, and guidance office processes
- Restricted to one academic period when the system is tested
- System usage is limited to enrollment staff, while evaluation feedback is limited to students.
- Focused solely on staff-side queue management; excludes redesign of other institutional workflows (cashiering, library, guidance).

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- Although the system is intended for all tertiary students, the study was limited to a sample of 100 Computer Science students to ensure manageability of data collection and focused evaluation.

Definition of Terms

Enrollment - The process where students officially register for classes and submit requirements to the institution.

Queuing System - A structured method of managing waiting lines, often supported by software or digital tools.

Queue Management - A method used to control the arrival, waiting, and service of students during enrollment to reduce crowding and delays.

Real-time Tracking - A feature that shows the current position of a student in the queue. It helps users plan their time and avoid unnecessary waiting.

Smart Enrollment Queuing System - A digital system operated by enrollment staff to organize student flow during enrollment. It provides virtual queue numbers, real-time status updates, and scheduled processing.

Service Window - A physical or digital point, where staff process enrollment steps such as evaluation or verification.

Waiting Time - The length of time a student spends before being served. It is used to measure efficiency.

Workflow - the sequence of tasks performed by enrollment staff during the enrollment process.

Virtual Ticketing - A system that allows enrollment staff to generate and manage digital queue numbers for students.

User Interface - the dashboard and screens that enrollment staff use to manage queues and update student status.

RELATED LITERATURE AND STUDIES

This chapter presents literature and studies that support the need for a smart queuing system for enrollment. For example, local literature supports the presence of expected service waits in the Philippines and that long queuing is an anticipated inevitable occurrence within schools, banks and other government institutions. These sources explain how poor system design leads to wasted time and reduced productivity. The foreign literature adds research on queuing models and digital queue systems used in universities abroad. These works show how real-time updates, virtual ticketing, and automated service allocation improve efficiency. Local studies provide data from Philippine colleges where students experience long waits and slow manual processes. Their findings show better outcomes when digital queuing or online registration systems are used. Foreign studies confirm similar improvements in other countries. Therefore, these findings support the development of a smart enrollment queuing system in St. Clare College of Caloocan.

Related Literature

Foreign Literature

According to Srivastava (2023), service systems under heavy load often suffer from long queues, reduced customer satisfaction, and financial losses. His study uses MG1, GM1, and GG1 queuing models to measure service quality under different system configurations, finding that the MG1 model yields the highest quality service when optimized. This supports using queuing theory in service settings like student enrollment to minimize waiting time, improve throughput, and elevate service standards.

Vizitor (2023) discusses how schools and universities worldwide use digital queue systems to reduce physical lines and improve student flow. Their article emphasizes that these systems provide virtual ticketing, real-time notifications, and improved student satisfaction, especially during enrollment and administrative processes.

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Wavetec (2022) highlights that queue management systems in universities help regulate service flow, reduce crowding, and speed up administrative processes such as enrollment, records request, and payments. The article notes that digital queue solutions increase efficiency and ensure fair service delivery to students.

These foreign studies highlight the effectiveness of digital queue systems in reducing waiting times and improving service flow. In this context, this supports the need for a staff-operated queuing system that indirectly enhances student service efficiency.

Local Literature

Dublar (2023) reviews how emerging technologies affect knowledge and skills acquisition among K-12 students in the Philippines. The study highlights tools such as artificial intelligence, social media, mobile learning, and gamified applications. Evidence shows improved student engagement, stronger critical thinking, and better performance when these technologies are integrated. Programs like the DepEd Computerization Program and ICT teacher training initiatives have expanded access, but challenges remain. Limited infrastructure, uneven teacher competency, and data privacy concerns reduce effectiveness. The review concludes that sustained investment in teacher training, infrastructure, and clear policies is essential to maximize technology's impact on learning outcomes.

Queue Problems in Philippine Services The Manila Times (2018) editorial "Long Queues Everywhere" highlights how Filipinos face long waiting lines in daily transactions. The article points out inefficiencies in public and private services such as MRT stations, banks, supermarkets, and government offices. It emphasizes that queues waste valuable time and reduce productivity, forcing people to spend hours for simple tasks like securing permits or banking transactions. The editorial frames long queues as a symptom of poor system management and weak service delivery. This supports the need for structured queue management in educational institutions, where enrollment processes often mirror the same inefficiencies.

Veluya (2015) presents a descriptive account of how queuing theory can be applied to improve enrollment flow in a Philippine higher education institution. The work outlines common causes of congestion in school enrollment such as simultaneous student arrivals, constrained service windows, and manual verification procedures. It also explains basic queuing concepts including arrival rate, service rate, waiting line behavior, queue discipline, and the function of single and multiple server models in school settings. Veluya describes how understanding these theoretical elements can guide the development of better queue structures, improve allocation of service counters, and enhance the overall enrollment experience. The descriptive sections emphasize the value of streamlining processes and applying simple analytical models to reduce waiting time and increase service efficiency in academic institutions.

Local literature emphasizes how poor system design leads to wasted time and reduced productivity. This mirrors the enrollment challenges faced by students, which enrollment staff must manage manually, reinforcing the need for a supportive digital tool.

While some systems include modules for document verification or cancellation, this study focuses on queue adjustment and staff-assisted data entry to maintain consistency with the institution's existing workflow.

Related Study

Foreign Study

Adetoye, Aribisala, and Adebimpe (2023) conducted a study on the implementation of an automatic registration and queueing management system in a Nigerian university setting. The study emphasized the inefficiencies present in traditional manual registration processes, such as long queues, frequent clerical errors, and delays in student processing. To address these challenges, the researchers designed and implemented a digital system that automated student registration, course enrollment, and queue management. Their system incorporated real-time notifications, user-friendly interfaces, and data validation to minimize errors and reduce processing time. The results of the study indicated a significant improvement in registration efficiency, decreased waiting times, and

enhanced overall student satisfaction. Furthermore, the system provided administrators with detailed reports and analytics to monitor registration trends and resource allocation (Adetoye, Aribisala, & Adebimpe, 2023).

Deoraj, Essop, and Aroba (2024) designed a VQS system for the Durban University of Technology, South Africa. According to them, the increased demand for higher learning institutions calls for advanced technologies that improve the student experience and ensure the security of information. Herein, their proposed VQS system aims at eliminating the physical waiting times by joining queues remotely, which would ease congestion and enhance service efficiency. To ensure security for the students, the designed VQS system employed a multi-layered security approach to ensure the privacy of the data and protection against unauthorized access. They used real-time analytics, dynamic scalability, and advanced algorithms in resource allocation through a comprehensive review to ensure optimization in queue performance and user experience. The results indicate that this kind of digital queuing solution holds immense promise for transforming the way universities handle student traffic, improving service quality and strengthening the security of information (Deoraj et al., 2024).

Jensen, Amos, Angrave, Mussulman, Schmitz, & Fagen-Ulmschneider (2019) conducted a case study at the University of Illinois Urbana-Champaign on the use of an online queuing application to improve student services in large enrollment courses. Traditionally, office hours relied on manual sign-ups, which led to overcrowding, long waiting times, and inequitable access. The study introduced a digital queue system that allowed students to register questions online, track their position in line, and receive notifications when it was their turn. The system was also applied in academic advising, peer-led team learning, and active learning sessions. Findings showed that the queue app saved time for both students and instructors, improved accessibility, facilitated group learning, and provided analytics to identify common issues. The authors concluded that online queuing systems enhance efficiency and student experience in higher education settings.

While many foreign systems allow students to interact directly with digital queues, the researchers' proposed system differs by being operated by enrollment staff. This ensures smoother queue management while students benefit indirectly through reduced waiting times and clearer processes.

Local Study

David et al., (2020) analyzed student queuing behavior within a 16-day enrollment period (July 8–30, 2019) at City College of Angeles (CCA). The researchers employed a mixed-methods approach of gathering primary data through direct observation and interviews with staff and students. It is also supplemented by a survey whose sample size was determined using an online calculator. According to David et al., (2020), 194 students arrived in just the first hour (8:30 am–9:30 am) at the Registrar's Office, indicating a high arrival pattern. The longest waiting time recorded in that office was 2 hours and 47 minutes for the 127th person in line, while service times ranged from as fast as 1 minute to as slow as 7 minutes per student. In the Dean's/Coordinator's Office, of the 80 students observed, the maximum waiting time reached 1 hour and 52 minutes for the 79th person, and service times varied from 1 to 17 minutes. On average, students waited 25 minutes 47 seconds in the Registrar's Office (with a service time of 1 minute 14 seconds) and 27 minutes 32 seconds in the Dean's Office (with an average service time of 2 minutes 53 seconds). The researchers argued that these long queues were caused by a high volume of students (partly due to free tuition), being short-staffed, and the lack of a formal queuing system. To address these issues, the researchers recommended implementing a computerized queue management system and conducting regular operational and system analysis. This increases the number of service "servers" (staff or windows) and to increase the overall productivity and efficiency and reduce waiting times.

The study by Lagman, Grefaldo, and Sarmiento (2024) delves into the development of an Online Student Registration System to address inefficiencies in manual enrollment processes, especially highlighted during the pandemic. The researchers aimed to build a content management system (CMS) where administrators can update information such as school policies, calendars, directories and registration modules for students to sign up and manage their accounts. To ensure quality, the system was evaluated against the ISO 25010 software-quality model, checking for its functionality, performance efficiency, usability, reliability, and security. Their findings indicate that the online system streamlined enrollment, made information more accessible, reduced the delays and errors inherent in manual registration, and improved stakeholder satisfaction by centralizing important school data. Their study supports the case for a smart, digital queuing system for St. Clare College of Caloocan. It also shows that moving from manual to online enrolment can significantly improve efficiency and minimize

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the physical "queue" just to register.

Mallari et al., (2020) developed a web-based queuing system to modernize and streamline the queuing processes at the Angeles University Foundation Registrar's Office. According to the researchers, a survey of 57 clients which mostly comprised students, faculty members, and staff revealed that the most common problems with the previous system were long waiting times, poor service, and lack of real-time queue visibility. With the new CLIQUE system, clients can monitor their queue status in real time through any device, and staff receive notifications when someone queues up in a specific service counter. The CLIQUE study proves that a web-based queuing system with real-time tracking can be effectively implemented in a Philippine college setting, enhancing student service efficiency. Using Design Thinking, the system was tailored to meet actual user needs. It also demonstrated that technologies like ASP.NET, MVC, MySQL, and JavaScript can support a robust and maintainable academic queuing system. Key features such as real-time notifications and queue monitoring significantly improved the student experience and streamlined administrative workflow.

Although some local studies included both staff and students as participants, this thesis only focuses on student feedback, with staff roles limited to system operation in simulation. This distinction ensures that the system is evaluated from the student experience while acknowledging staff as the primary users.

METHODS OF RESEARCH AND PROCEDURES

This chapter explains the methods used to conduct the study. It presents the research design, population, sampling technique, research locale, respondents, data gathering procedure, research instrument, and statistical treatment. Each section describes how information was collected and analyzed to support the development of the Smart Enrollment Queuing System for St. Clare College of Caloocan.

Research Methodology

This chapter addressed the study design and procedure used to collect data and information. Surveys and other methods can be used as part of the methodology.

Research Design

The researchers used a descriptive-quantitative approach to conduct the study. A structured survey form was administered to tertiary students, specifically of the BSCS course, to gather their responses to the research questions. The survey served as the primary descriptive research tool. Enrollment staff were not included as survey respondents; their role was simulated by the researchers during the mock test demonstration.

Population and Sampling Technique

The population of this study consists of all tertiary students of St. Clare College of Caloocan who are directly involved in the enrollment process. This group was chosen because they experience the challenges of long queues, overlapping transactions, and lack of real-time updates during enrollment.

However, for manageability of data collection, the sample size was limited to 100 Computer Science students. Although the system is designed to benefit all tertiary students across different courses, this delimitation ensured a focused and practical evaluation.

Purposive Sampling Technique

The researchers used purposive sampling to select respondents who have direct experience with the enrollment process. By focusing on Computer Science students undergoing enrollment, the study ensures that the data collected is specific, relevant, and aligned with the objectives of the research. Enrollment staff are system users in the mock test simulation but are not included as survey respondents.

Research Locale

The study was conducted at St. Clare College of Caloocan, specifically in areas where the traditional enrollment process is still being used. This location was chosen as it represents the actual environment where students

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encounter long queues, delays, and inefficiencies during the enrollment period.

Respondents of the Study

The respondents of this study consist solely of 100 Computer Science students from St. Clare College of Caloocan. While the system targets all tertiary students, the sample was limited to this group to provide a focused and manageable evaluation. Students directly engage in the enrollment process and encounter issues such as long queues, unclear steps, and delays. Their feedback provides the necessary data to evaluate the effectiveness of the Smart Enrollment Queuing System. Enrollment staff were not involved; instead, the researchers operated the system during the mock test demonstration.

Data Gathering Procedure

In this study, informed consent was obtained from student participants prior to data collection, ensuring that they were fully aware of the purpose of the research and procedures involved. Participants' confidentiality was strictly maintained, and all collected data was used solely for academic purposes.

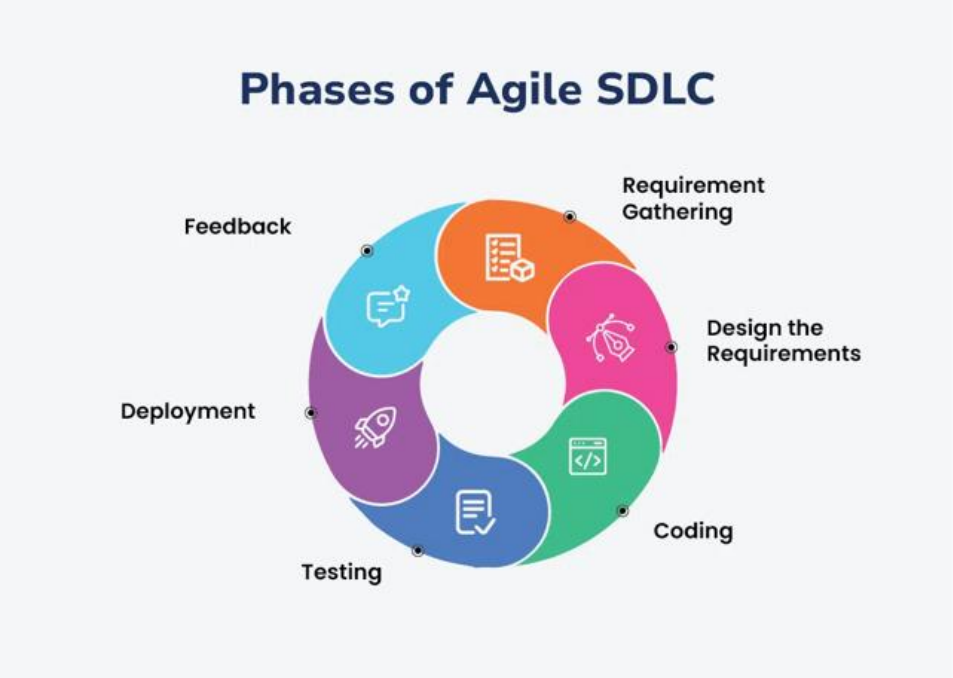
Permission was secured from the administration of St. Clare College of Caloocan before conducting the study. The researchers coordinated with the Institute of Computer Studies to ensure compliance with institutional policies. Once approval was granted, the researchers prepared the research instruments and distributed questionnaires to Computer Science students only. Enrollment staff were excluded as survey respondents, but their role was simulated during the mock test to demonstrate system usage.

