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Faculty of Engineering and Natural Sciences

LGS Tracking Application (Final)

Prepared by

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Project Details

Project Title : LGS Tracking Application

University : Maltepe University

Department : Faculty of Engineering and Natural Sciences

Course : SE 374 01 Visual Programming

Instructor : Assoc. Prof. Dr. Emre ATLIER OLCA

Project Start Date : May 1, 2025

Submission Deadline Part (2) : May 27, 2025

Group Members

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1. Project Objective

The LGS Tracking Application serves as a comprehensive desktop solution designed to monitor and analyze student performance in High School Entrance Examination (LGS) practice tests. The primary objective centers around creating an efficient educational management system that facilitates both administrative oversight and individual student progress tracking.

This application addresses the growing need for systematic examination data management in educational institutions. By providing dual-interface functionality for administrators and students, the system ensures comprehensive coverage of examination lifecycle management - from initial data entry through detailed performance analysis and reporting.
The core objectives include:

- **Performance Monitoring**: Enable continuous tracking of student performance across multiple practice examinations
- **Data Management**: Provide secure, role-based access to examination data with appropriate permissions
- **Analytical Insights**: Deliver visual representations of performance trends through charts and graphical analysis
- **Administrative Efficiency**: Streamline the process of exam result entry through multiple input methods including manual entry, PDF import, and OCR technology
- **Student Empowerment**: Allow students to independently track their progress and add personal practice test results

The application specifically targets the Turkish education system's LGS examination structure, incorporating all six subject areas: Mathematics, Science, Turkish Language, History, Religious Studies, and English. This specialization ensures accurate representation of the actual examination format while providing meaningful analytics for educational decision-making.

2. User Roles and Permissions

The system implements a comprehensive role-based access control mechanism featuring two distinct user categories, each with carefully defined permissions and capabilities.

Administrative Users

Administrative personnel possess comprehensive system access, enabling full management of student data and examination records. Their permissions encompass:

Student Management Capabilities:

- Complete CRUD operations on student records (Create, Read, Update, Delete)
- Access to detailed student information including personal data, contact information, and academic history
- Bulk student data operations and management utilities

Examination Data Control:

- Authority to input examination results for all registered students
- Access to multiple data entry methods including manual input, PDF import functionality, and OCR-based data extraction
- Comprehensive viewing rights for all student examination histories and performance metrics

Advanced Features:

- Full access to reporting modules with PDF export capabilities
- System-wide analytics and performance visualization tools
- Chart generation for individual students or comparative analysis across multiple students

Student Users

Student accounts provide focused, personalized access to individual academic progress while maintaining appropriate privacy boundaries:

Personal Data Access:

- Individual examination history viewing with detailed subject-wise breakdown
- Personal performance analytics including trend analysis and progress tracking

- Customized dashboard experience with gender-based theming (blue for male students, pink for female students)

Self-Service Capabilities:

- Independent addition of personal practice test results
- Personal report generation and PDF export functionality
- Access to individual performance visualizations and charts

Restricted Operations:

- Limited to personal data only - no access to other students' information
- Cannot modify historical examination data entered by administrators
- No access to system administration features or bulk operations

This dual-role architecture ensures data security while providing appropriate functionality for each user type's specific needs and responsibilities within the educational framework.

3. User Login System

The authentication mechanism implements a robust, database-driven login system ensuring secure access control throughout the application lifecycle.

Authentication Architecture

The login system utilizes a centralized authentication service that validates user credentials against encrypted database records. The system maintains user sessions throughout the application lifecycle, ensuring consistent access control across all modules.

Database Integration: The authentication process interfaces directly with the Users table in the SQL Server database, which stores encrypted password hashes alongside user identification information. This approach eliminates plain-text password storage while maintaining efficient authentication performance.

Role-Based Redirection: Upon successful authentication, the system automatically determines user roles and redirects to appropriate interfaces:

- Administrative users receive access to the comprehensive AdminDashboardForm with full system capabilities
- Student users are directed to personalized StudentForm interfaces with role-appropriate functionality

Security Implementation

Password Security: The system implements industry-standard password hashing mechanisms, ensuring that user credentials remain protected even in the event of database compromise. Password validation occurs server-side with appropriate error handling for failed authentication attempts.

Session Management: Active user sessions maintain role information throughout the application lifecycle, eliminating the need for repeated authentication while ensuring that user permissions remain consistently enforced across all system interactions.

Access Control Enforcement: Each system module verifies user permissions before granting access to specific functionality. This approach ensures that role-based restrictions remain effective regardless of how users attempt to access system features.

The login interface provides clear feedback for authentication attempts, including appropriate error messages for invalid credentials while avoiding information disclosure that could facilitate unauthorized access attempts.

4. Practice Test Structure and Recording

The examination data model accurately reflects the structure of the Turkish LGS examination system, ensuring compatibility with actual test formats and enabling meaningful performance analysis.

Subject Area Configuration

The application manages six distinct subject areas, each with specific question allocation matching the actual LGS examination format:

Mathematical Sciences Section:

- Mathematics: 20 questions with comprehensive scoring and net calculation
- Science: 20 questions covering physics, chemistry, and biology content areas

Verbal Sciences Section:

- Turkish Language: 20 questions focusing on reading comprehension and language skills
- History and Social Studies: 10 questions covering Turkish history and Atatürk principles
- Religious Studies: 10 questions on religious culture and moral education

- English Language: 10 questions testing foreign language proficiency

Data Recording Mechanisms

The system provides multiple pathways for examination data entry, accommodating different operational requirements and technological capabilities:

Manual Data Entry: Administrative users can directly input examination results through structured forms that validate data accuracy and completeness. This method provides maximum flexibility for handling irregular data scenarios or when digital sources are unavailable.

PDF Import Functionality: Advanced PDF parsing capabilities enable automatic extraction of examination data from standardized test reports. The system utilizes iTextSharp library for reliable PDF text extraction, automatically parsing structured examination documents and populating database records with minimal manual intervention.

OCR Technology Integration: Optical Character Recognition functionality processes scanned examination sheets or printed reports, converting physical documents into digital data. The implementation incorporates Tesseract OCR engine with both English and Turkish language support, ensuring accurate text recognition across diverse document types.

Performance Calculation System

The application implements comprehensive performance metrics beyond simple scoring:

Net Score Calculation: For each subject area, the system calculates net scores using the standard formula: Net = Correct Answers - (Wrong Answers ÷ 4), providing accurate performance measurement aligned with actual examination scoring methods.

Aggregate Performance Metrics: Total examination scores aggregate individual subject performance while maintaining detailed subject-wise breakdowns for analytical purposes. This dual-level approach enables both overall performance assessment and targeted improvement identification.

5. Technologies Used

The application leverages a comprehensive technology stack designed to deliver robust performance, maintainability, and user experience across diverse operational requirements.

Core Development Framework

Microsoft .NET Framework with C#: The application utilizes C# programming language within the .NET Framework ecosystem, providing strong type safety, comprehensive error handling, and extensive library support. Windows Forms technology delivers native desktop application experience with optimal performance characteristics.

Windows Forms Architecture: The user interface implementation relies on Windows Forms controls, ensuring consistent behavior across Windows operating systems while providing familiar interaction patterns for end users. Custom control implementations extend standard functionality to meet specific application requirements.

Database Technology

Microsoft SQL Server: The data persistence layer utilizes SQL Server database management system, providing enterprise-grade reliability, transaction support, and scalability. Database connectivity occurs through ADO.NET SqlConnection classes, ensuring efficient data access with proper connection pooling and resource management.

Connection String Configuration: Database connection parameters are externalized through application configuration files, enabling deployment flexibility and environment-specific customization without code modifications.

Document Processing Libraries

PDF Processing - PdfSharp: Export functionality leverages PdfSharp library for generating professional PDF reports containing examination results, performance summaries, and analytical charts. This library provides comprehensive PDF creation capabilities with precise layout control and formatting options.

PDF Import - iTextSharp: PDF import functionality utilizes iTextSharp library for extracting text content from existing PDF documents. The system parses structured examination reports, automatically identifying and extracting relevant data fields for database insertion.

Optical Character Recognition

Tesseract OCR Engine: OCR functionality incorporates Tesseract open-source OCR engine, providing robust text recognition capabilities for processing scanned documents and printed examination sheets. The implementation includes both English and Turkish language models, ensuring accurate recognition across bilingual content.

Image Processing: Supporting image processing capabilities handle document preparation, noise reduction, and image enhancement to optimize OCR accuracy. The system automatically adjusts image parameters to improve text recognition reliability.

Data Visualization

Microsoft Chart Controls: Performance visualization utilizes Microsoft Chart Controls, providing comprehensive charting capabilities including line graphs, pie charts, and bar charts. These visualizations deliver intuitive performance trend analysis and comparative assessment tools.

Custom Chart Implementations: Specialized chart configurations provide educational-specific visualizations, including subject-wise performance breakdowns and temporal performance analysis aligned with examination cycle requirements.

Development Tools and Libraries

NuGet Package Management: The project incorporates various NuGet packages for extended functionality:

- System.Data.SqlClient for database connectivity
- Tesseract for OCR capabilities
- PdfSharp for PDF generation
- iTextSharp for PDF text extraction
- Microsoft Chart Controls for data visualization

This comprehensive technology stack ensures reliable application performance while providing extensibility for future enhancement requirements.

6. Application Interface

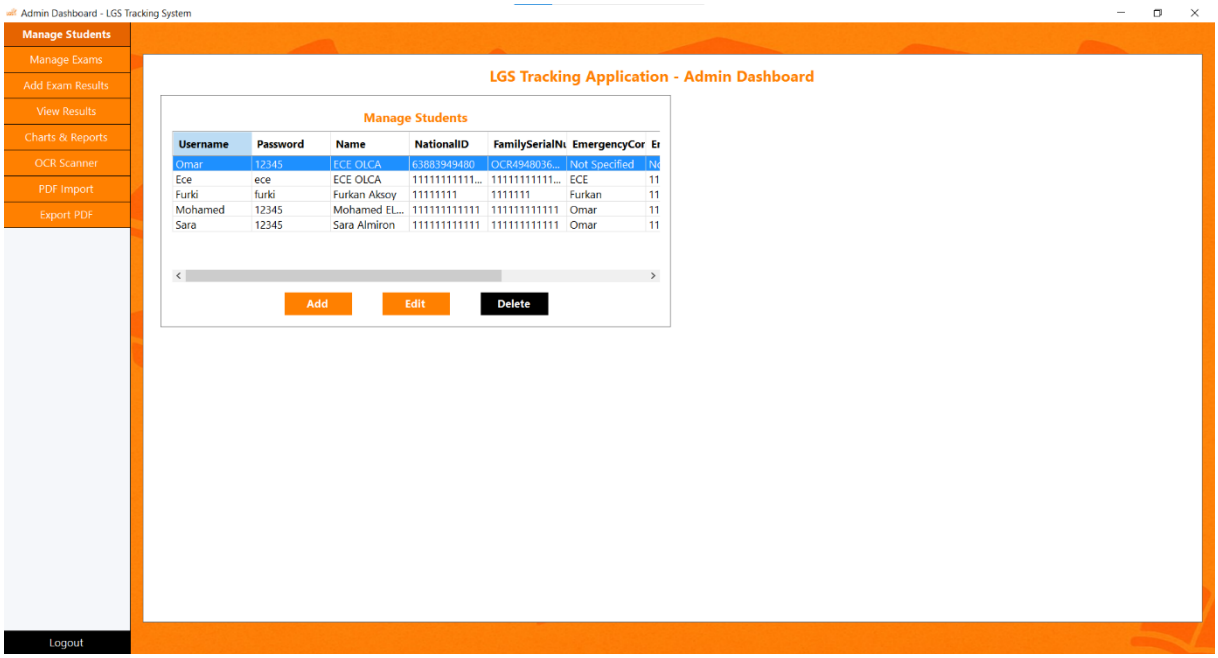
The user interface design emphasizes usability, accessibility, and role-appropriate functionality through carefully crafted visual design and interaction patterns.