Research Instrument

The primary instrument used in this study was a structured survey questionnaire, administered physically and virtually (online survey). It was divided into four sections:

- **Respondent's Information** – demographic data such as gender and year level.
- **Student Views on Enrollment Efficiency** – Likert-scale items measuring perceptions of delays, waiting times, and the potential benefits of using a smart queuing system.
- **Assessment of Enrollment System Performance** – Likert-scale items evaluating speed, fairness, clarity of instructions, and comfort of facilities.
- **Proposed Features** – Likert-scale items identifying desirable features of a smart queuing system.

System Development Procedure



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The development of the Smart Enrollment Queuing System for St. Clare College of Caloocan followed the Agile Software Development Life Cycle (Agile SDLC). This model was chosen because it supports iterative development, continuous user feedback, rapid prototyping, and flexible adaptation—all of which are necessary for a system intended to improve student service efficiency.

Each phase was conducted in multiple cycles (sprints), allowing the researchers to enhance specific system features based on stakeholder feedback, collected from students during mock test simulation.

A. Requirement Gathering

In this phase, the researchers identified all functional and non-functional requirements of the system. Through surveys, interviews, and observations, the team collected data on:

- Long queues during enrollment
- Need for real-time queue update
- Lack of scheduling feature
- Need for digital familiarity among students
- Existing workflow challenges faced by staff in handling enrollment procedures

These requirements served as the foundation for designing all system modules.

B. Planning

The project team created a development roadmap that outlined:

- System architecture
- Major modules such as virtual ticketing, queue monitoring, user interface, staff dashboard, analytics, and notifications
- Sprint timeline & deliverables
- User roles (staff, admin)
- Database structure and security requirements

C. Prototyping

Initial wireframes and interface prototypes were created to visualize:

- Student virtual queue interface
- Queue number generation screen
- Real-time tracking board
- Staff service window dashboard
- Admin monitoring and reports

These prototypes were presented to clients, and their feedback guided adjustments for the improvement of our system.

D. Development

Using the approved prototypes, the researchers developed the core system features across several Agile sprints:

- Virtual Queue Number Generation - Allows students to get a queue number upon registering.
- Real-Time Queue Tracking - Displays the student's current position in the queue and service status.
- Staff Dashboard - Enables staff to call the next student, manage queues, and update service progress.

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- User & Admin Panels - Manage student information, queue records, logs, and system configuration.
- Incremental builds were demonstrated to users at the end of each sprint.

E. Testing

The system underwent multiple testing cycles:

- Unit Testing - Each module was tested individually.
- Integration Testing - Ensured that modules (queueing, tracking, user panels) worked together seamlessly.
- Usability Testing – Researchers assessed UI clarity, speed, and ease of interaction.
- Functionality Testing - Validated that the system performed according to requirements.
- Issues found were logged and corrected in the next sprint.

F. Deployment

After successful testing, the final version of the Smart Enrollment Queuing System will be deployed in the enrollment area for regular use. The deployment process included:

- System installation
- Database configuration
- User onboarding for staff
- Initial monitoring during the enrollment period

G. Evaluation

Post-deployment evaluation was conducted to assess overall performance. Feedback was collected only from students regarding:

- System usability
- Real-time tracking accuracy
- Reduction in waiting time
- Improvement in workflow efficiency
- Accessibility and convenience

Enrollment staff usage was simulated during testing but excluded from survey feedback.

System Requirements and Minimum Specifications

A. Minimum Operational Specifications

Component	Minimum / Recommended Specification and Purpose
Processor (CPU)	Intel Core i5, 10th generation or higher, or AMD Ryzen 5 equivalent. This is needed to handle queue processing for hundreds of students without lag. A mid-range CPU ensures smooth multitasking between the staff dashboard and queue display.
Memory (RAM)	8 GB minimum; 16 GB recommended. This allows the system to run multiple processes at once. With two monitors and real-time updates, higher RAM prevents slowdowns and ensures responsiveness.
Storage	256 GB SSD. SSDs provide faster boot times and help the system load quickly during enrollment periods to avoid delays.
Graphics	Integrated GPU is sufficient; dedicated GPU is optional. Dual-monitor support requires stable graphics handling. Integrated GPUs can manage the queue display and staff dashboard, while dedicated GPUs may provide smoother performance.

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Monitors	Two monitors are recommended. The first monitor is for the staff dashboard, while the second monitor is for the real-time queue display for students. This separation supports clarity and efficiency.
Connectivity	Stable LAN or Wi-Fi connection. This is essential for syncing updates between staff and student displays. Poor connectivity may cause delays or inaccurate queue information.
Operating System	Windows 10/11 64-bit. This provides compatibility with modern applications, security updates, and dual-monitor support.
Other Requirements	Dual monitor ports such as HDMI or DisplayPort are needed to support two displays. A UPS or backup power source is also recommended to prevent disruptions during enrollment in case of power outages.

B. Hardware Requirements

Device	Description / Specification
Computer	Processor: Intel i5 or AMD Ryzen 5; RAM: 8 GB minimum; Storage: 256 GB SSD or HDD minimum; Operating System: Windows 10/11.
Laptop	Processor: Intel i5 or AMD Ryzen 5 or higher; RAM: 8 GB minimum; Storage: 256 GB SSD; Operating System: Windows 10/11.
Monitor/TV	Size: 27 inches; Resolution: 2560 x 1140; Refresh Rate: 144 Hz.
Network Switch	Managed Gigabit Ethernet Switch with 24 to 48 ports. It serves as the central network hub connecting all workstations and servers and should support PoE or Power over Ethernet for future access points.
Network Cables	Cat6a Ethernet cables, length as needed. These cables connect devices to the router and are gigabit-rated for optimal performance.
Wi-Fi Access Point	Building-wide coverage with overlap in dead zones. This enables wireless connectivity for devices and provides backup connectivity.

C. Software Requirements

The Smart Enrollment Queuing System was built using programming languages and technologies that support the local web application, hosted API, and client-side interactivity. These technologies were selected for their strengths in web development, server-side processing, real-time communication, and database management, enabling a robust and feature-rich system.

Programming Language / Technology	Purpose and Usage
HTML	Markup structure for web pages. It creates the user interface framework for the Student Enrollment Queuing System frontend.
CSS	Styling and layout. It provides responsive design and visual styling for the web interface.
JavaScript	Frontend client-side scripts for interactive features.
Node.js	Backend server application, API routes, data models, middleware, and utilities.
Socket.IO	Real-time communication for live queue monitoring and notifications.
JSON	Configuration files such as package.json in the root and backend folders. It manages project dependencies and npm scripts for both frontend and backend.

D. Network Requirements

1. Network Architecture and Connectivity
   - Wi-Fi compatibility must support modern Wi-Fi standards, including 802.11a/b/g/n/ac/ax.
   - The system must work on 2.4 GHz and 5 GHz networks.
   - Real-time features require a stable connection with recommended latency of less than 100ms.

Requirement	Specification
Minimum Bandwidth	1 Mbps per client.
Recommended Bandwidth	5 to 10 Mbps per concurrent user for real-time queue updates through WebSocket.
Peak Bandwidth	Approximately 50 Mbps for 10 concurrent stations with continuous data synchronization.

2. Network Deployment Options
   - Local Network or LAN deployment places all clients and the server on the same Wi-Fi or Ethernet network.
   - Cloud deployment makes the server accessible through HTTPS over the internet.

E. Security Requirements

1. Authentication and Authorization
   - The system uses JWT or JSON Web Tokens for authentication.
   - JWT expiration is 7 days and is configurable through JWT_EXPIRE.
   - The secret key must be changed from the default value before production deployment.
   - Token storage may use HTTP-only cookies or an Authorization header with a Bearer token.
   - Role-based access control or RBAC must support admin, staff, and student roles.
2. Password Security
   - The system uses ‘bcryptjs’ for password hashing.
   - Minimum password length is 6 characters during development, but it should be increased to 12 or more characters for production.
   - Passwords are hashed before storage and must never be stored in plaintext.
   - Password confirmation is required during registration.
3. Data Encryption and HTTPS
   - Current development communication uses ‘http://localhost:3000’, which is suitable for local network use only and is not suitable for internet-facing deployment.
   - Production deployment requires HTTPS/TLS with SSL/TLS certificates installed on the Node.js server.
   - WebSocket communication should use the WSS or Secure WebSocket protocol.
   - Let's Encrypt free SSL certificates are recommended for production deployment.
4. Database Security
   - The default MongoDB connection is ‘mongodb://localhost:3000/test1’, which is for local use only and has no authentication by default.
   - Production deployment must implement MongoDB authentication with username and password.
   - MongoDB Atlas may be considered for cloud deployment with encrypted connections.
   - Password fields must be excluded from API responses using ‘.select('-password')’.
   - Sensitive data such as student numbers, emails, and enrollment records must be protected by JWT.
5. Firewall and Network Access Rules
   - For local network deployment, port 3000 should be open to all devices on the local network.
   - For local network deployment, port 27017 for MongoDB should be restricted to localhost only.
   - External internet access to port 3000 should be restricted for local deployment.
   - For cloud or internet deployment, port 3000 or 443 should be open for HTTPS traffic from clients.
   - For cloud or internet deployment, port 27017 should be restricted to the server internal network and must not be directly public.
   - Rate limiting should be implemented on API endpoints.
   - A Web Application Firewall or WAF should be set up for additional protection.

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F. Network Latency and Performance Requirements

Metric	Acceptable	Recommended
API Response Time	Less than 500 ms	Less than 200 ms
WebSocket Latency	Less than 100 ms	Less than 50 ms
Database Query	Less than 100 ms	Less than 50 ms
Page Load	Less than 3 seconds	Less than 1.5 seconds

G. Device Compatibility

- Browsers: All modern browsers, including Chrome, Firefox, Safari, and Edge.
- Mobile: iOS Safari, Android Chrome, and Firefox.
- Network Type: The system adapts to available bandwidth.

Statistical Treatment Formula

The following statistical tools and formulas were applied to analyze the survey results:

1. Frequency

$$\boldsymbol{F = n}$$

Where:

- **F** = frequency
- **n** = number of respondents who selected a given response

2. Percentage

$$\boldsymbol{P = \frac{f}{N} \times 100}$$

Where:

- **P** = percentage
- **f** = frequency of a given response
- **N** = total number of respondents

3. Weighted Mean

$$\boldsymbol{WM = \frac{\Sigma f * w}{N}}$$

Where:

- **WM** = weighted mean
- **F** = frequency of each response
- **w** = weight assigned to each scale point *(5 = Strongly Agree, …, 1 = Strongly Disagree)*
- **N** = total number of respondents

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

Introduction

This chapter presents the results of the post-survey conducted among 100 Computer Science students of St. Clare College of Caloocan after the mock test demonstration of the Smart Enrollment Queuing System. The data are organized according to the specific objectives of the study. Each section includes tables, weighted means, and interpretation in relation to the problem statement and objectives.

Table 4.1. Weighted Mean of Responses on the Effectiveness of the Smart Enrollment Queuing System in Minimizing Long Queues and Overcrowding

Statement	Weighted Mean
I experienced shorter waiting times compared to the manual process.	4.6
The smart queuing system reduced confusion and made the process clearer.	4.5

I found the enrollment process less stressful when using the system.	4.5
The system helped me manage my time better during enrollment.	4.4
The system minimized overcrowding in enrollment areas.	4.4
I felt more confident completing enrollment with the system's guidance.	4.5
The step-by-step queuing process was easier to follow than the manual method.	4.6
Overall, the smart queuing system improved my enrollment experience.	4.7
The smart queuing system made the enrollment process faster.	4.6
Total	**4.56**

In **Table 4.1**, out of 100 Computer Science students who responded to the survey, the total weighted mean is 4.56, which indicates that the proposed enrollment queuing system was highly effective. This score shows that overall, students strongly agreed the system reduced waiting times, minimized overcrowding, and made the enrollment process less stressful compared to the manual method.

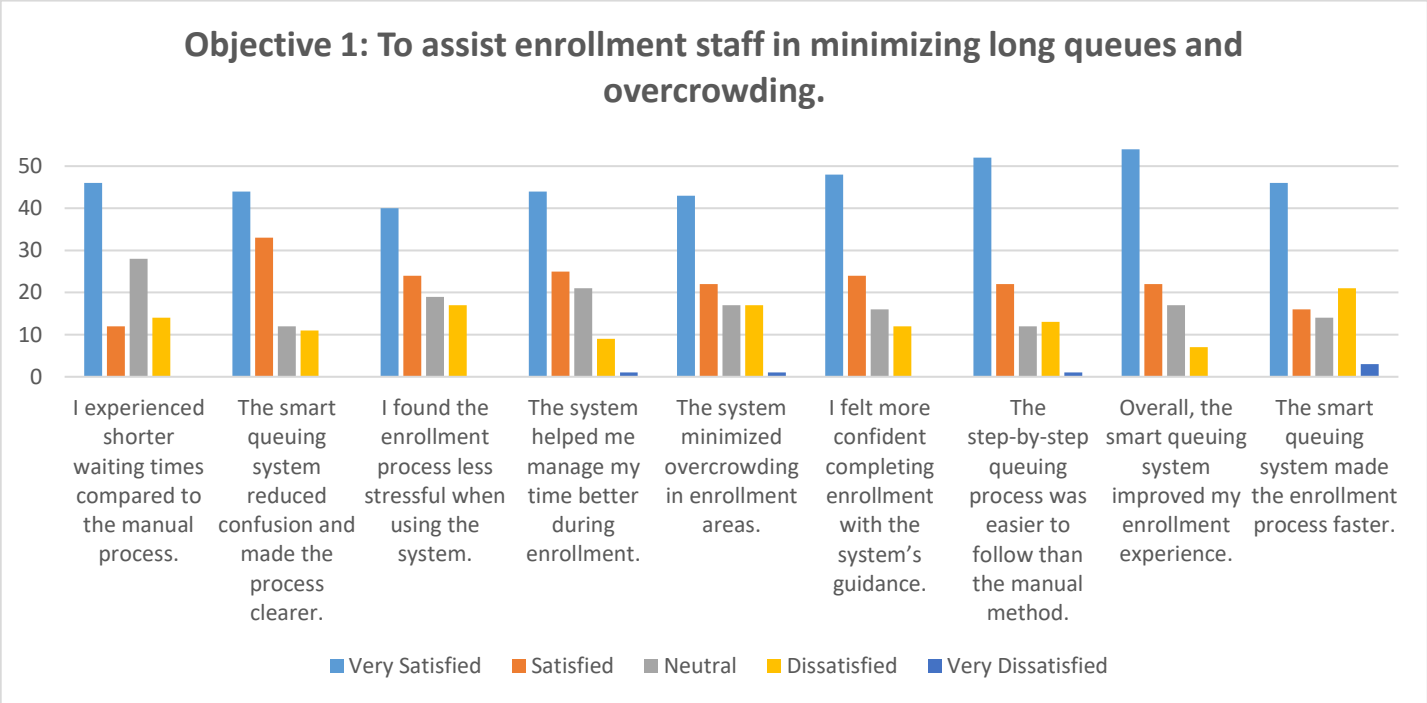

Table 4.2. Weighted Mean of Responses on the Effectiveness of the Smart Enrollment Queuing System in Providing Real-Time Queue Tracking

Statement	Weighted Mean
The virtual ticket feature made tracking my progress easier.	4.6
The screen-based number display was effective in guiding me through the process.	4.5
The system provided accurate updates about my enrollment status.	4.5
I was able to monitor my queue status in real time.	4.5
The system's visual representation of queues was helpful.	4.6
The digital organization of queues made tracking easier.	4.5
I could see the total number of students in the queue, which helped me plan.	4.4
Total	**4.51**

In **Table 4.2**, out of 100 Computer Science students who responded to the survey, the total weighted mean is 4.51, which signifies that the real-time tracking features of the proposed system were rated very effective. This high score reflects that students strongly agreed that the system's virtual ticket, queue monitoring, and visual displays made tracking their enrollment progress easier and more reliable.