Administrative Interface Design

The administrative dashboard provides comprehensive system access through an organized navigation structure that prioritizes frequently used functions while maintaining easy access to advanced features.

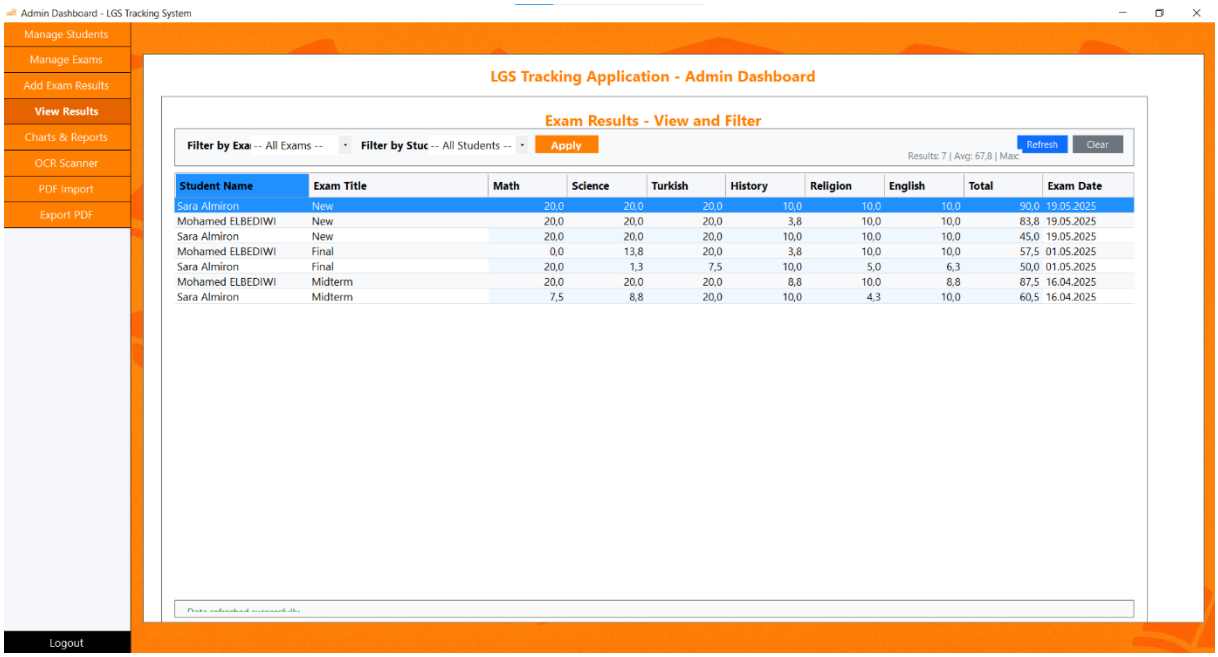
Navigation Architecture: The main administrative interface features a left-side navigation panel with clearly labeled sections for major system functions. Color-coded buttons utilize a consistent orange theme (RGB: 255, 128, 0) that provides visual continuity throughout the administrative experience. This warm orange color scheme creates a professional, institutional appearance suitable for administrative users while maintaining excellent readability and visual hierarchy.

Student Management Interface: The student management section displays comprehensive student information in a tabular format with integrated action buttons for adding, editing, and removing student records. The interface provides search and filtering capabilities to efficiently locate specific students within large datasets.



[Image: Admin Dashboard - Student Management Interface showing the student list with username, password, name, and other details in a tabular format with Add, Edit, and Delete buttons]

Examination Results Management: Results viewing and management utilize advanced filtering capabilities, allowing administrators to view results by student, examination, or date ranges. The interface provides statistical summaries including average scores and performance trends.



[Image: Admin Dashboard - Examination Results View showing filtered results with subject-wise scores, totals, and statistical summaries]

OCR Processing Interface: The OCR functionality features an intuitive workflow that guides users through image selection, processing, and result validation. The interface displays extracted text alongside structured data fields, enabling verification and correction before database commitment.

PDF Export Functionality: The PDF export interface provides comprehensive report generation capabilities with professional formatting. As demonstrated in the generated PDF reports, the system creates well-structured documents featuring:

- Professional header sections with application branding and generation timestamps
- Comprehensive examination result tables with color-coded headers using the system's blue theme
- Subject-wise score breakdowns (Math, Science, Turkish, History, Religion, English) with precise decimal formatting
- Statistical summaries including total examination count and average performance calculations
- Proper pagination and consistent formatting throughout multi-page reports
- Clean, readable layout suitable for academic and administrative purposes

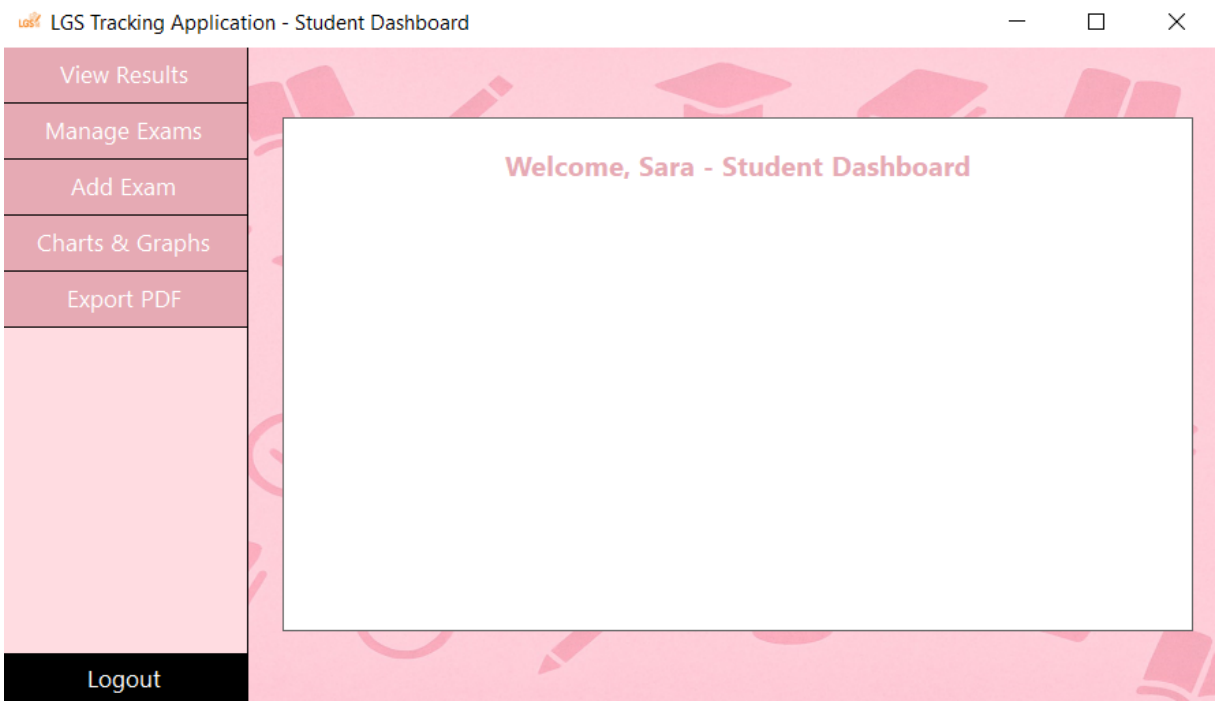
The PDF export feature maintains the same professional standards across both administrative and student-generated reports, ensuring consistency in document presentation regardless of the user role generating the report.

Student Interface Design

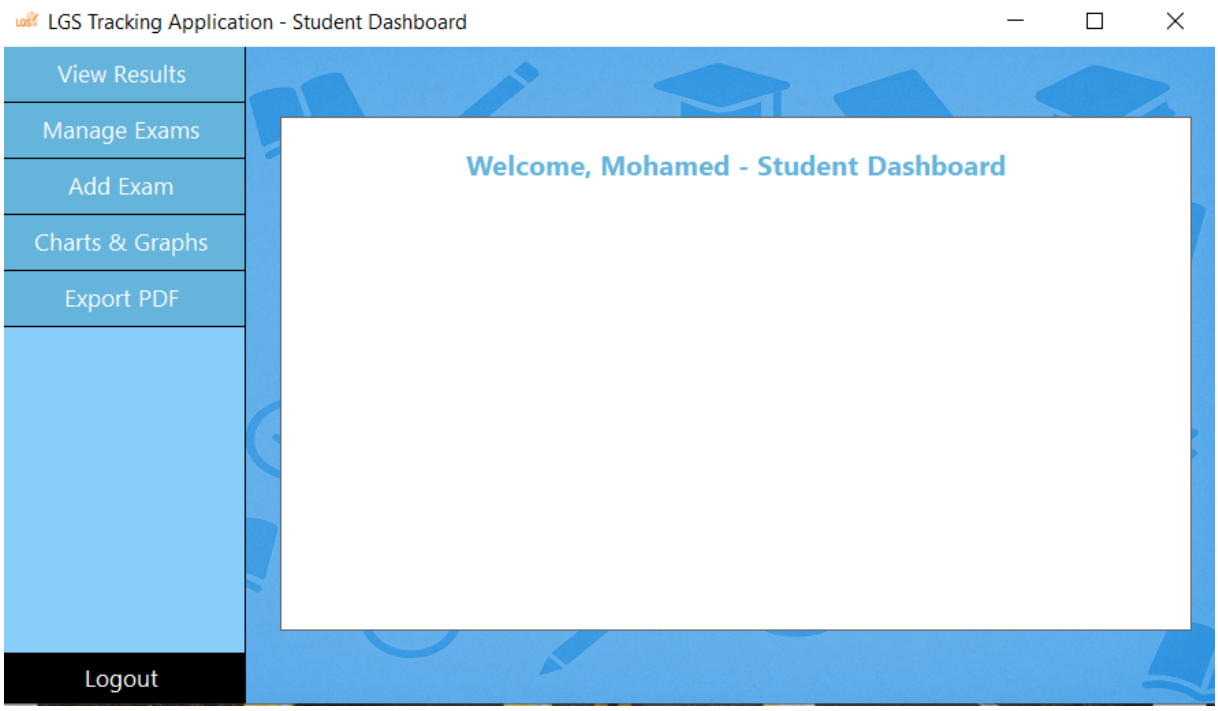
Student interfaces implement personalized theming that enhances user engagement while maintaining professional appearance standards.

Gender-Based Theming: The system automatically applies appropriate color schemes based on student gender information:

- Male students receive blue-themed interfaces (RGB: 135, 206, 250) with complementary darker shades for interactive elements
- Female students experience pink-themed interfaces (RGB: 255, 192, 203) maintaining the same interaction patterns with gender-appropriate coloring



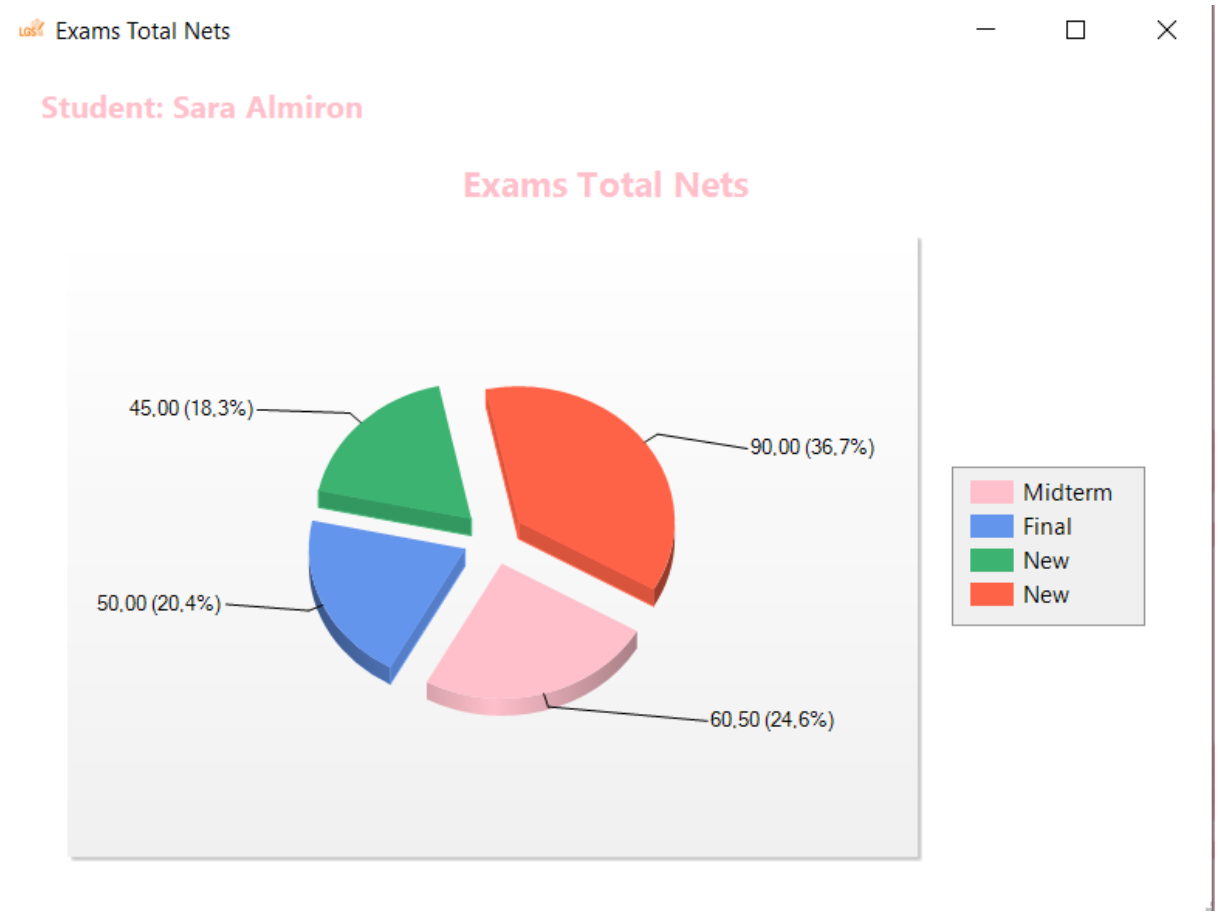
[Image: Female Student Dashboard showing pink-themed interface with "Welcome, Sara - Student Dashboard" and navigation menu]



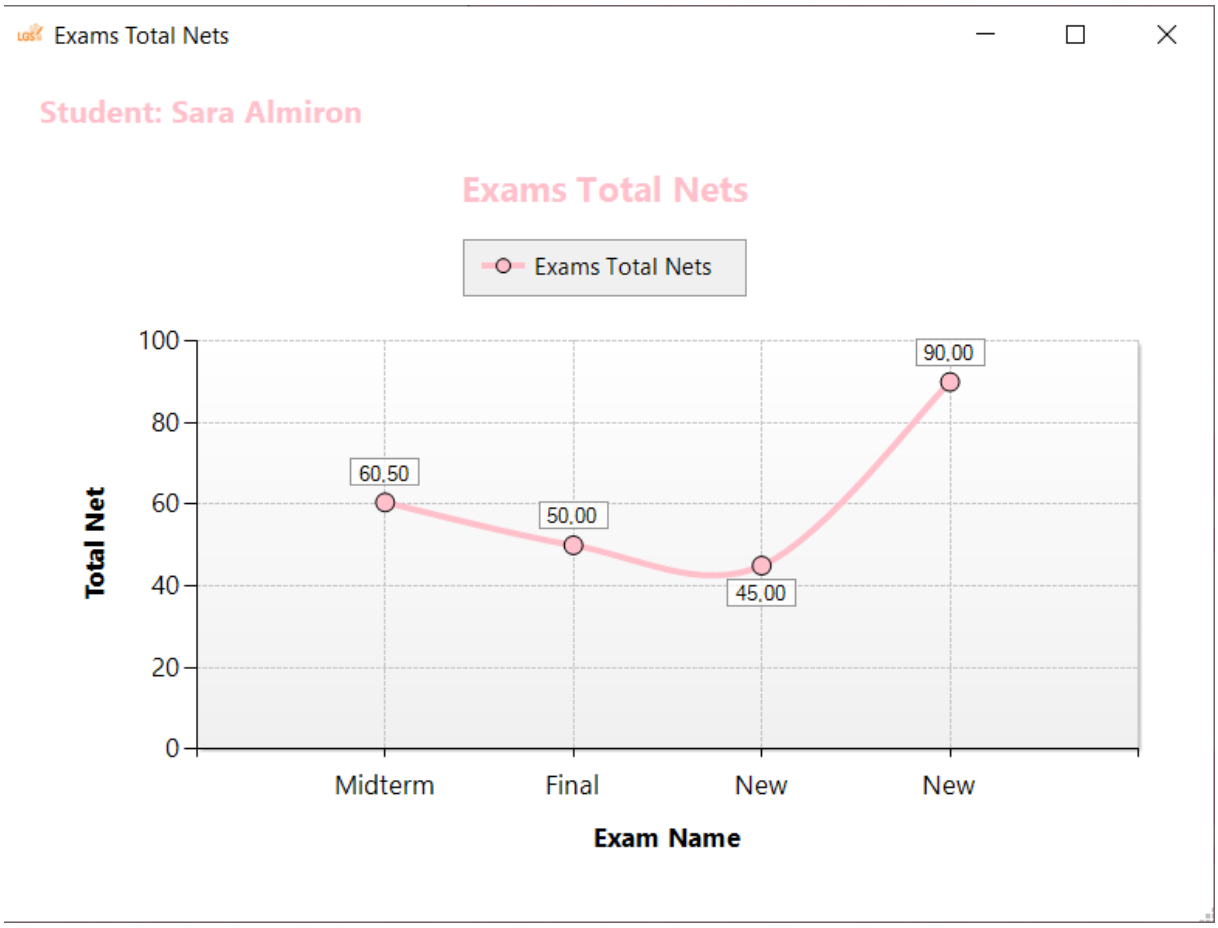
[Image: Male Student Dashboard displaying blue-themed interface with "Welcome, Mohamed - Student Dashboard" and consistent navigation structure]

Personal Dashboard: Student dashboards provide immediate access to personal examination history with visual performance indicators. The interface emphasizes recent examination results while providing easy navigation to historical data and trend analysis.

Results Visualization: Performance charts integrate seamlessly into the student interface, providing both tabular data display and graphical representations. Students can easily switch between different visualization modes to understand their performance patterns.



[Image: Pie Chart Visualization showing "Exams Total Nets" for Sara Almiron with percentage breakdowns for different examinations (Midterm, Final, New exams)]



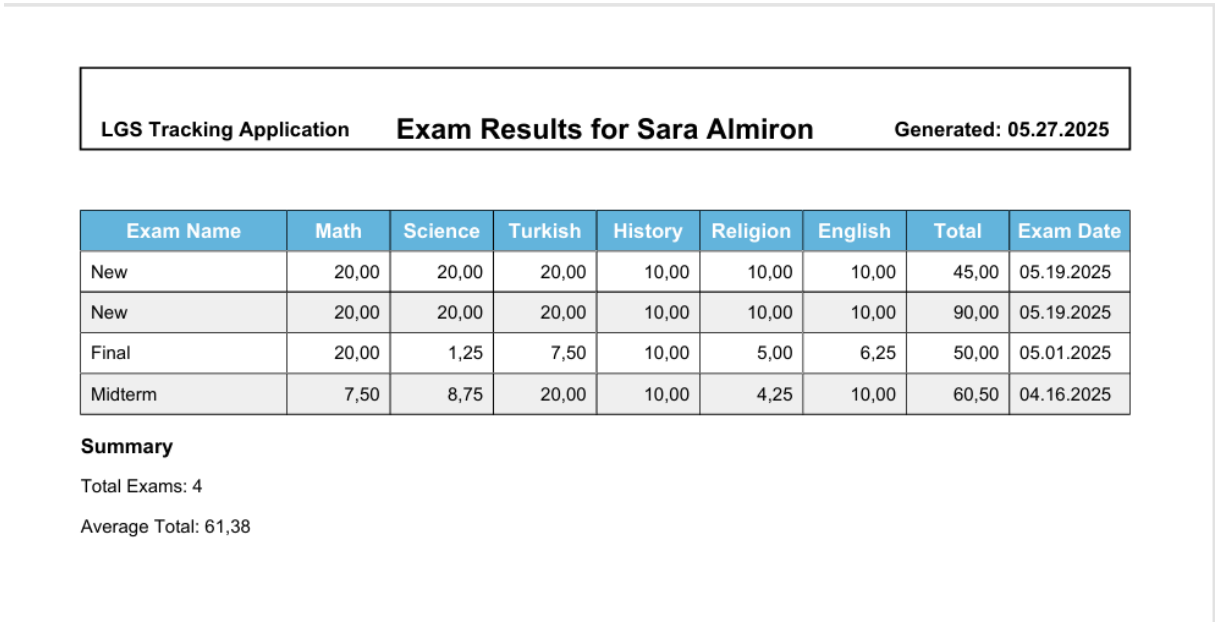
[Image: Line Chart Visualization displaying performance trends over time with clear data points and professional formatting]

Personal PDF Report Generation: One of the most valuable features for students is the ability to generate personalized PDF reports of their academic performance. This self-service capability empowers students to create professional documentation of their progress for sharing with parents, tutors, or educational advisors.

The student PDF export functionality includes:

- Personalized Report Headers: Each report is customized with the student's name and generation timestamp
- Comprehensive Performance Tables: Color-coded examination results showing all subject areas (Math, Science, Turkish, History, Religion, English) with precise scoring
- Statistical Analysis: Automatic calculation of total examinations taken and average performance metrics

- Professional Formatting: Clean, academic-standard layout suitable for educational documentation
- Historical Performance Tracking: Complete examination history with chronological organization
- Subject-Wise Breakdown: Detailed analysis of strengths and areas for improvement across all academic subjects



LGS Tracking Application **Exam Results for Sara Almiron** Generated: 05.27.2025

Exam Name	Math	Science	Turkish	History	Religion	English	Total	Exam Date
New	20,00	20,00	20,00	10,00	10,00	10,00	45,00	05.19.2025
New	20,00	20,00	20,00	10,00	10,00	10,00	90,00	05.19.2025
Final	20,00	1,25	7,50	10,00	5,00	6,25	50,00	05.01.2025
Midterm	7,50	8,75	20,00	10,00	4,25	10,00	60,50	04.16.2025

Summary

Total Exams: 4

Average Total: 61,38

[Image: Student-Generated PDF Report - Examination Results for Sara Almiron demonstrating professional formatting with comprehensive subject breakdowns, showing 4 total examinations with an average score of 61.38, highlighting the student's performance trajectory across different assessment periods]

Cross-Platform Interface Elements

Application Startup and Branding: The application features a professional startup screen that reinforces brand identity while providing user feedback during system initialization.

[Image: LGS Tracking Application Startup Screen showing orange-themed loading interface with version information and progress indicator]

Consistent Interaction Patterns: Both administrative and student interfaces maintain consistent interaction patterns for common operations such as data entry, navigation, and report generation. This consistency reduces learning time and improves overall user experience.

Responsive Layout Design: Interface layouts automatically adjust to different screen resolutions and window sizes, ensuring optimal usability across diverse hardware configurations commonly found in educational environments.

Accessibility Considerations: Color choices maintain sufficient contrast ratios for accessibility compliance, while font sizes and control spacing accommodate users with varying visual capabilities.

Database Structure Visualization: The underlying data architecture supports all interface functionality through a well-designed relational structure that ensures data integrity and efficient querying.