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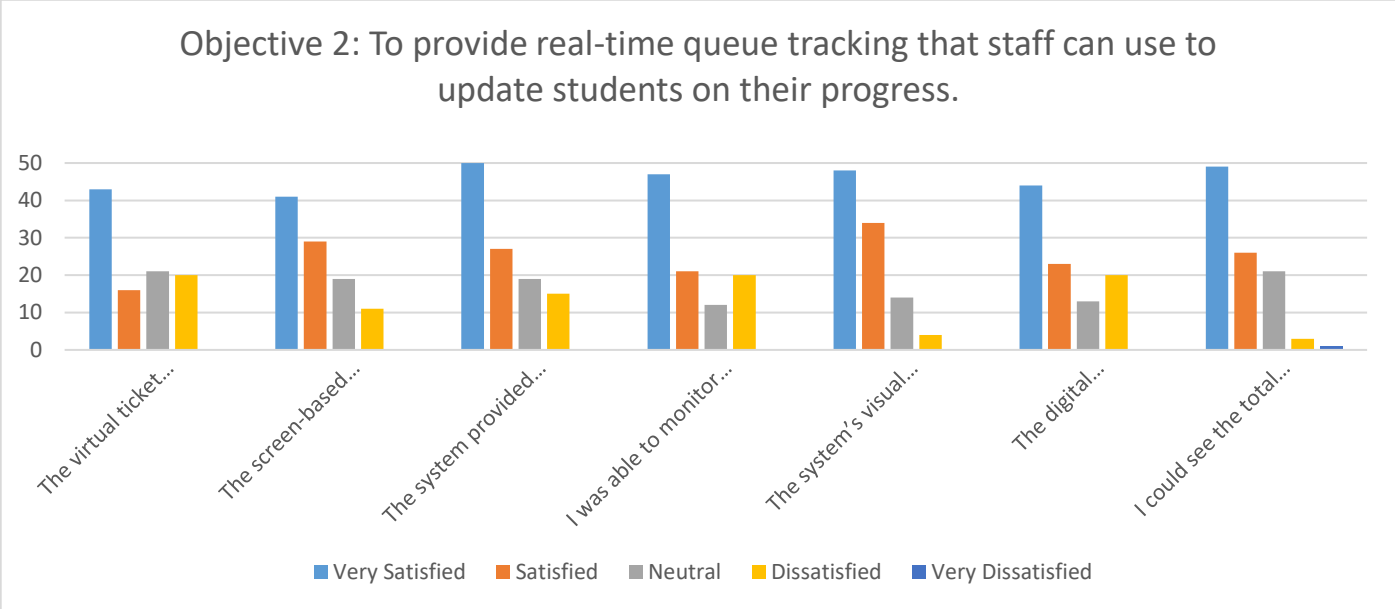


Table 4.3. Weighted Mean of Responses on the Effectiveness of the Smart Enrollment Queuing System in Improving Workflow Organization

Statement	Weighted Mean
The system ensured fairness in queue management.	4.5
The system helped organize the flow of students more smoothly.	4.6
Instructions provided through the system were clear and easy to understand.	4.5
The system reduced overlapping procedures and delays.	4.4
The enrollment environment felt more organized with the system.	4.5
The system improved clarity in the enrollment process.	4.5
Overall, the smart queuing system met my expectations for efficiency.	4.6
Limiting the number of students per station reduced congestion.	4.4
The system followed the first-come-first-serve rule consistently.	4.6
Total	**4.51**

In **Table 4.3**, out of 100 Computer Science students who participated in the survey, the total weighted mean is 4.51, which indicates that the proposed system was very effective in improving workflow organization. This score shows that students strongly agreed the system helped streamline the flow of enrollment, provided clear instructions, reduced delays, and created a more organized environment overall.

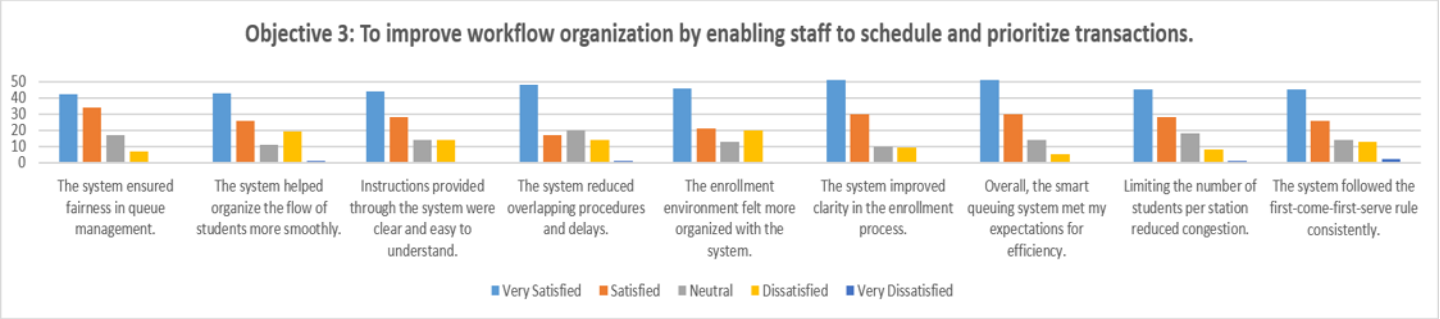
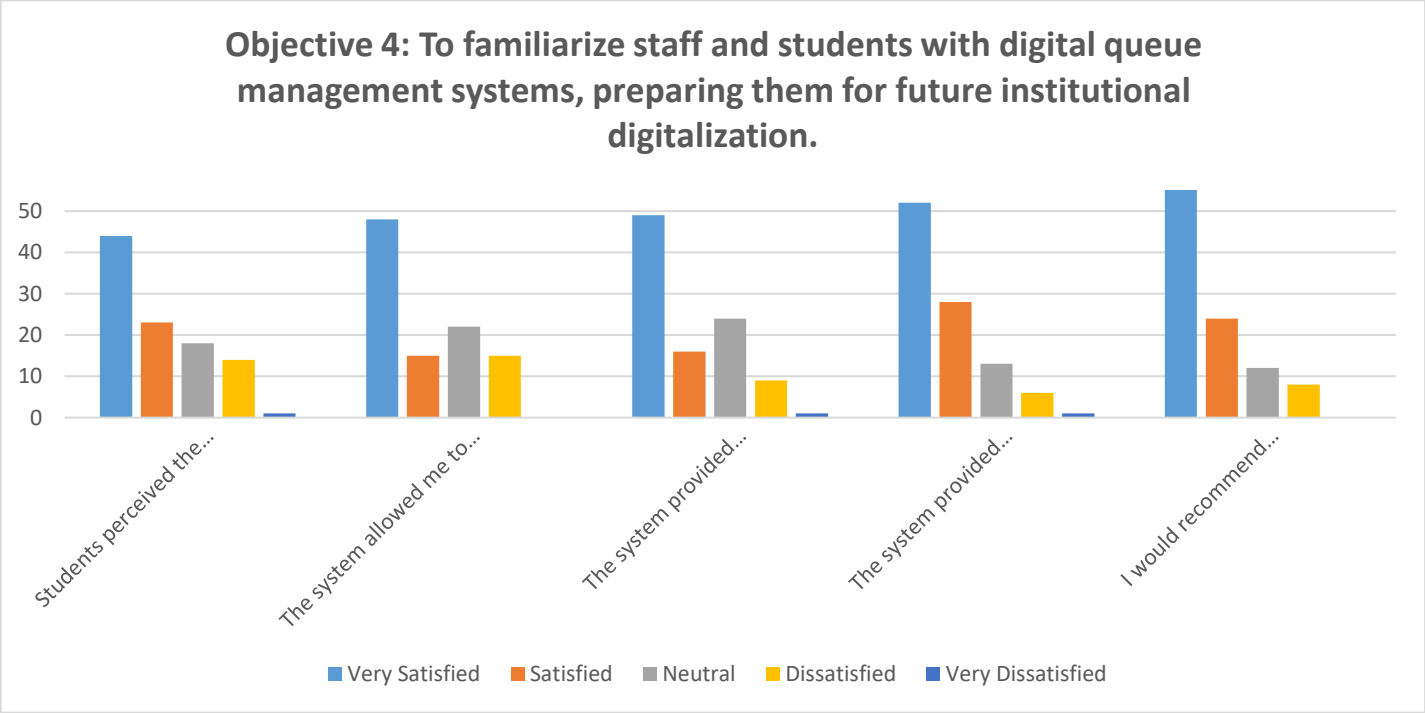


Table 4.4. Weighted Mean of Responses on the Effectiveness of the Smart Enrollment Queuing System in Familiarizing Staff and Students with Digital Queue Management Systems

Statement	Weighted Mean
Students perceived the demonstrated system as supportive of enrollment.	4.7

The system allowed me to adjust my queue position when necessary.	4.4
The system provided accessible and convenient options for Persons with Disabilities (PWDs) without disrupting the queue order.	4.3
The system provided useful feedback after each step.	4.5
I would recommend continuing the use of the smart queuing system in future enrollment periods.	4.8
Total	**4.54**

In **Table 4.4**, out of 100 Computer Science students who responded to the survey, the total weighted mean is 4.54, which indicates that the digital queue management system was perceived as very effective. This high score reflects that students strongly agreed the system supported enrollment, ensured fairness, reduced congestion, consistently followed the first-come-first-serve rule, and included prioritization features for PWDs. Overall, the results show that the system successfully familiarized staff and students with digital queue management, preparing the institution for future digitalization.



Summary of Findings

- The Smart Enrollment Queuing System reduced waiting times and minimized overcrowding.
- Real time tracking features (virtual tickets, screen displays) improved clarity and reduced stress.
- Workflow organization was enhanced, with clearer instructions and fewer overlapping steps.
- Students perceived the system as supportive, fair, and inclusive, with readiness for future digitalization.
- Overall, the system met expectations for efficiency, fairness, and improved workflow.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was conducted to develop and evaluate a Smart Enrollment Queuing System for St. Clare College of Caloocan. The system was designed as a staff-operated assistive tool to minimize queues, provide real-time updates, improve workflow organization, and prepare staff for future digitalization.

A post-survey was conducted among 100 Computer Science students after a mock test demonstration of the system. Results showed strong agreement that the system reduced waiting times, minimized overcrowding, clarified instructions, and improved workflow organization. Students also perceived the system as supportive, fair, and inclusive, with readiness for future institutional digitalization.

Overall, the findings confirm that the Smart Enrollment Queuing System achieved its objectives and indirectly enhanced student service efficiency.

Conclusions

Based on the findings of the study, the following conclusions were drawn:

- The Smart Enrollment Queuing System effectively assisted enrollment staff in minimizing queues and overcrowding, thereby reducing student stress.
- Real time tracking features such as virtual tickets and screen-based displays provided clarity and reduced uncertainty during enrollment.
- Workflow organization was improved, with clearer instructions and fewer overlapping steps, resulting in smoother enrollment procedures.
- Students recognized the system as a modern, fair, and supportive tool, which prepares staff for future institutional digitalization.
- The system met expectations for efficiency, fairness, and improved workflow, validating its role as a supplementary mechanism for enrollment service efficiency.

Recommendations

In light of the study's findings and conclusions, the following recommendations are proposed:

- **For Students** – Students should utilize the Smart Enrollment Queuing System properly and provide feedback to help improve its effectiveness and convenience during enrollment.
- **For Staff** – Enrollment staff should adopt and maximize the use of the system to improve queue management, reduce delays, and enhance service efficiency.
- **For the School** – The institution should support the deployment and continuous improvement of the system, including providing resources, maintenance, and possible integration with existing enrollment processes.
- **For Future Researchers** – Future researchers may expand the study by testing the system with a larger population, exploring additional features, or evaluating its effectiveness in other institutional settings.