Additional Interface Screenshots and System Features

The LGS Tracking Application includes numerous additional interface components and features that demonstrate the comprehensive nature of the system

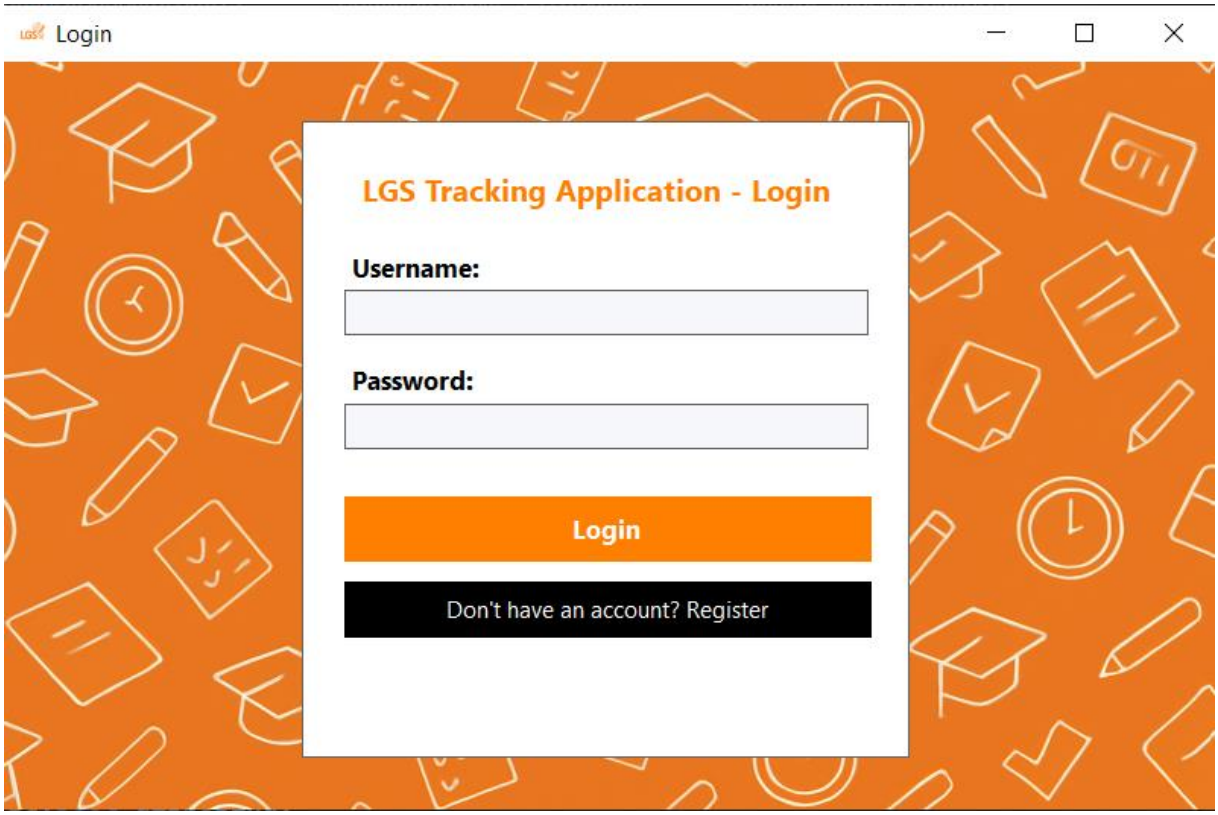
implementation. These supplementary interface elements showcase the attention to detail in user experience design and the extensive functionality provided across different user scenarios.

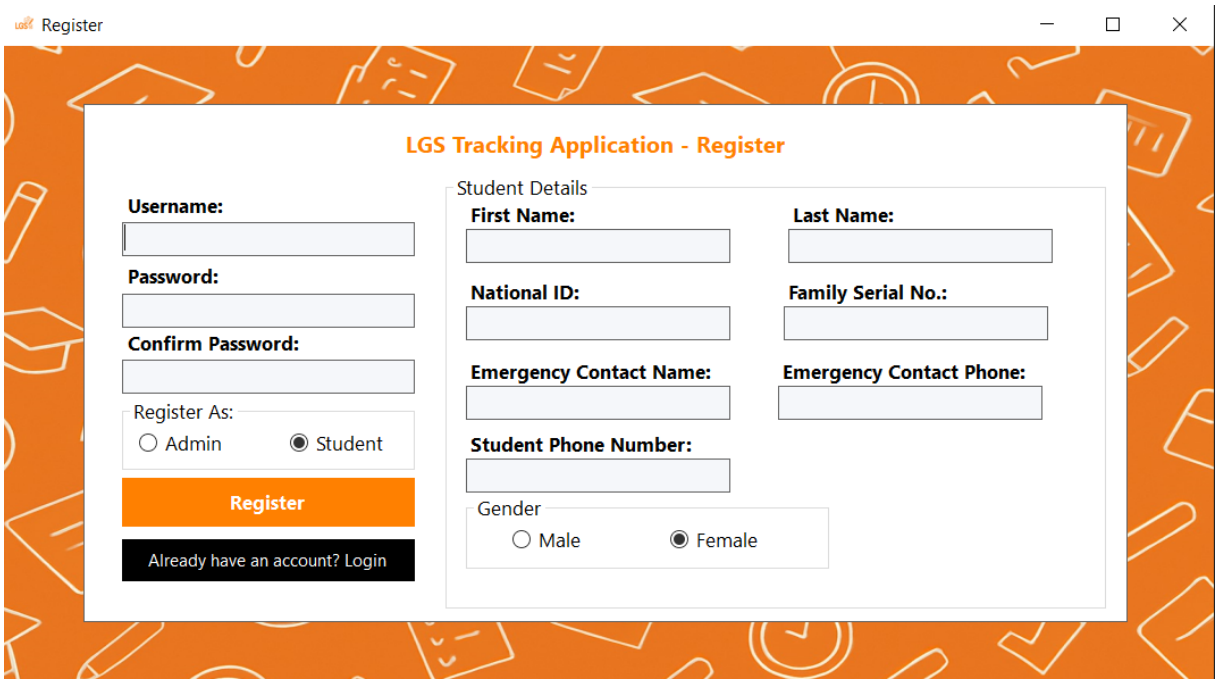
Additional Administrative Features: The system includes various specialized administrative interfaces for advanced system management, configuration options, and detailed data analysis tools. These interfaces maintain the consistent orange theme and professional layout standards established throughout the administrative experience.

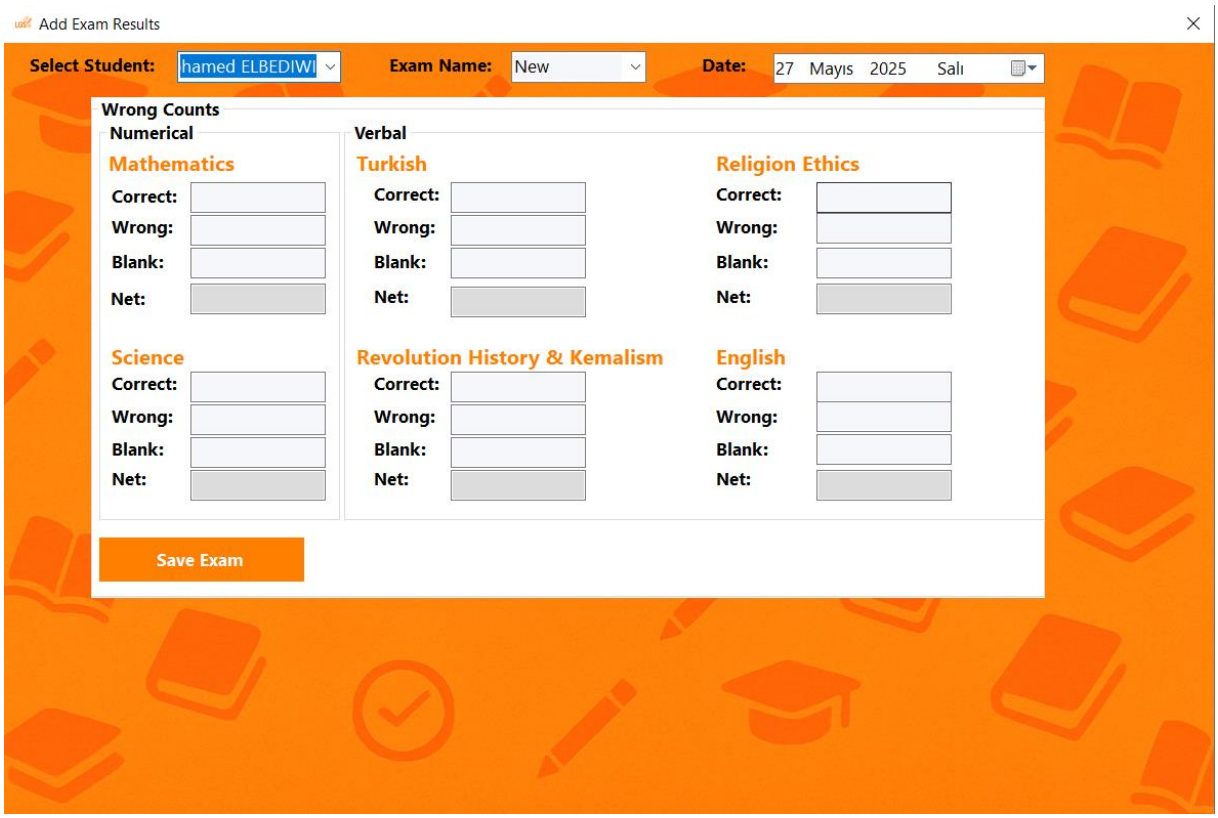
Extended Student Functionality: Student interfaces include additional self-service capabilities, personalized dashboard customizations, and extended visualization options that enhance the individual learning experience. These features demonstrate the system's commitment to student engagement and academic progress transparency.

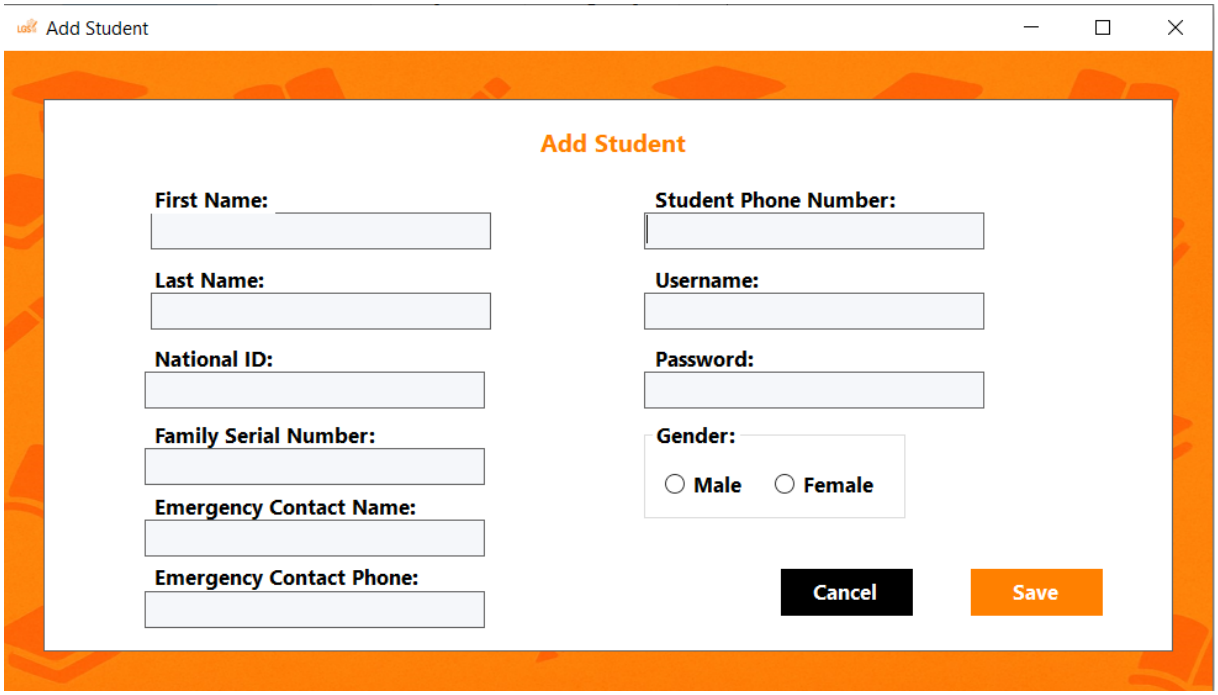
System Integration Components: Various system integration points, modal dialogs, configuration screens, and utility interfaces showcase the robust architecture and comprehensive feature set. These components ensure that all aspects of examination data management are covered within the unified application framework.