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APPENDICES

Appendix A. Data Flow Diagram (DFD)

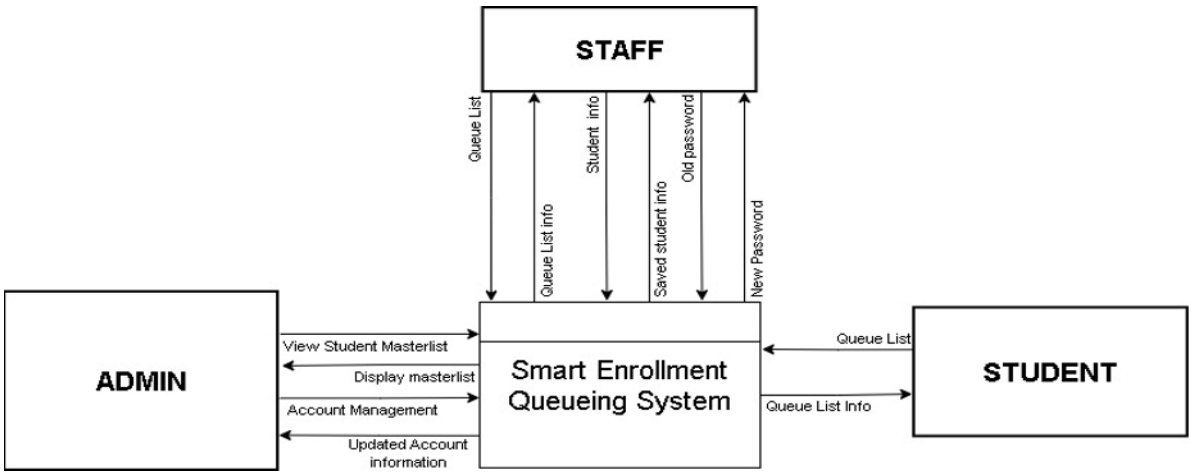

Figure. *DFD - Context Diagram*

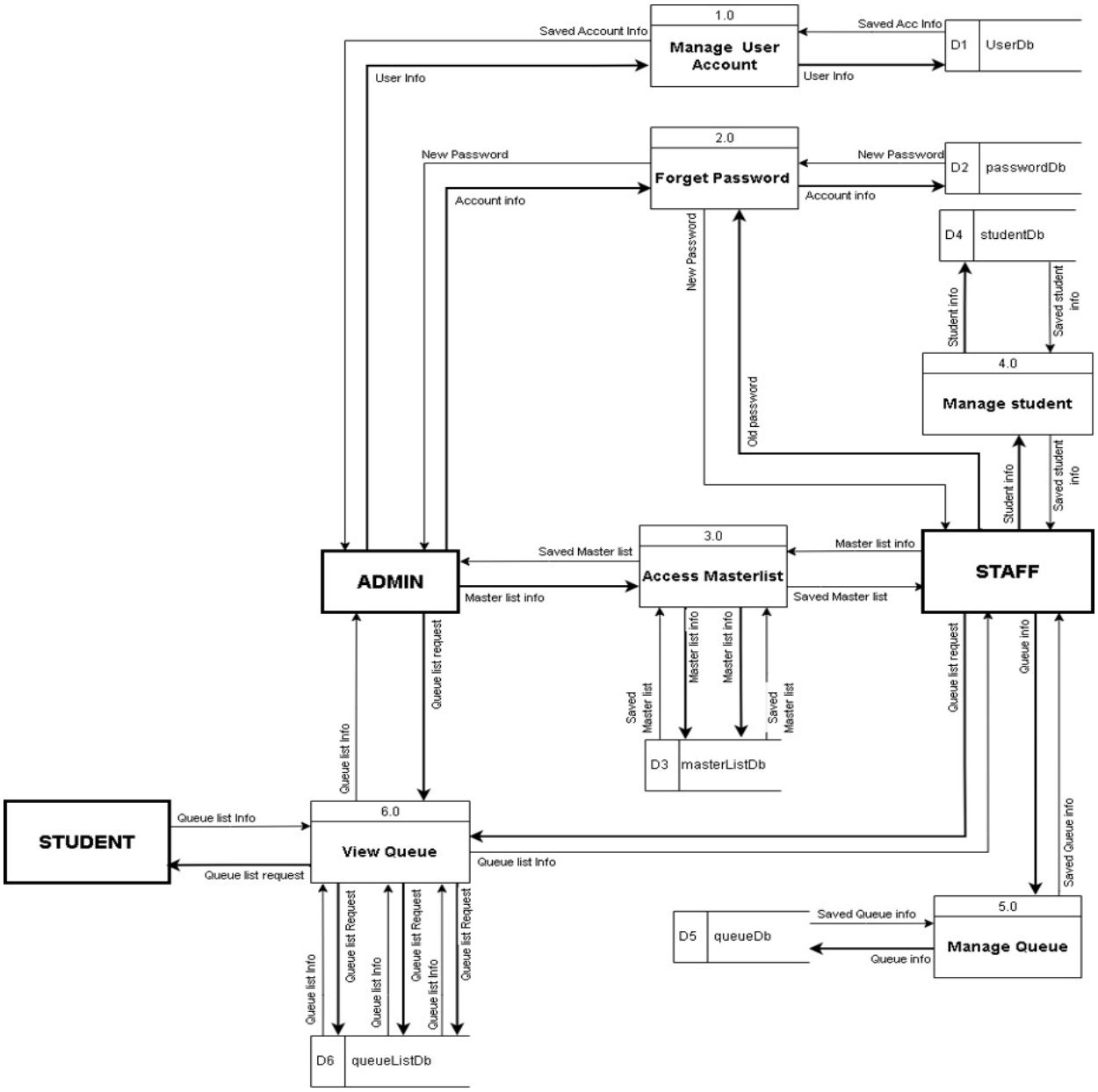

Figure. *DFD – Exploded Diagram*

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Appendix B. Entity Relationship Diagram

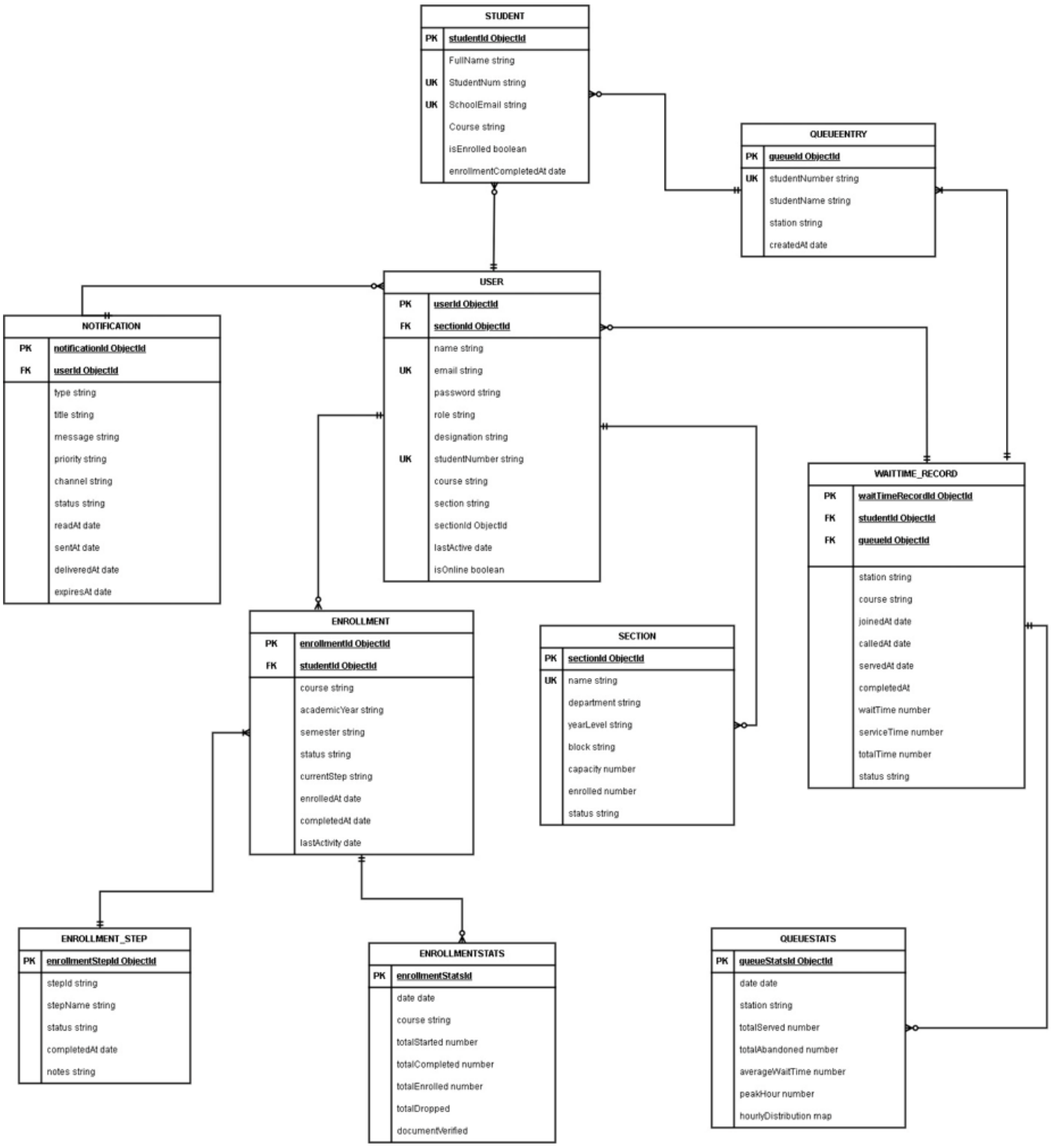

Figure. *Entity Relationship Diagram*

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Appendix C. Program Flowcharts

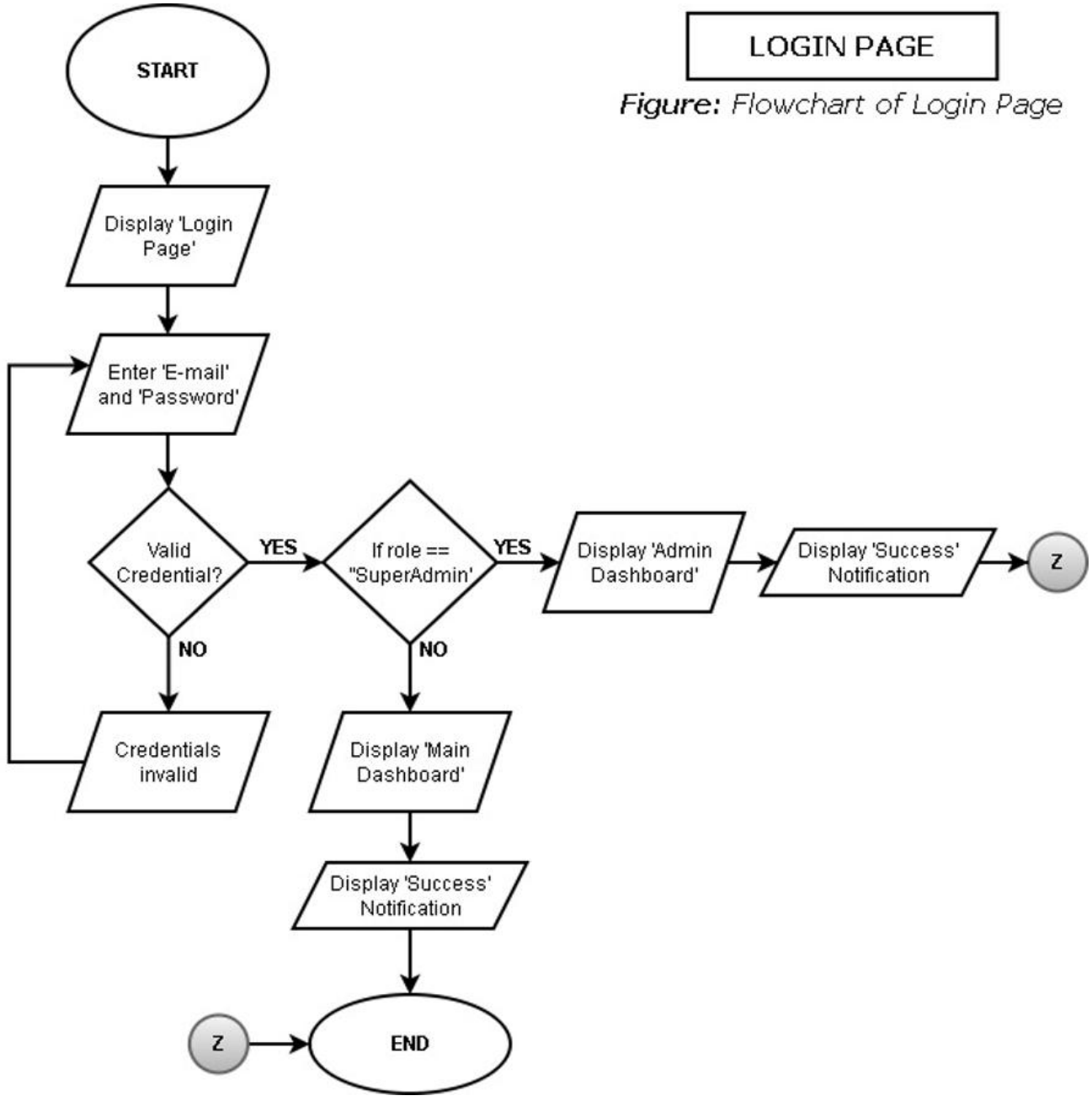

Figure: Flowchart of Login Page

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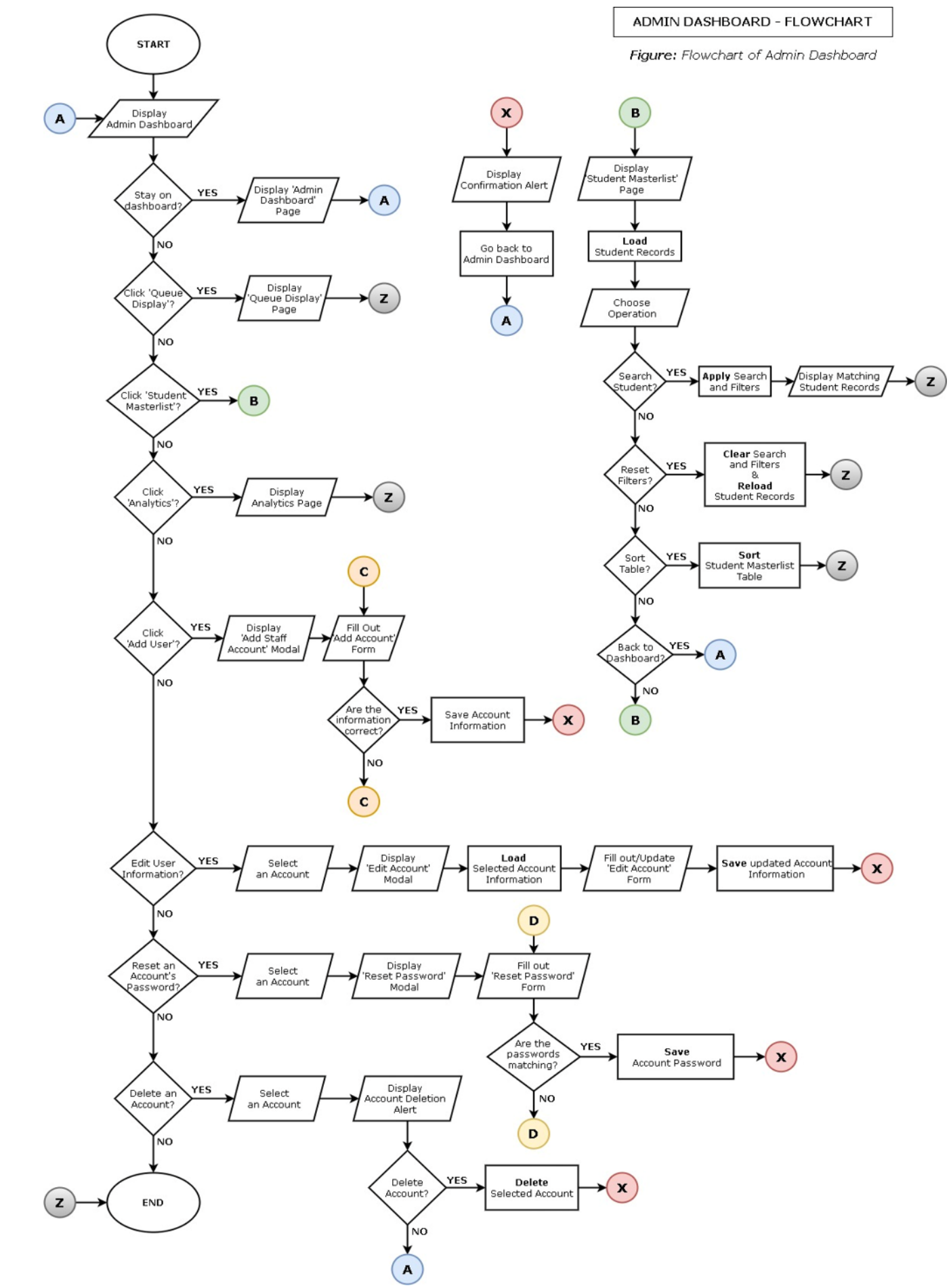

Figure: Flowchart of Admin Dashboard

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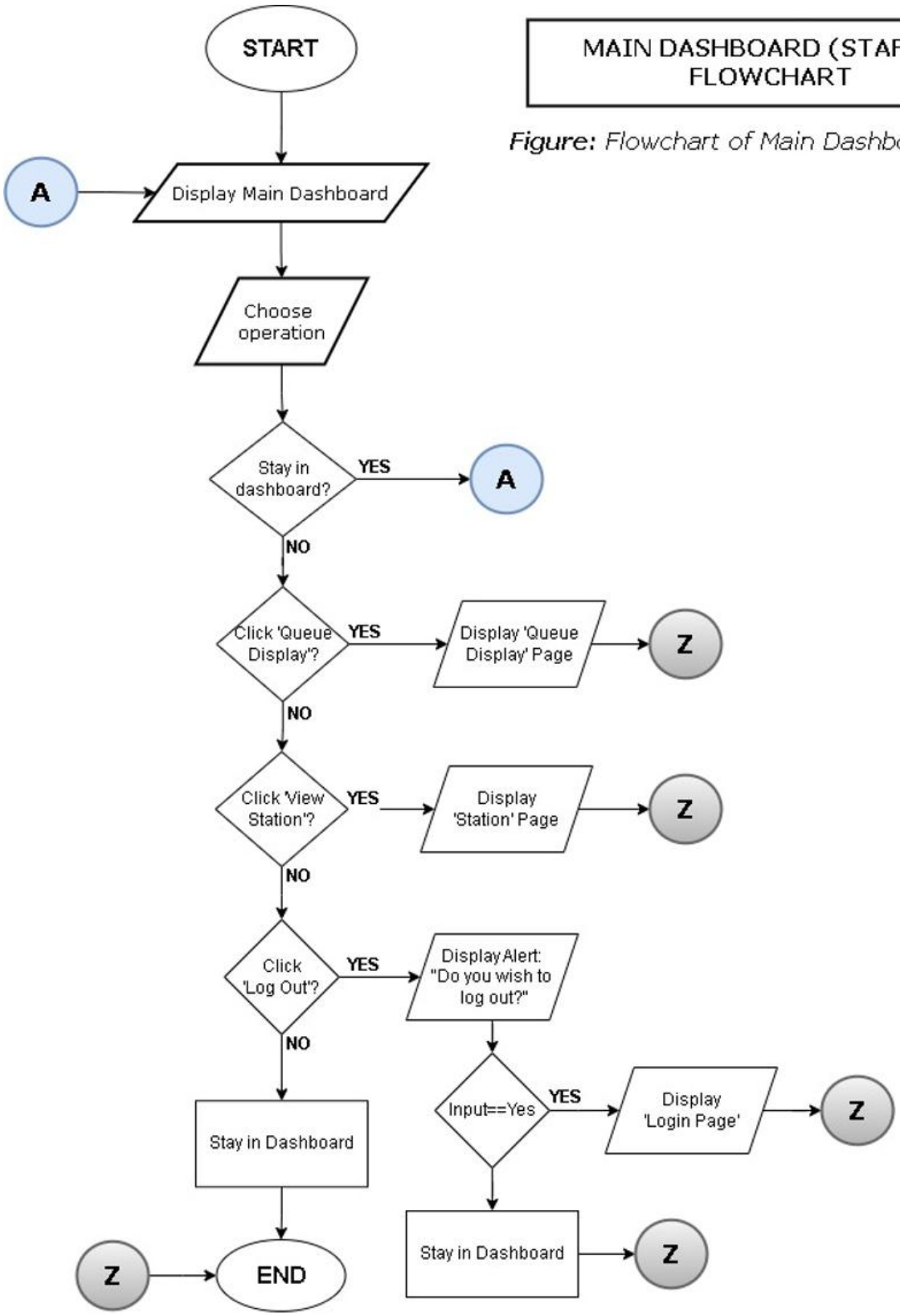

Figure: Flowchart of Main Dashboard (Staff)

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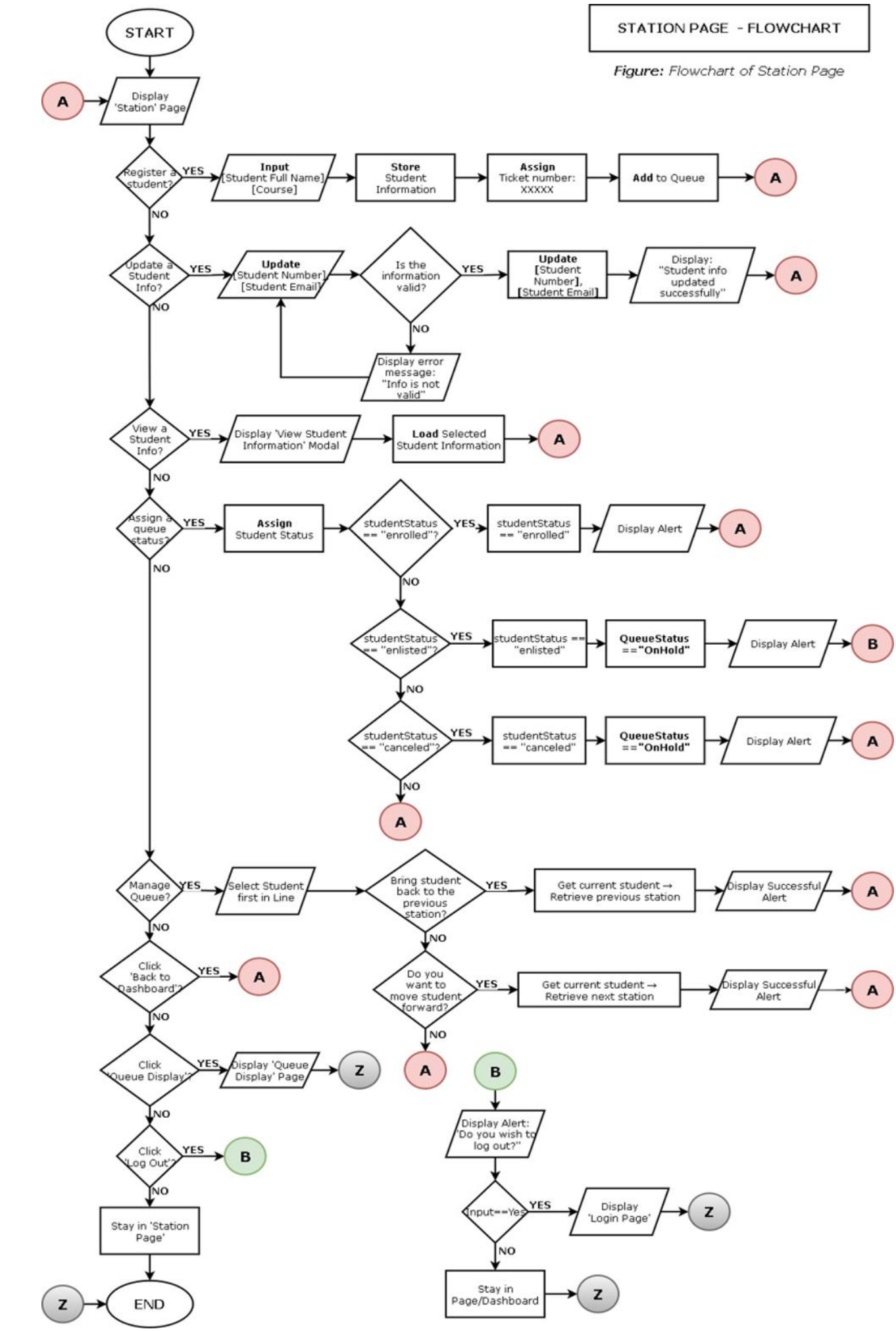

Figure: Flowchart of Station Page

Appendix D. VTOC Diagram

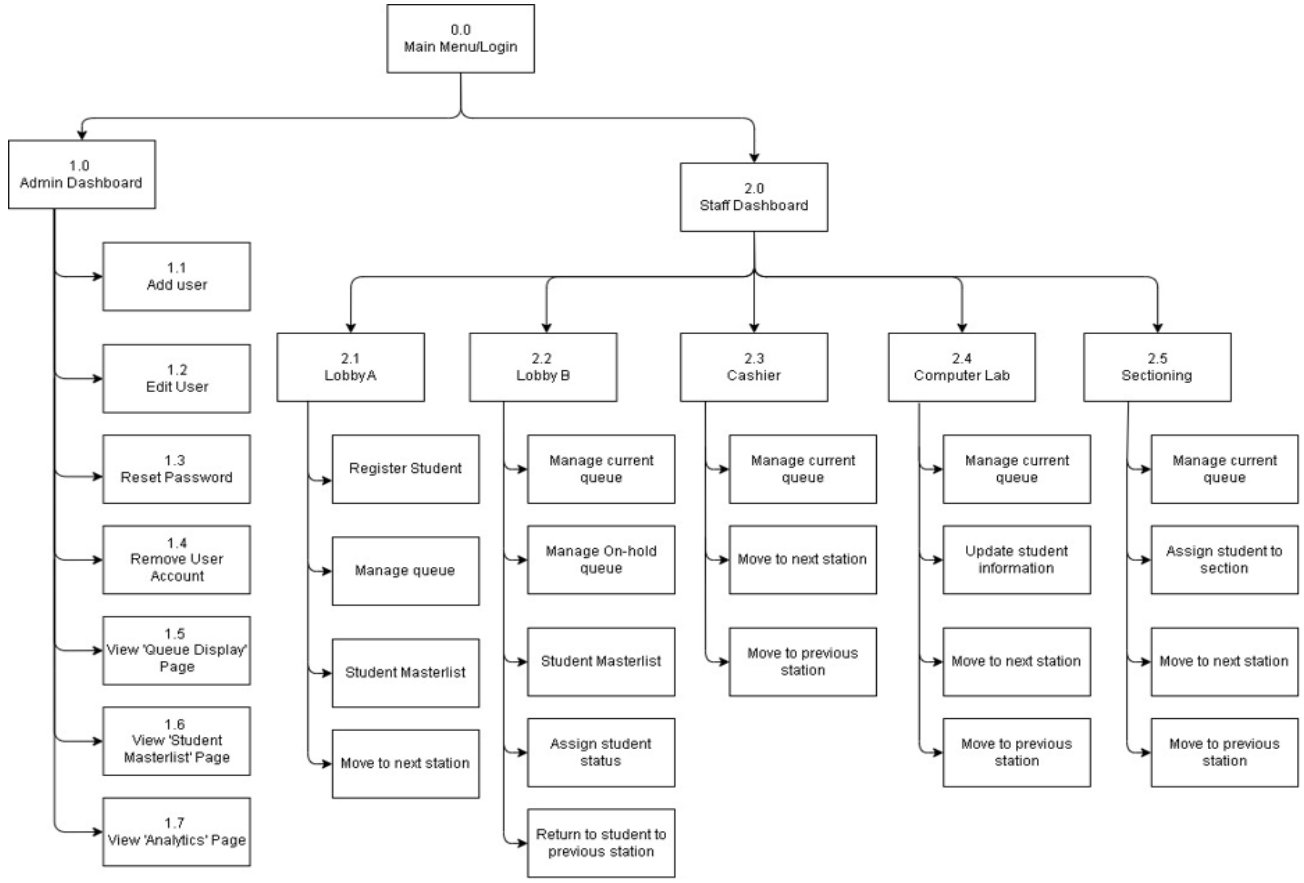

Figure. *VTOC Diagram*

Appendix E. IPO Diagram

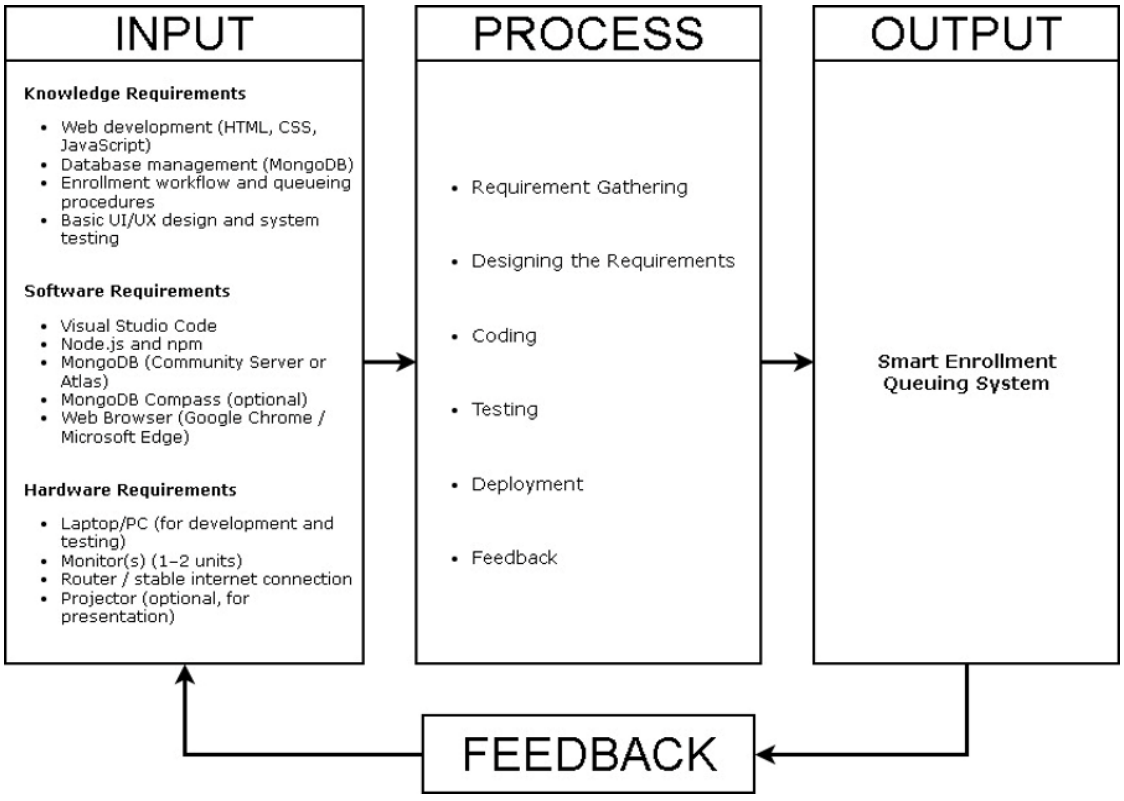

Figure. *IPO Diagram*

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Appendix F. Sample Screen Outputs