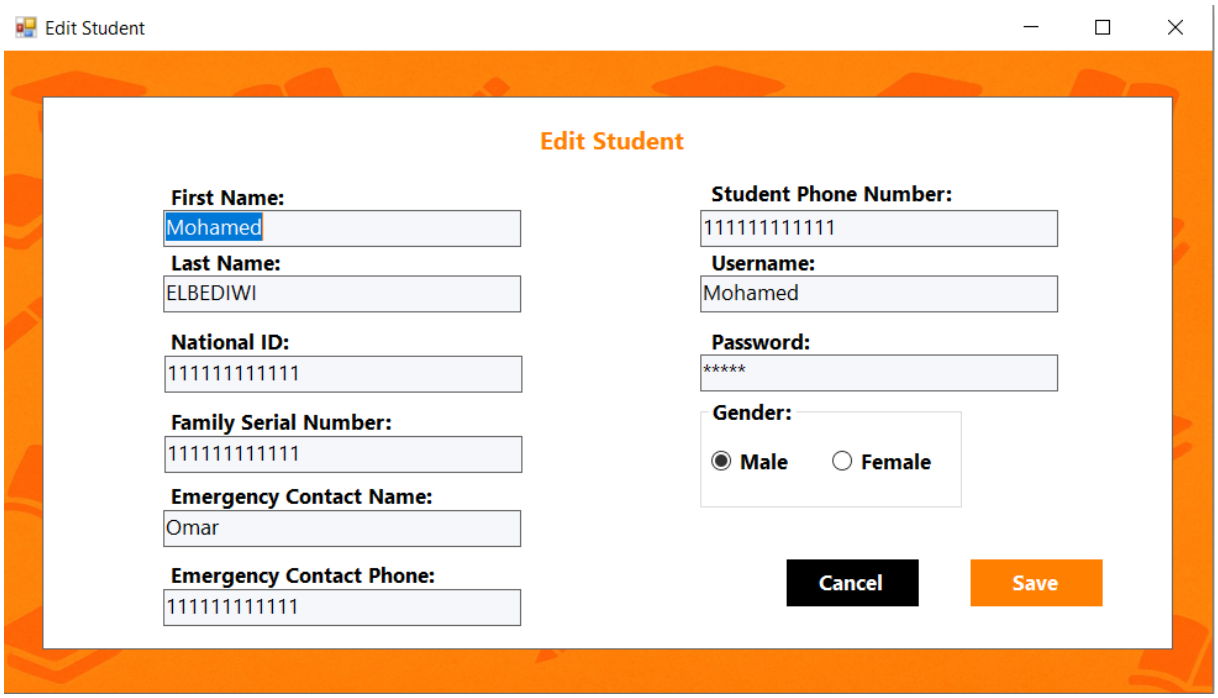
Specialized Data Entry Forms: The application includes numerous specialized forms for different data entry scenarios, validation interfaces, and confirmation dialogs that ensure data accuracy and provide appropriate user feedback throughout all system interactions.

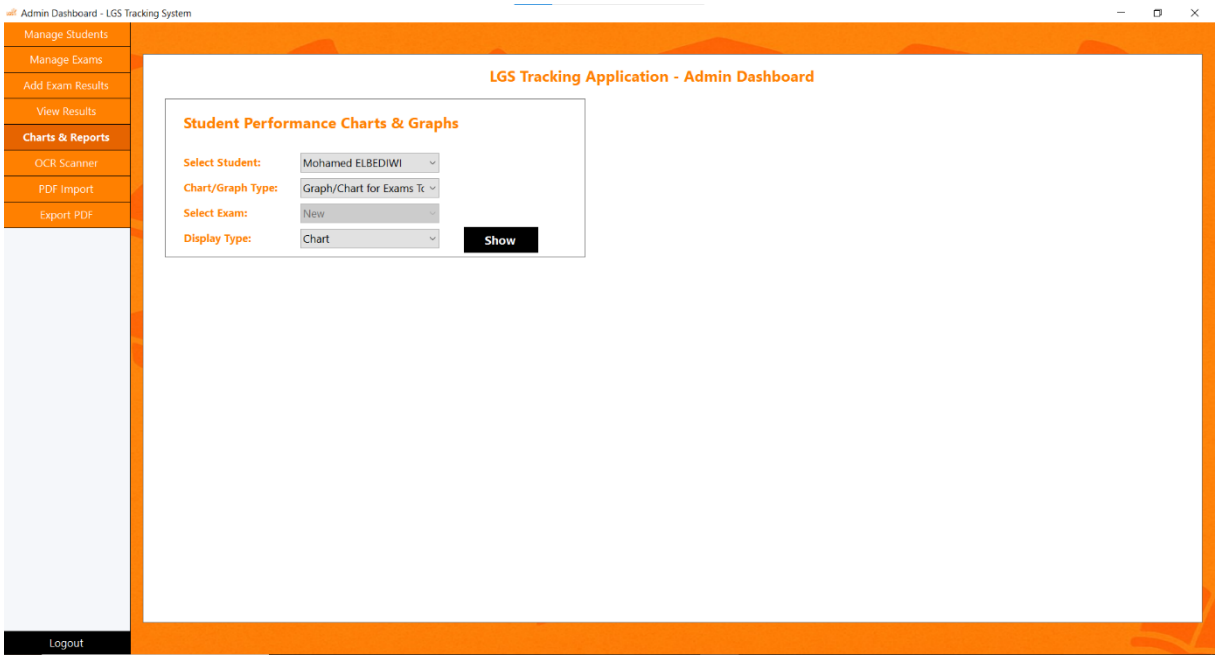

Login
LGS Tracking Application - Login
Username:
Password:
Login
Don't have an account? Register

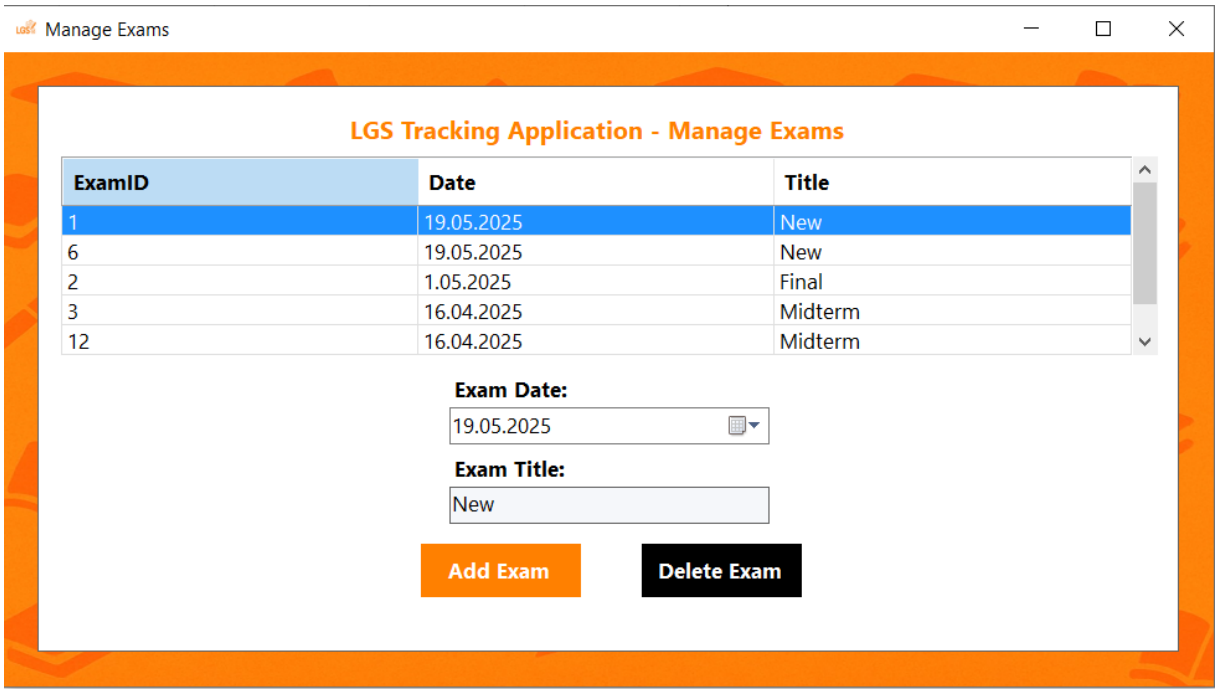

Register
LGS Tracking Application - Register
Username:
Password:
Confirm Password:
Register As:
Admin
Student
Register
Already have an account? Login
Student Details
First Name:
Last Name:
National ID:
Family Serial No.:
Emergency Contact Name:
Emergency Contact Phone:
Student Phone Number:
Gender
Male
Female

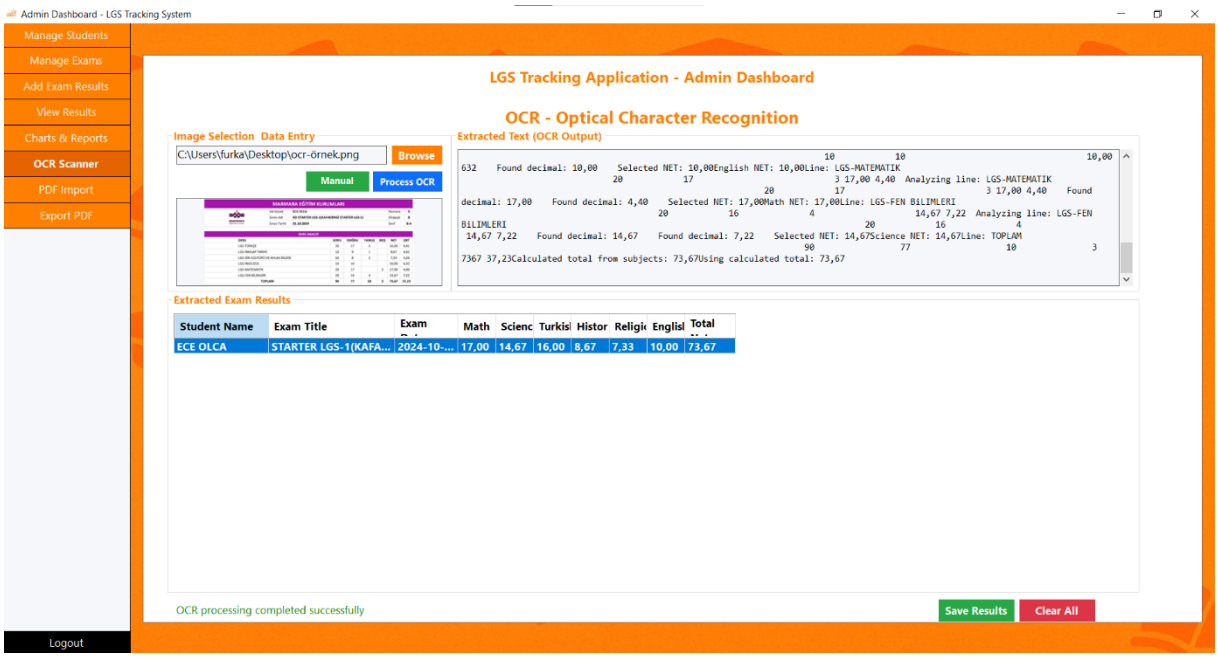

Add Exam Results
Select Student:
hamed ELBEDIWI
Exam Name:
New
Date:
27 Mayıs 2025 Salı
Wrong Counts
Numerical
Mathematics
Correct:
Wrong:
Blank:
Net:
Science
Correct:
Wrong:
Blank:
Net:
Verbal
Turkish
Correct:
Wrong:
Blank:
Net:
Revolution History & Kemalism
Correct:
Wrong:
Blank:
Net:
Religion Ethics
Correct:
Wrong:
Blank:
Net:
English
Correct:
Wrong:
Blank:
Net:
Save Exam


Add Student
Add Student
First Name:
Last Name:
National ID:
Family Serial Number:
Emergency Contact Name:
Emergency Contact Phone:
Student Phone Number:
Username:
Password:
Gender:
Male
Female
Cancel
Save


Edit Student
Edit Student
First Name:
Mohamed
Last Name:
ELBEDIWI
National ID:
111111111111
Family Serial Number:
111111111111
Emergency Contact Name:
Omar
Emergency Contact Phone:
111111111111
Student Phone Number:
111111111111
Username:
Mohamed
Password:
*****
Gender:
Male
Female
Cancel
Save


Admin Dashboard - LGS Tracking System
Manage Students
Manage Exams
Add Exam Results
View Results
Charts & Reports
OCR Scanner
PDF Import
Export PDF
Logout
LGS Tracking Application - Admin Dashboard
Student Performance Charts & Graphs
Select Student:
Mohamed ELBEDIWI
Chart/Graph Type:
Graph/Chart for Exams Tc
Select Exam:
New
Display Type:
Chart
Show


Manage Exams
LGS Tracking Application - Manage Exams
ExamID
Date
Title
1
19.05.2025
New
6
19.05.2025
New
2
1.05.2025
Final
3
16.04.2025
Midterm
12
16.04.2025
Midterm
Exam Date:
19.05.2025
Exam Title:
New
Add Exam
Delete Exam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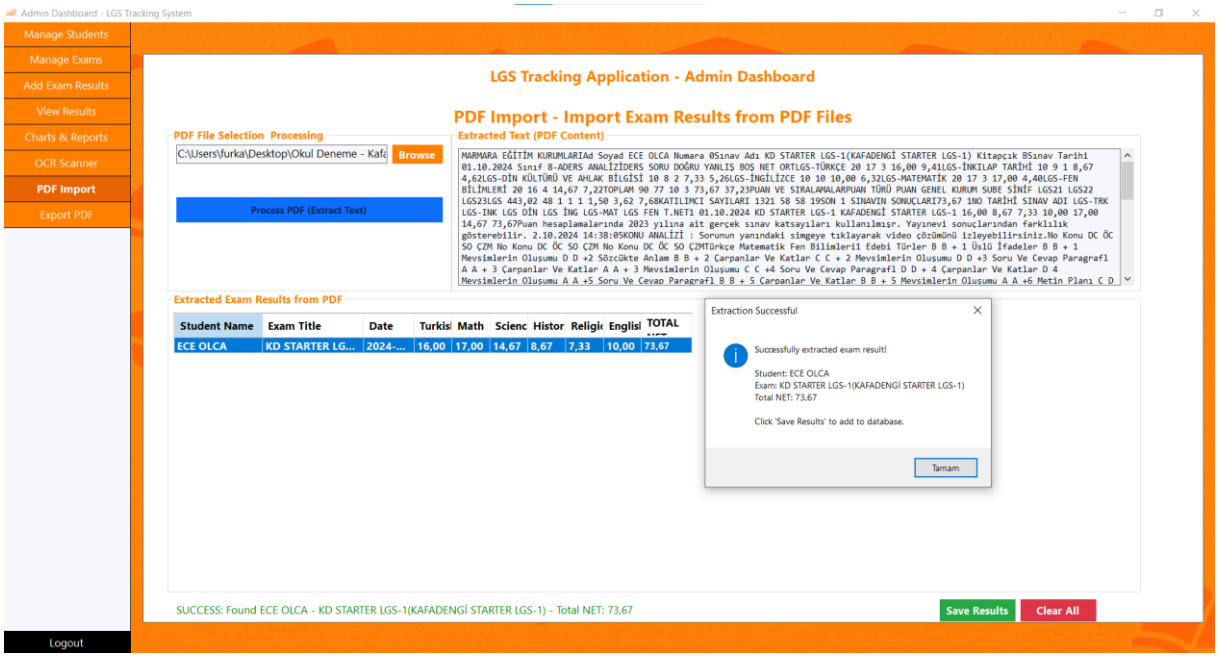
Add Exam Results
View Results
Charts & Reports
OCR Scanner
PDF Import
Export PDF
Logout
LGS Tracking Application - Admin Dashboard
OCR - Optical Character Recognition
Image Selection Data Entry
C:\Users\furka\Desktop\ocr-örnek.png
Browse
Manual
Process OCR
Extracted Text (OCR Output)
Extracted Exam Results
Student Name
Exam Title
Math
ECE OLCA
STARTER LGS-1(KAFA...
17,00
14,67
16,00
8,67
7,33
10,00
73,67
OCR processing completed successfully
Save Results
Clear All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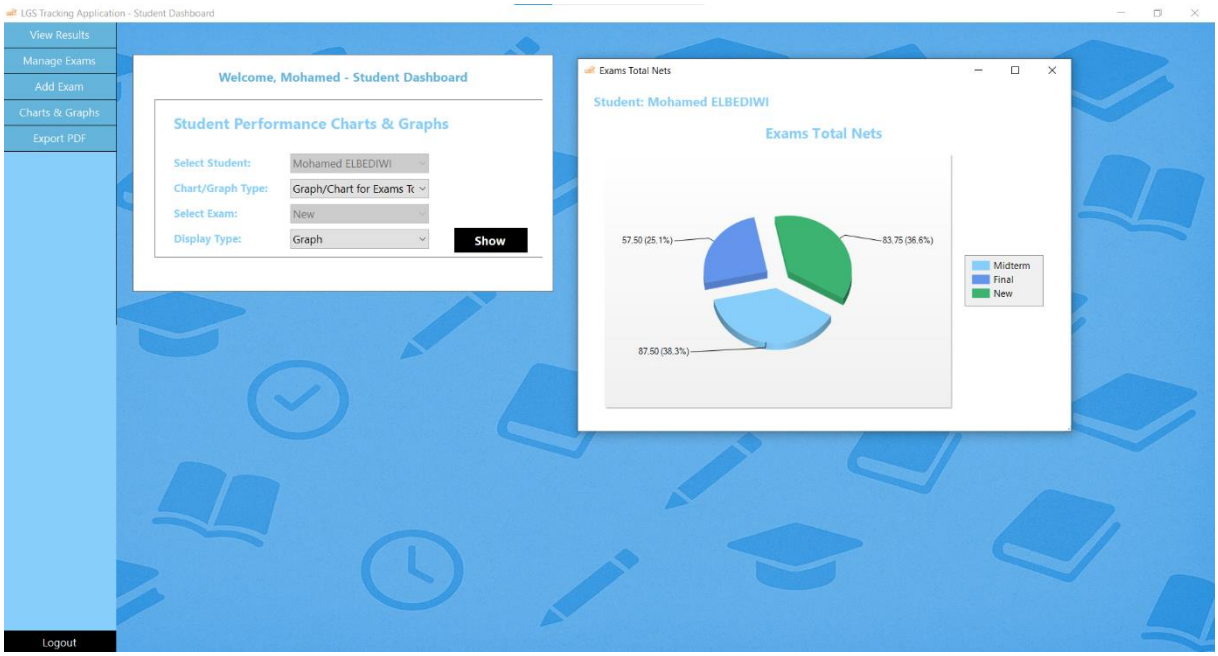
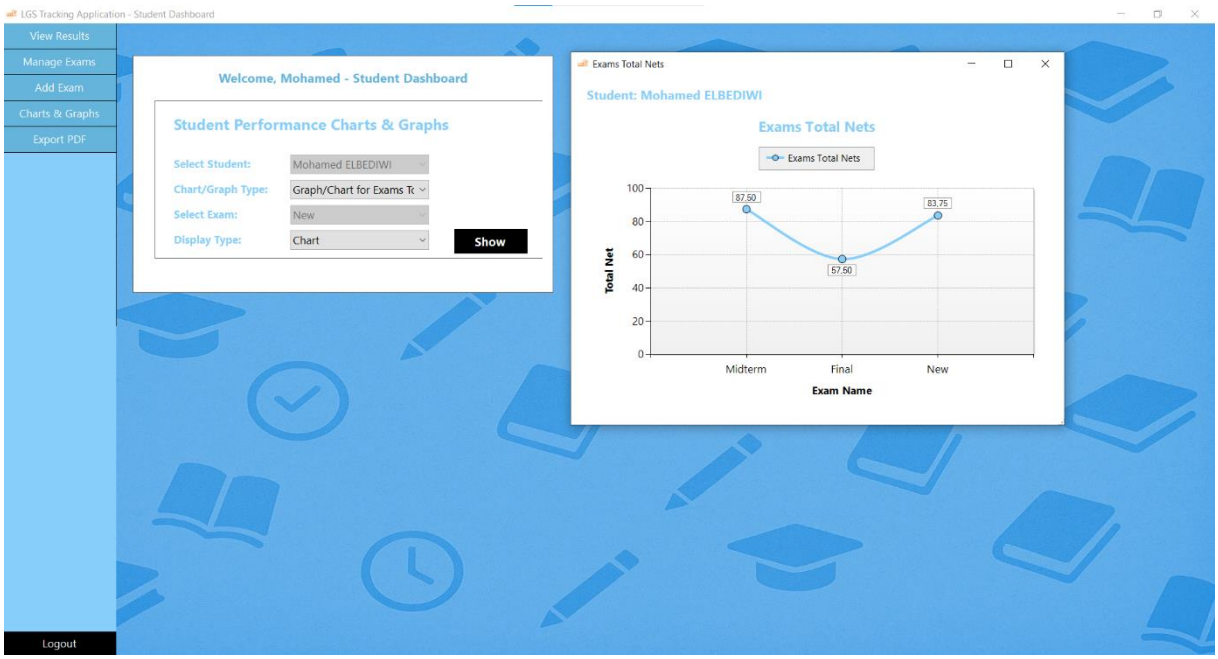
View Results
Charts & Reports
OCR Scanner
PDF Import
Export PDF
Logout
LGS Tracking Application - Admin Dashboard
PDF Import - Import Exam Results from PDF Files
PDF File Selection Processing
C:\Users\furka\Desktop\Okul Deneme - Kafa
Browse
Process PDF (Extract Text)
Extracted Text (PDF Content)
Extracted Exam Results from PDF
Student Name
Exam Title
Date
Turkis
Math
Scienc
Histor
Religi
Englis
TOTAL
ECE OLCA
KD STARTER LG...
2024-...
16,00
17,00
14,67
8,67
7,33
10,00
73,67
Extraction Successful
Successfully extracted exam result!
Student: ECE OLCA
Exam: KD STARTER LGS-1(KAFADENGİ STARTER LGS-1)
Total NET: 73.67
Click 'Save Results' to add to database.
Tamam
SUCCESS: Found ECE OLCA - KD STARTER LGS-1(KAFADENGİ STARTER LGS-1) - Total NET: 73,67
Save Results
Clear All