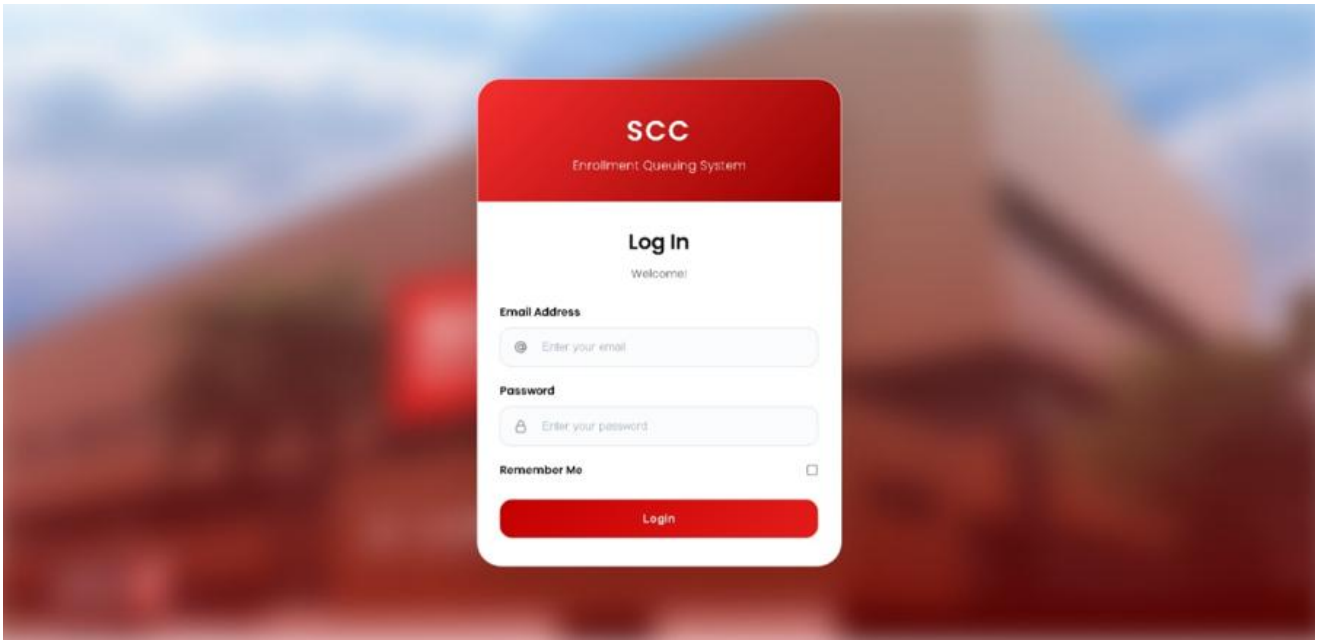
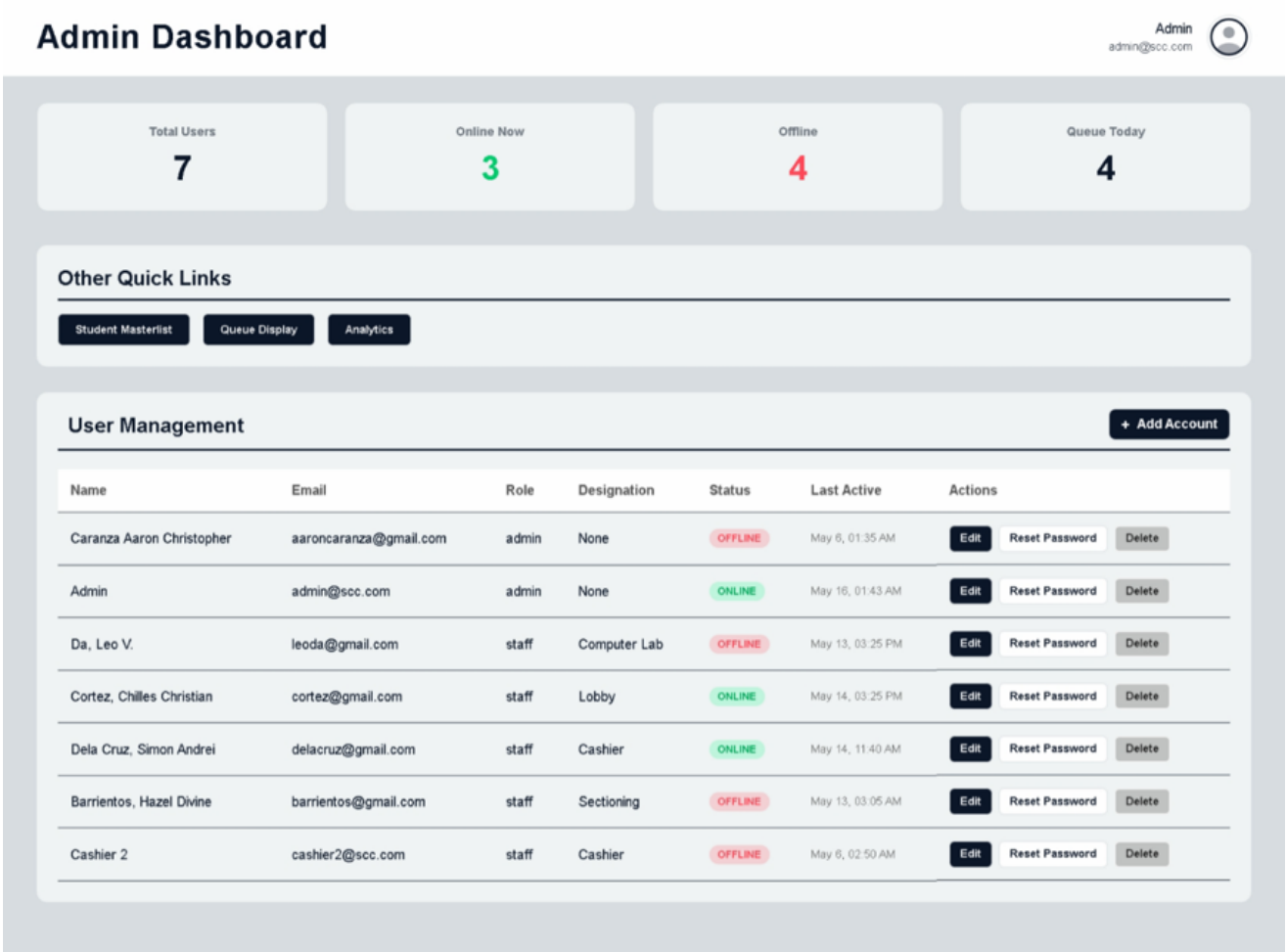