LGS Tracking Application - Student Dashboard
View Results
Manage Exams
Add Exam
Charts & Graphs
Export PDF
Logout
Welcome, Mohamed - Student Dashboard
Student Performance Charts & Graphs
Select Student:
Mohamed ELBEDIWI
Chart/Graph Type:
Graph/Chart for Exams Te
Select Exam:
New
Display Type:
Graph
Show
Exams Total Nets
Student: Mohamed ELBEDIWI
Exams Total Nets
57.50 (25.1%)
83.75 (36.6%)
87.50 (38.3%)
Midterm
Final
New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Charts & Graphs
Export PDF
Logout
Welcome, Mohamed - Student Dashboard
Student Performance Charts & Graphs
Select Student:
Mohamed ELBEDIWI
Chart/Graph Type:
Graph/Chart for Exams Tc
Select Exam:
New
Display Type:
Chart
Show
Exams Total Nets
Student: Mohamed ELBEDIWI
Exams Total Nets
Exams Total Nets
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100
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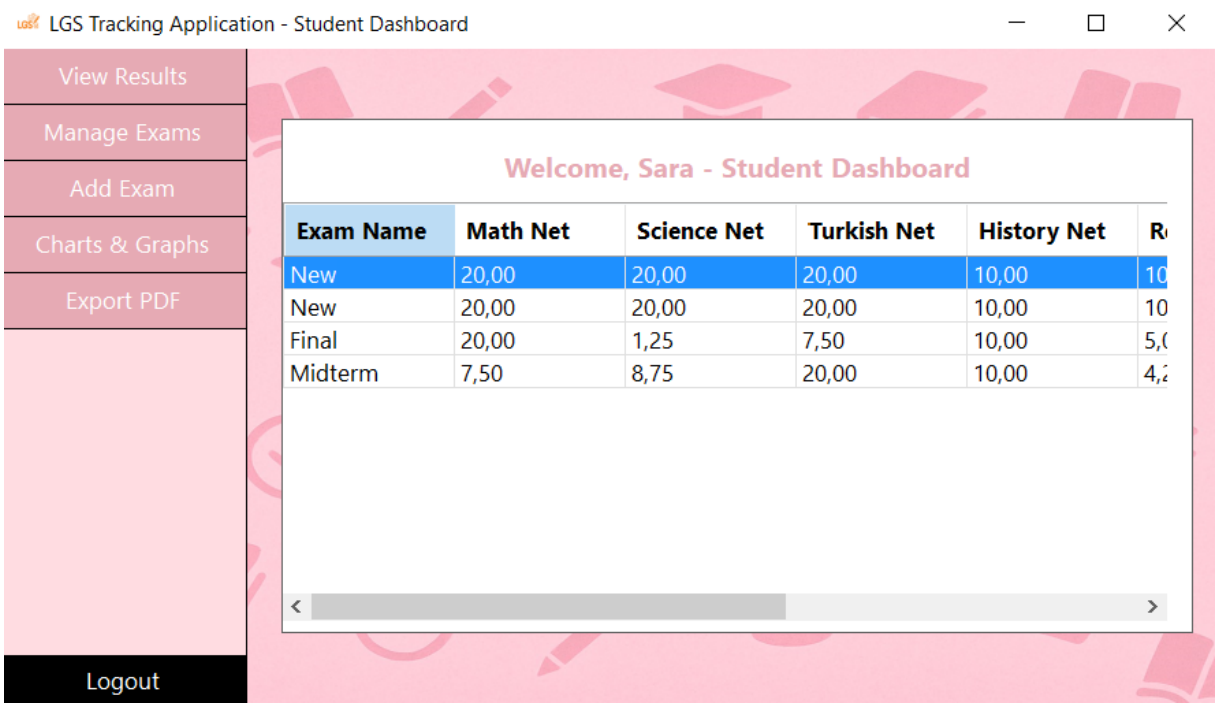
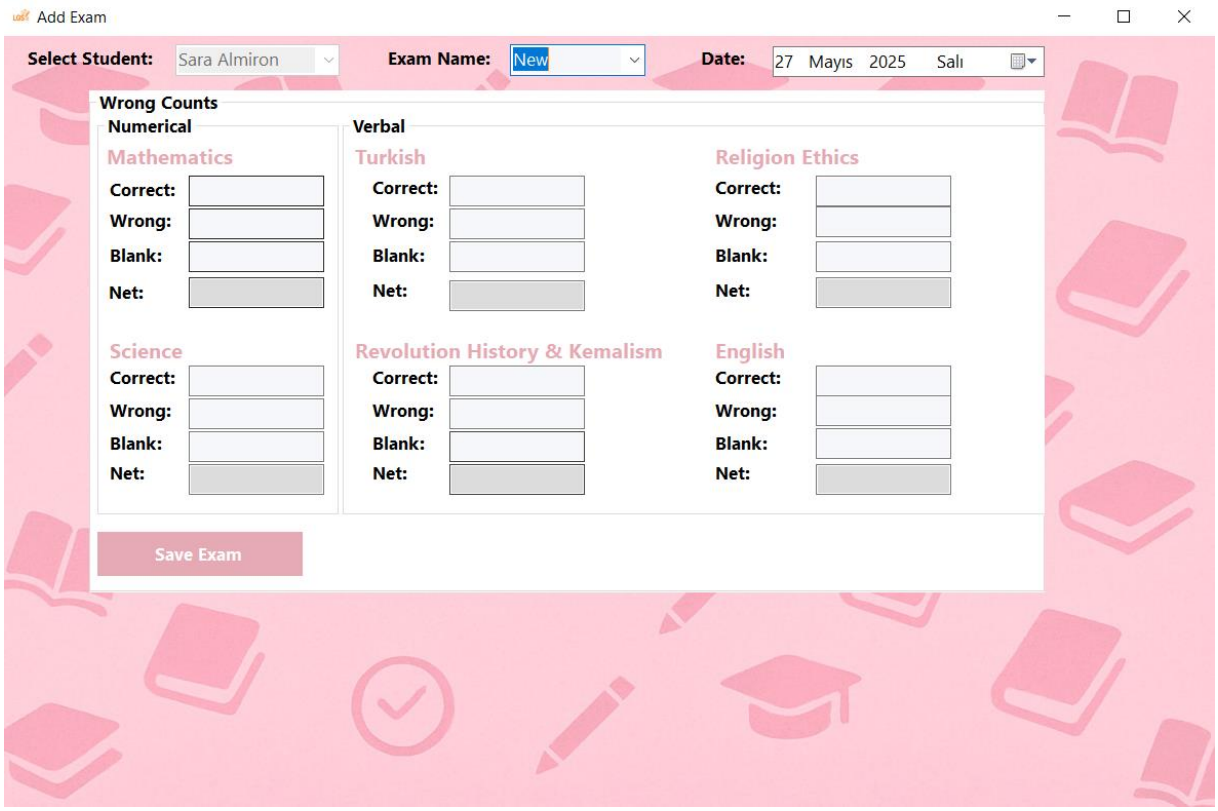
60
40
20
0
87,50
57,50
83,75
Midterm
Final
New
Exam Name


LGS Tracking Application - Student Dashboard
View Results
Manage Exams
Add Exam
Charts & Graphs
Export PDF
Logout
Welcome, Sara - Student Dashboard
Exam Name
Math Net
Science Net
Turkish Net
History Net
New
20,00
20,00
20,00
10,00
New
20,00
20,00
20,00
10,00
Final
20,00
1,25
7,50
10,00
Midterm
7,50
8,75
20,00
10,00


Add Exam
Select Student:
Sara Almiron
Exam Name:
New
Date:
27 Mayıs 2025 Salı
Wrong Counts
Numerical
Mathematics
Correct:
Wrong:
Blank:
Net:
Science
Correct:
Wrong:
Blank:
Net:
Verbal
Turkish
Correct:
Wrong:
Blank:
Net:
Revolution History & Kemalism
Correct:
Wrong:
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English
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Wrong:
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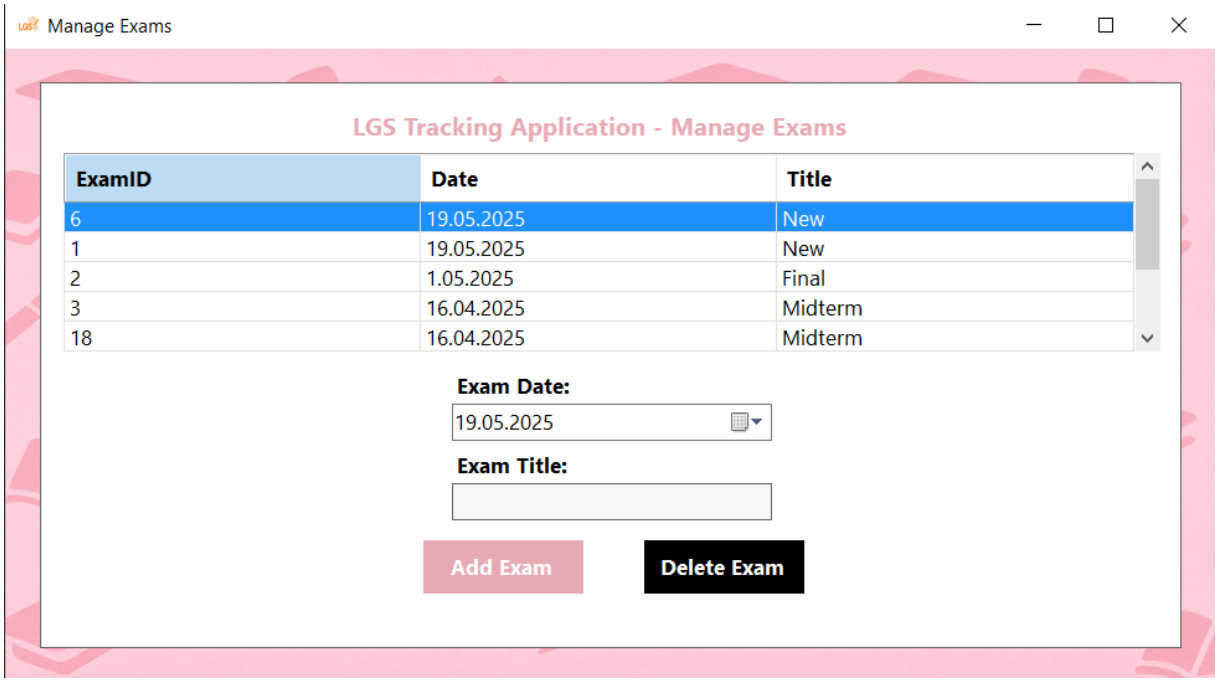
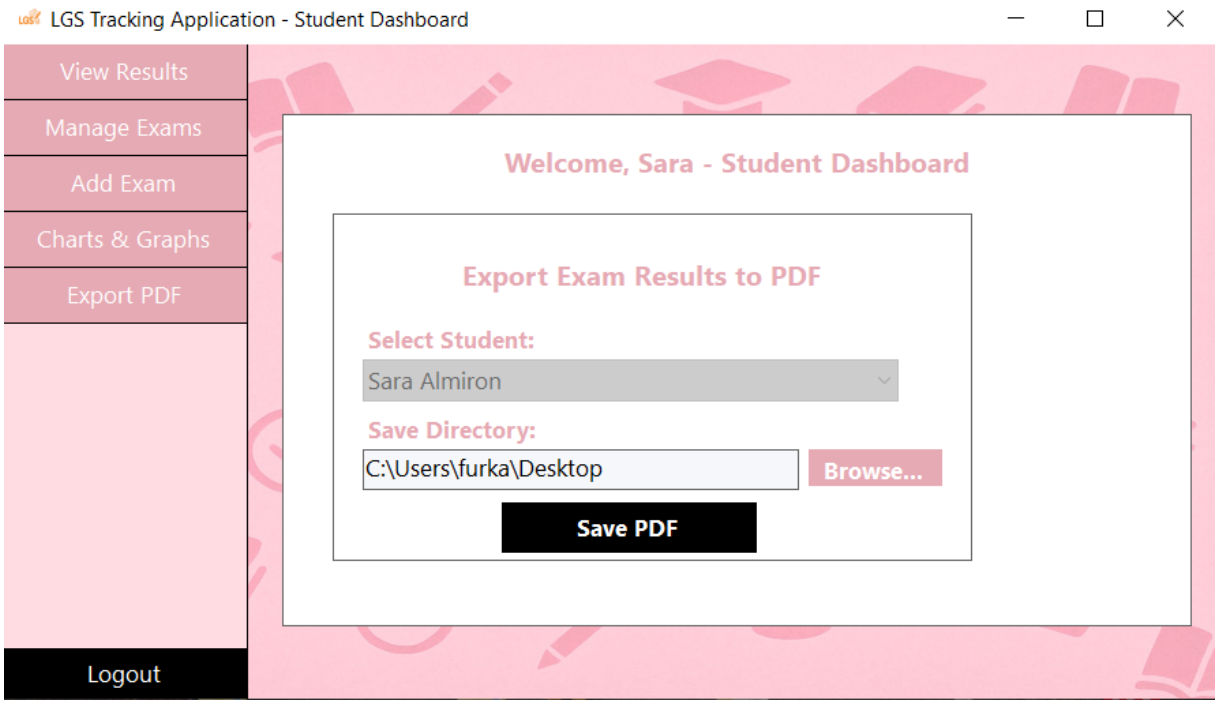
Save Exam


Manage Exams
LGS Tracking Application - Manage Exams
ExamID
Date
Title
6
19.05.2025
New
1
19.05.2025
New
2
1.05.2025
Final
3
16.04.2025
Midterm
18
16.04.2025
Midterm
Exam Date:
19.05.2025
Exam Title:
Add Exam
Delete Exam



[Images: Each demonstrating different aspects of system functionality, user workflows, and interface design consistency across the comprehensive LGS Tracking Application]

7. Implemented Features

The application delivers comprehensive functionality addressing all aspects of examination data management, from initial data entry through advanced analytics and reporting.