Figure. *Login Form*

Figure. *Admin Dashboard*



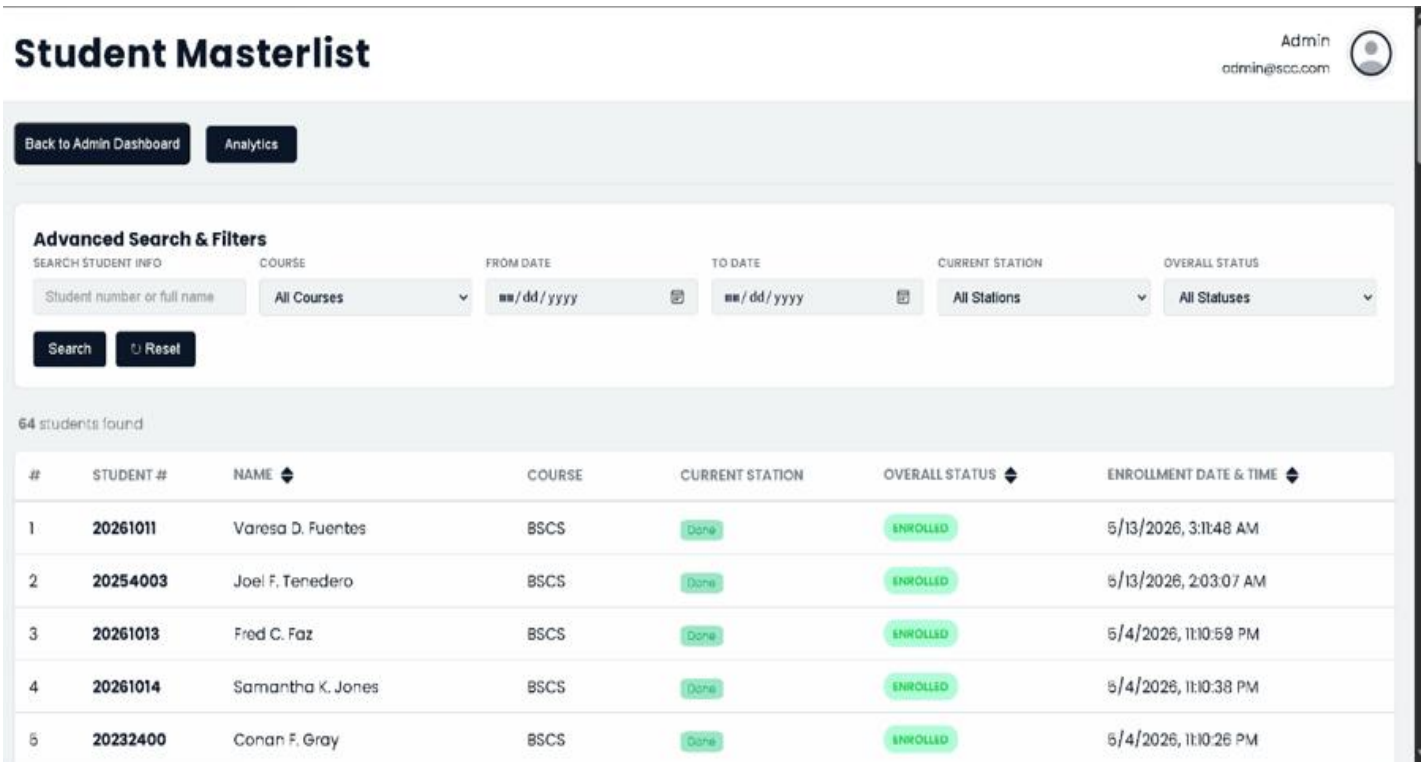


Figure. *Admin - Student Masterlist Page*

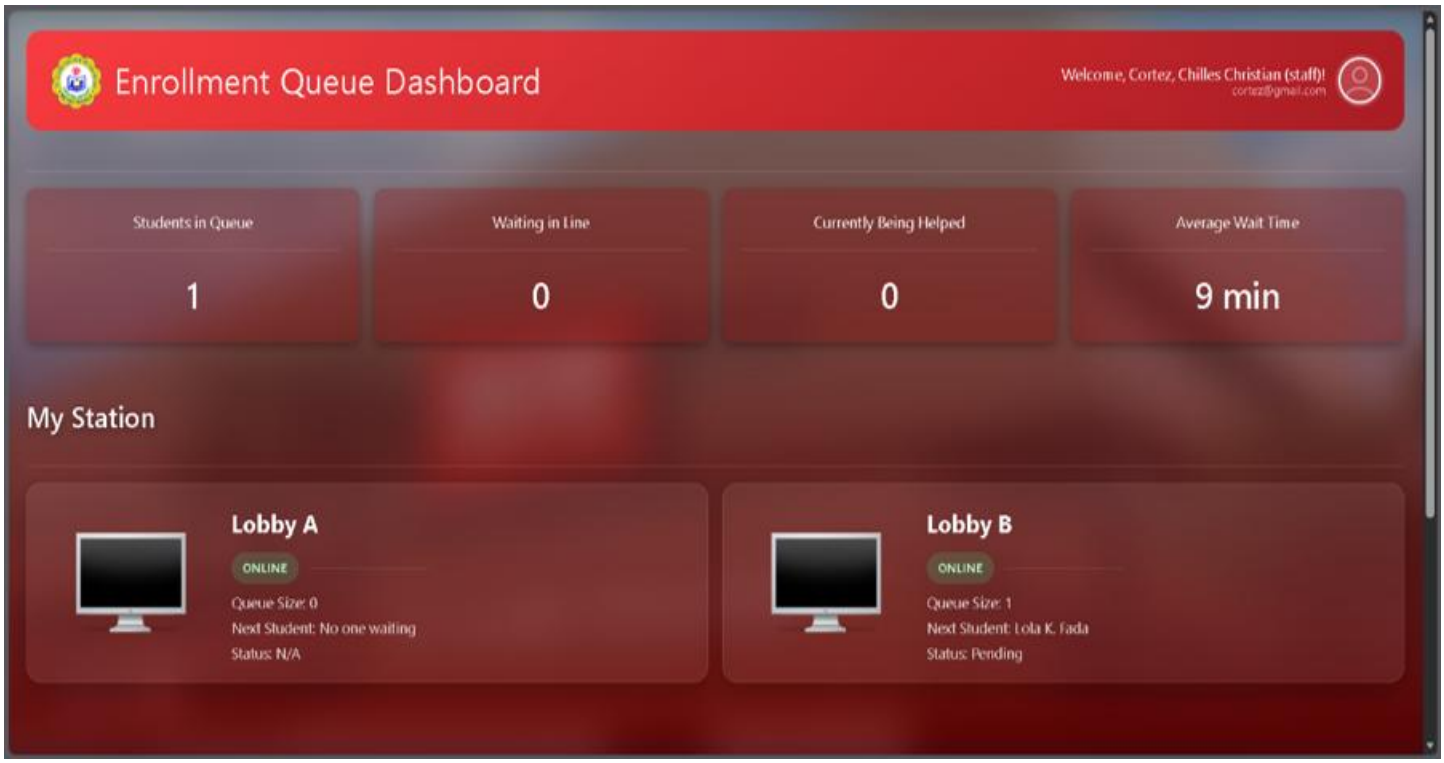


Figure. *Staff - Main Dashboard*

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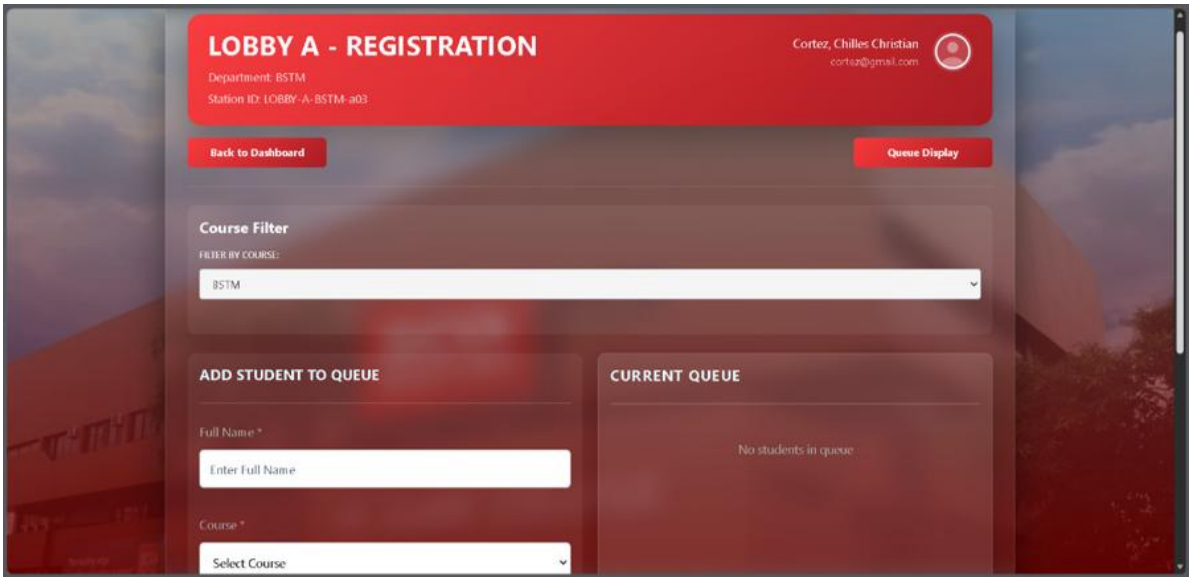

Figure. *Station: Lobby A - Registration*

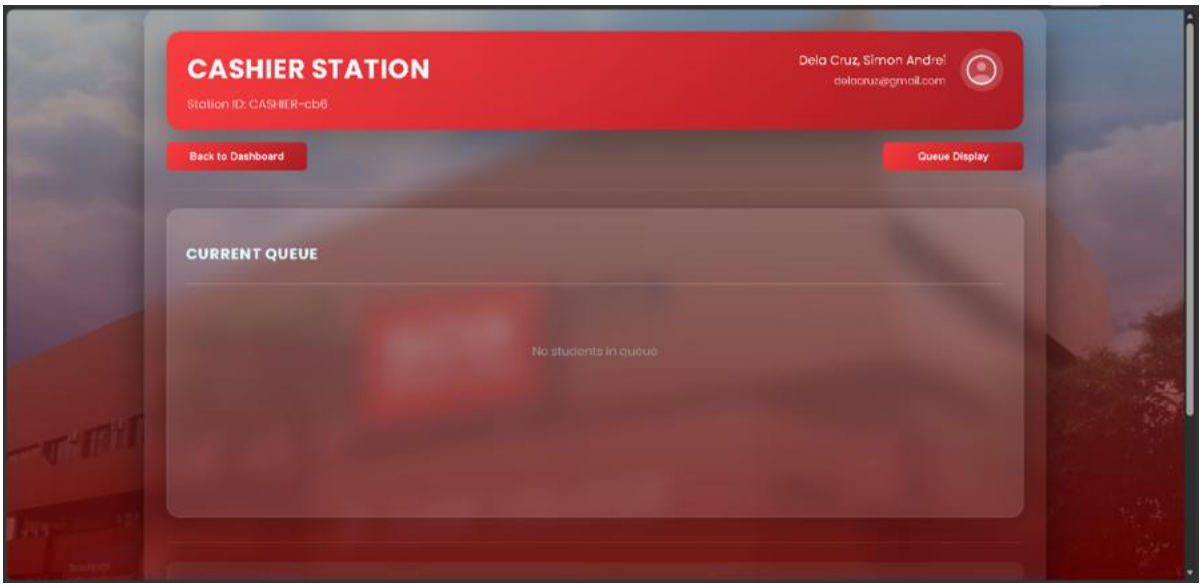

Figure. *Station: Cashier Page*

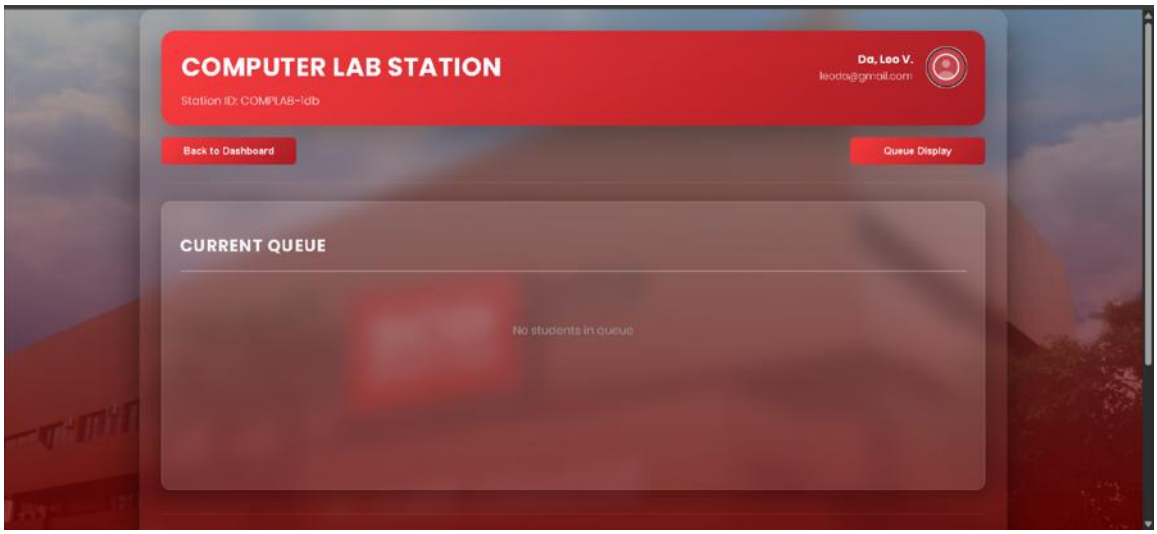

Figure. *Station: Computer Lab Page*

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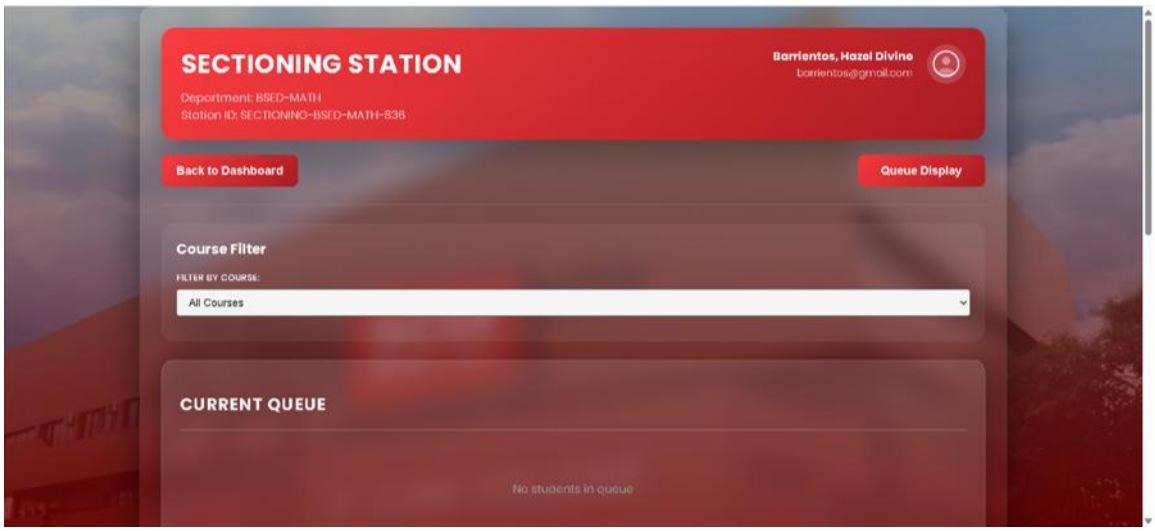


Figure. *Station: Sectioning Page*

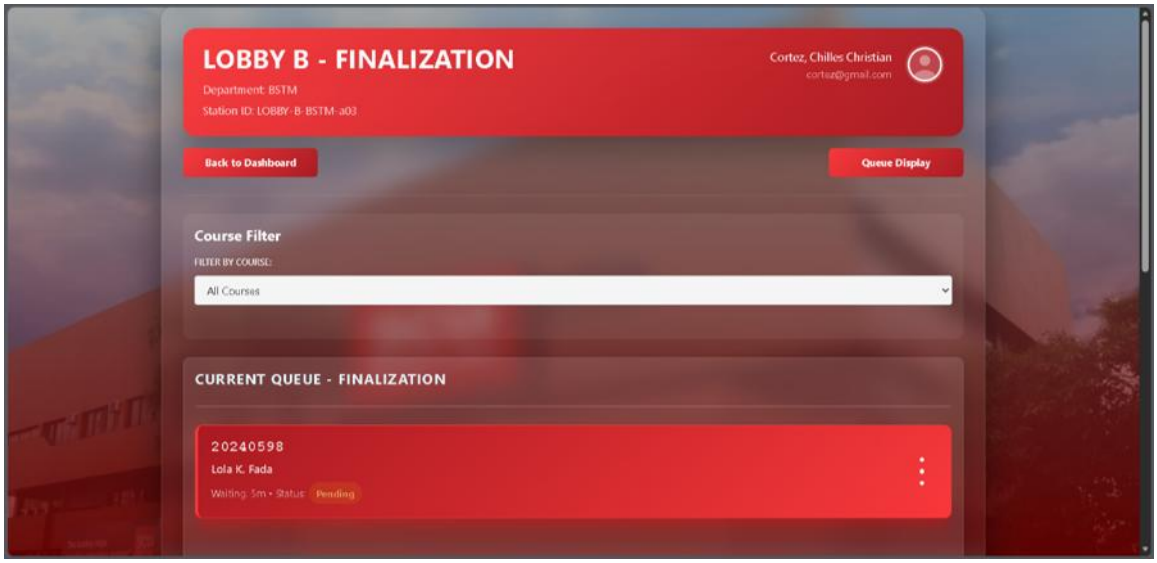
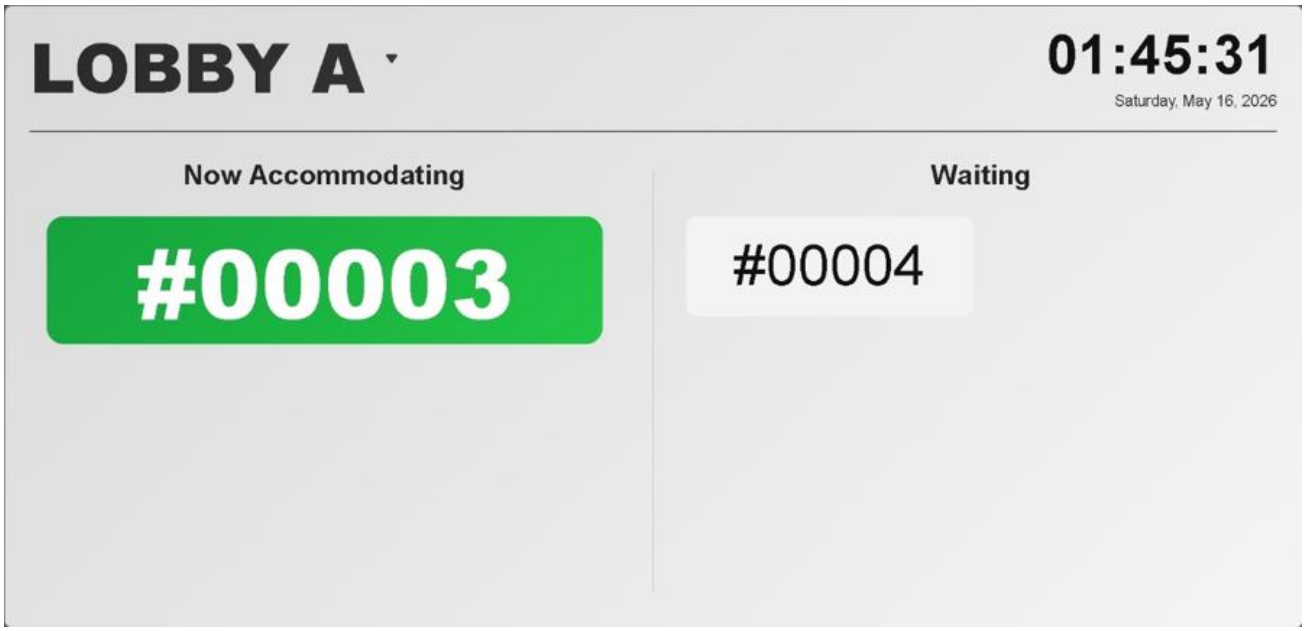


Figure. *Station: Lobby B – Finalization*



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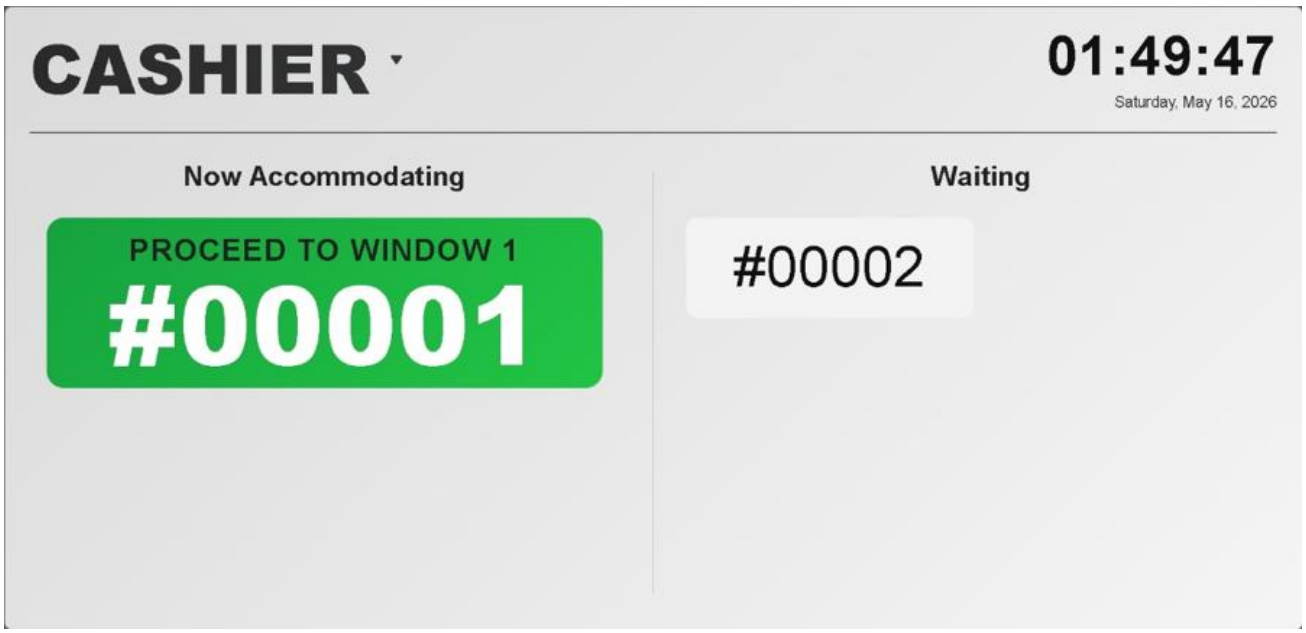

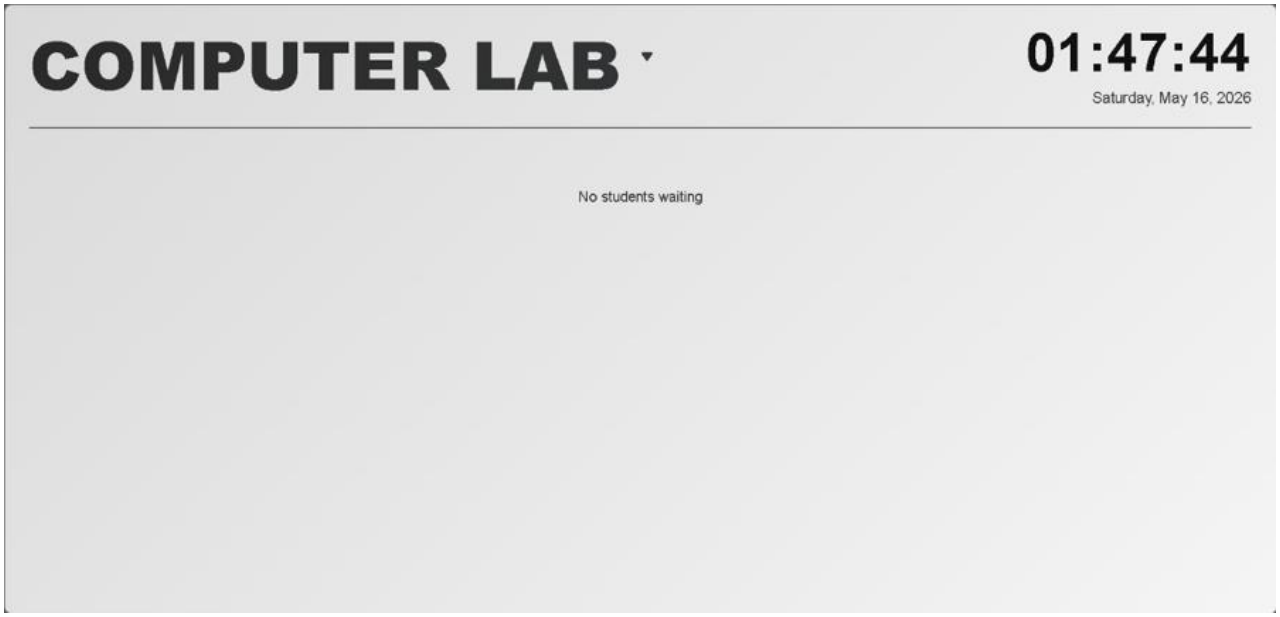

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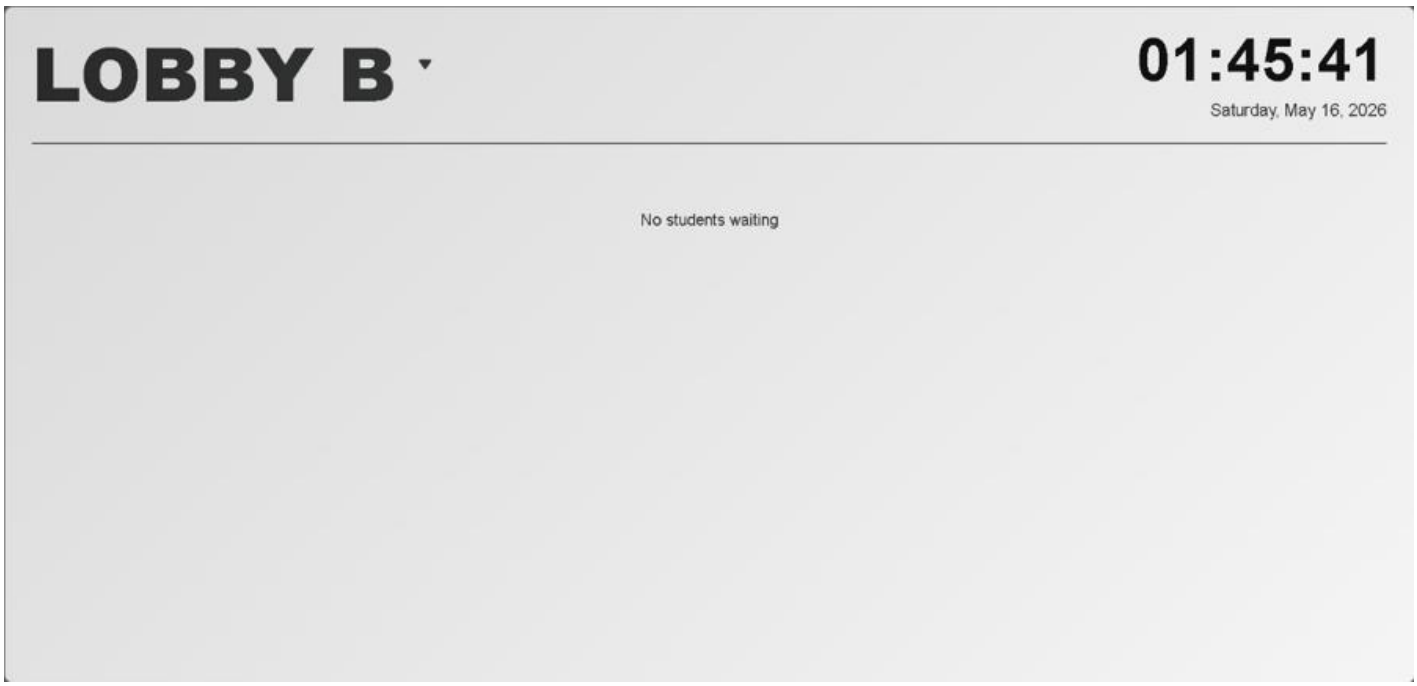

Figure. *Queue Display Page –*

Lobby A. Cashier, Computer Lab, Sectioning, and Lobby B

Appendix G. User's Manual for the Smart Enrollment Queuing System of St. Clare College of Caloocan

1. System Overview

The Smart Enrollment Queuing System is a staff-operated digital system designed to organize student flow during enrollment. It provides virtual queue numbers, real-time tracking, staff-side queue management, and administrative controls to improve service efficiency and reduce delays.

2. User Roles

The system has two user roles: Admin and Staff. The Admin manages user accounts and student records, while the Staff operates the assigned station panels and queue management functions.

3. Main System Modules

The system consists of the following modules:

3.1 Login Panel
3.2 Main Dashboard Panel
3.3 Station Panels
3.4 Queue Display Panel
3.5 Admin Dashboard
3.6 Student Masterlist

3.7 Queue Analytics

4. Login Procedure

To access the system, the user enters valid login credentials in the Login Panel. If the credentials are correct, the user is redirected to the appropriate dashboard. Invalid credentials prompt an error message.

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5. Main Dashboard

The Main Dashboard allows the user to view assigned stations, open station panels, access the queue display, and log out of the system.

6. Station Operations

The station panels are used to process students through the enrollment flow. These include Lobby A, Cashier, Computer Lab, Sectioning, and Lobby B. Staff can register students, manage current queues, update student information, move students to the next or previous station, and assign enrollment status when necessary.

7. Queue Display

The Queue Display Panel is used to monitor and present the current queue per station. It helps staff and students track queue progress in real time.

8. Admin Functions

The Admin Dashboard provides functions for adding accounts, editing user accounts, resetting passwords, removing user accounts, viewing the queue display, and accessing the student masterlist.

9. Student Masterlist

The Student Masterlist contains student records across all stations. It supports searching, filtering, record viewing, and status monitoring.

10. Queue Analytics

The Queue Analytics module provides a summary of queue-related data during the enrollment process. It allows authorized users to view important information such as the number of students served, queue activity per station, student status, and overall enrollment flow performance. This module helps the admin monitor system efficiency, identify stations with high queue volume, and evaluate how students move through each enrollment station. The data shown in Queue Analytics can support decision-making, improve queue management, and help reduce delays during enrollment operations.

11. Proper Use of the System

Only authorized users are allowed to access the system. All data entered must be accurate and complete to ensure proper queue processing and record management. The system should be used only for enrollment-related operations.

12. Basic Troubleshooting

If the system does not respond properly, the user should verify the entered data, check the selected module, and refresh the page if necessary. Invalid login credentials, incomplete records, and unsaved updates should be corrected before proceeding.

13. Logout Procedure

To end the session, the user must select the logout option from the dashboard. This ensures the security of the system and prevents unauthorized access.

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Appendix H. Evaluation Results

Table 4.1. Weighted Mean of Responses on the Effectiveness of the Smart Enrollment Queuing system in Minimizing Long Queues and Overcrowding

Statement	Weighted Mean
I experienced shorter waiting times compared to the manual process.	4.6
The smart queuing system reduced confusion and made the process clearer.	4.5
I found the enrollment process less stressful when using the system.	4.5
The system helped me manage my time better during enrollment.	4.4
The system minimized overcrowding in enrollment areas.	4.4
I felt more confident completing enrollment with the system's guidance.	4.5
The step-by-step queuing process was easier to follow than the manual method.	4.6
Overall, the smart queuing system improved my enrollment experience.	4.7
The smart queuing system made the enrollment process faster.	4.6
Total	**4.56**

Table 4.2. Weighted Mean of Responses on the Effectiveness of the Smart Enrollment Queuing system in Providing Real-Time Queue Tracking

Statement	Weighted Mean
I experienced shorter waiting times compared to the manual process.	4.6
The smart queuing system reduced confusion and made the process clearer.	4.5
I found the enrollment process less stressful when using the system.	4.5
The system helped me manage my time better during enrollment.	4.4
The system minimized overcrowding in enrollment areas.	4.4
I felt more confident completing enrollment with the system's guidance.	4.5
The step-by-step queuing process was easier to follow than the manual method.	4.6
Overall, the smart queuing system improved my enrollment experience.	4.7
The smart queuing system made the enrollment process faster.	4.6
Total	**4.56**

Table 4.3. Weighted Mean of Responses on the Effectiveness of the Smart Enrollment Queuing System in Improving Workflow Organization

Statement	Weighted Mean
The system ensured fairness in queue management.	4.5
The system helped organize the flow of students more smoothly.	4.6
Instructions provided through the system were clear and easy to understand.	4.5
The system reduced overlapping procedures and delays.	4.4
The enrollment environment felt more organized with the system.	4.5
The system improved clarity in the enrollment process.	4.5

Overall, the smart queuing system met my expectations for efficiency.	4.6
Limiting the number of students per station reduced congestion.	4.4
The system followed the first-come-first-serve rule consistently.	4.6
Total	**4.51**

Table 4.4. Weighted Mean of Responses on the Effectiveness of the Smart Enrollment Queuing System in Familiarizing Staff and Students with Digital Queue Management Systems

Statement	Weighted Mean
The system ensured fairness in queue management.	4.5
The system helped organize the flow of students more smoothly.	4.6
Instructions provided through the system were clear and easy to understand.	4.5
The system reduced overlapping procedures and delays.	4.4
The enrollment environment felt more organized with the system.	4.5
The system improved clarity in the enrollment process.	4.5
Overall, the smart queuing system met my expectations for efficiency.	4.6
Limiting the number of students per station reduced congestion.	4.4
The system followed the first-come-first-serve rule consistently.	4.6
Total	**4.51**

Appendix I. Cost-Benefit Analysis

Cost

For a school enrollment queuing system using WiFi connectivity, multiple display monitors, and a centralized server PC, the cost becomes more flexible and potentially lower due to the use of existing staff laptops. The system will require 6–7 display monitors (₱6,000–₱10,000 each, totaling around ₱48,000–₱70,000) to show queue numbers across different areas. A dedicated server PC (₱20,000) will handle queue management, data processing, and system coordination. Since staff may use their own laptops, the need for new workstations is optional; however, if desktops are provided, allocating ₱20,000–₱25,000 per unit for 4–5 stations would add ₱80,000–₱125,000.

The system will rely on a stable Wi-Fi network setup, including routers and access points, costing approximately ₱8,000–₱15,000 depending on coverage and reliability requirements. Overall, the estimated initial investment ranges from ₱50,000 to ₱100,000.

Benefit

This WiFi-enabled enrollment queuing system offers strong practical benefits in a school environment, especially during high-volume enrollment periods. By distributing 6–7 monitors, students can easily track queue progress from multiple locations, reducing crowding and confusion in hallways and offices. The use of a centralized server PC ensures real-time synchronization across all displays and service points, improving coordination and minimizing errors such as skipped or duplicated queue numbers.

Allowing staff to use their own laptops will significantly lower hardware costs while maintaining operational flexibility. The system improves overall efficiency and flow, as students are guided clearly through each step of the enrollment process, leading to shorter waiting times and a more organized process. It also enhances staff productivity, since personnel can focus on assisting enrollees instead of manually managing lines.

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In the long term, the system can support data collection and reporting, helping administrators identify peak hours, optimize staffing, and improve future enrollment planning. These operational improvements and time savings can offset the initial investment, making the system a cost-effective solution for managing large student populations.

Summary Chart (Estimated Costs)

Component	**Estimated Cost (PHP)**
6 - 7 display monitors	₱48,000 – ₱70,000
Server PC	₱20,000
Optional Desktops (4 - 5)	₱80,000 – ₱125,000
WiFi Network Setup	₱8,000 – ₱15,000
Total (Laptop-based)	**₱76,000 – ₱105,000**
Total (With Desktops)	**₱156,000 – ₱230,000**