Core Administrative Features

Complete Student Lifecycle Management: Administrators possess full control over student records, including registration, profile updates, and account deactivation. The system maintains comprehensive student information including personal details, contact information, and academic history.

Multi-Modal Data Entry System: The application supports three distinct methods for examination data input:

- Manual entry through structured forms with validation and error checking
- PDF import with automatic text extraction and data parsing
- OCR processing of scanned documents with text recognition and field mapping

Comprehensive Examination Management: Administrative users can create new examinations, modify existing test configurations, and manage examination schedules. The system maintains detailed examination metadata including creation dates, test parameters, and associated student groups.

Student Self-Service Capabilities

Personal Data Management: Students can independently add personal practice examination results, enabling comprehensive tracking of both formal and informal test performance. This feature encourages continued engagement with the system while building complete performance profiles.

Individual Performance Analytics: Each student receives access to personalized analytics including performance trends, subject-wise breakdowns, and comparative analysis against personal historical performance. These insights support targeted study planning and progress monitoring.

Personal Report Generation: Students can generate and export personal performance reports in PDF format, providing portable documentation of academic progress suitable for sharing with parents, tutors, or educational advisors.

Advanced Analytics and Visualization

Multi-Dimensional Chart Generation: The system produces various chart types to support different analytical needs:

- Line charts displaying performance trends over time
- Pie charts showing subject-wise performance distribution
- Bar charts enabling comparative analysis across different time periods

Performance Trend Analysis: Advanced analytical capabilities identify performance patterns, highlight improvement areas, and provide statistical summaries supporting educational decision-making.

Comparative Analysis Tools: Administrative users can generate comparative reports across multiple students, identifying high-performing individuals and students requiring additional support.

Data Export and Reporting

PDF Report Generation: Comprehensive PDF reporting utilizes PdfSharp library to create professional-quality reports including:

- Individual student performance summaries
- Examination result compilations with statistical analysis

- Visual chart integration within PDF documents
- Customizable report layouts meeting institutional requirements

Data Visualization Integration: Reports seamlessly integrate charts and graphs, providing visual context alongside tabular data to enhance comprehension and support decision-making processes.

Security and Data Integrity Features

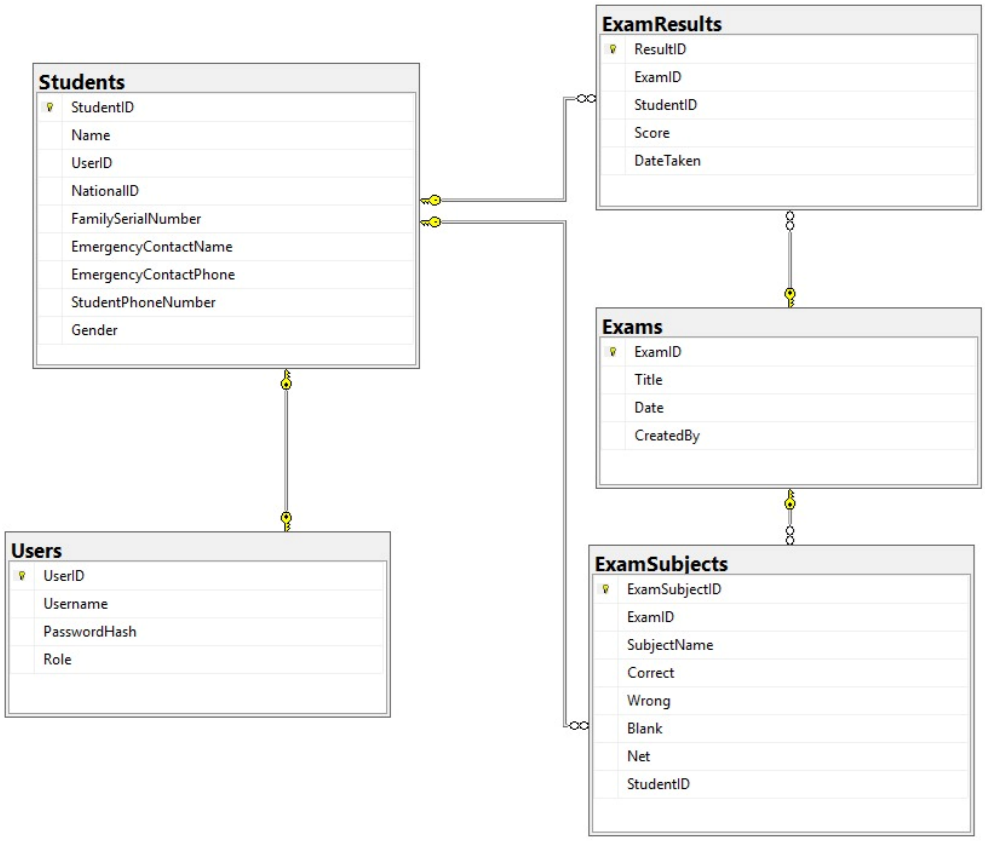
Role-Based Access Control: The system enforces strict access controls ensuring that users can only access appropriate functionality and data based on their assigned roles and permissions.

Data Validation and Integrity: Comprehensive input validation prevents invalid data entry while maintaining database integrity through constraint enforcement and transaction management.

Audit Trail Capabilities: The system maintains records of data modifications, supporting accountability and enabling tracking of changes to student records and examination data.

This comprehensive feature set addresses the complete spectrum of examination data management requirements while providing extensibility for future enhancement needs.

8. Database Design



[Image: Database Entity Relationship Diagram showing the complete table structure with Users, Students, Exams, ExamResults, and ExamSubjects tables and their relationships]

The database architecture implements a normalized relational design that ensures data integrity, supports efficient querying, and provides scalability for institutional deployment requirements.

Core Entity Relationships

Users Table: The central authentication table maintains user credentials and role assignments:

- UserID (Primary Key): Unique identifier for each system user
- Username: Unique login identifier with appropriate constraints
- PasswordHash: Encrypted password storage ensuring security compliance
- Role: Role designation ('Admin' or 'Student') determining system access levels

Students Table: Comprehensive student information storage with foreign key relationship to Users:

- StudentID (Primary Key): Unique student identification number
- UserID (Foreign Key): Links to Users table for authentication integration
- Name: Full student name for identification and reporting
- NationalID: Turkish national identification number with uniqueness constraints
- FamilySerialNumber: Family registration number for administrative purposes
- EmergencyContactName: Emergency contact information for safety protocols
- EmergencyContactPhone: Emergency contact telephone number
- StudentPhoneNumber: Direct student contact information
- Gender: Gender designation enabling interface theming functionality

Exams Table: Examination metadata and configuration information:

- ExamID (Primary Key): Unique examination identifier
- Title: Descriptive examination name for identification
- Date: Examination administration date for chronological organization
- CreatedBy: Administrative user responsible for examination creation

ExamResults Table: Aggregate examination performance storage:

- ResultID (Primary Key): Unique result record identifier
- ExamID (Foreign Key): Links to specific examination instance
- StudentID (Foreign Key): Associates results with specific students
- Score: Total examination score aggregating all subject areas
- DateTaken: Timestamp of result entry for tracking purposes

ExamSubjects Table: Detailed subject-wise performance breakdown:

- ExamSubjectID (Primary Key): Unique subject result identifier
- ExamID (Foreign Key): Links to examination instance
- StudentID (Foreign Key): Associates with specific student
- SubjectName: Subject area designation (Math, Science, Turkish, History, Religion, English)
- Correct: Number of correct answers for net score calculation
- Wrong: Number of incorrect answers for penalty calculation
- Blank: Number of unanswered questions for completion analysis
- Net: Calculated net score using standard LGS formula

Database Relationships and Constraints

Primary Relationships:

- Users ↔ Students: One-to-one relationship ensuring each student has corresponding user account
- Students ↔ ExamResults: One-to-many relationship supporting multiple examination attempts
- Exams ↔ ExamResults: One-to-many relationship enabling multiple student participation
- ExamResults ↔ ExamSubjects: One-to-many relationship providing detailed subject breakdown

Referential Integrity: The database implements comprehensive foreign key constraints ensuring data consistency and preventing orphaned records. Cascade delete operations maintain referential integrity when removing student or examination records.

Data Validation Constraints:

- Unique constraints on critical identification fields (Username, NationalID)
- Check constraints ensuring logical data ranges (scores within valid parameters)
- Not-null constraints on essential fields maintaining data completeness

Query Optimization and Indexing

Index Strategy: Strategic index placement on frequently queried columns improves performance:

- Clustered indexes on primary key fields
- Non-clustered indexes on foreign key relationships
- Composite indexes on frequently joined column combinations

Query Performance: Complex analytical queries utilize optimized JOIN operations across multiple tables, with appropriate WHERE clause filtering to minimize result set processing time.

Database Security Implementation

Access Control: Database security implements role-based access patterns matching application user roles, ensuring that database-level security reinforces application-level restrictions.

Connection Security: Database connections utilize trusted authentication mechanisms with connection string encryption protecting sensitive connection parameters.

This comprehensive database design provides robust data management capabilities while maintaining performance characteristics suitable for educational institution deployment scenarios.

9. Problems Encountered and Solutions

During the development process, several technical challenges emerged that required innovative solutions and careful consideration of system architecture decisions.

OCR Implementation Challenges

Challenge: Turkish Language Recognition Accuracy The initial OCR implementation suffered from poor recognition accuracy when processing Turkish examination documents, particularly with special characters (ç, ğ, ı, ö, ş, ü) common in Turkish text.

Solution Implemented: The development team integrated dual-language OCR models using Tesseract engine with both Turkish ("tur") and English ("eng") language packs. Additionally, custom character whitelisting was implemented to focus recognition on expected characters:

```
_ocrEngine.SetVariable("tessedit_char_whitelist",

"ABCÇDEFGĞHIİJKLMNOÖPRSŞTUÜVYZabcçdefgğhıijklmnoöprsştuüvyz0123456789.,:-/ ()");
```

This approach significantly improved recognition accuracy while reducing processing time by limiting the character recognition scope.

Challenge: Image Quality and Preprocessing Scanned examination documents often contained noise, skew, or poor contrast that hindered OCR accuracy.

Solution Implemented: Advanced image preprocessing algorithms were integrated to automatically enhance document quality before OCR processing. The system implements contrast adjustment, noise reduction, and automatic rotation correction to optimize text recognition reliability.

PDF Import Processing Issues

Challenge: Inconsistent PDF Format Handling Different examination providers utilize varying PDF formats, making consistent data extraction challenging. Some PDFs contained embedded text while others consisted of scanned images.

Solution Implemented: A hybrid PDF processing approach was developed that first attempts text extraction using iTextSharp library for PDF files containing embedded text. When text extraction fails or produces insufficient results, the system automatically converts PDF pages to images and applies OCR processing as a fallback mechanism.

Challenge: Data Field Mapping and Validation Extracted PDF content required intelligent parsing to identify and map examination data to appropriate database fields.

Solution Implemented: Pattern recognition algorithms were developed using regular expressions to identify key data elements such as student names, examination titles, dates, and subject scores. The system implements multiple parsing strategies with confidence scoring to ensure accurate data extraction.

Database Performance Optimization

Challenge: Complex Query Performance Analytical queries requiring multiple table joins and aggregate calculations experienced performance degradation with larger datasets.

Solution Implemented: Database optimization strategies were implemented including:

- Strategic index creation on frequently queried columns
- Query optimization through proper JOIN ordering and WHERE clause filtering
- Connection pooling to reduce database connection overhead
- Stored procedure implementation for complex recurring queries

User Interface Responsiveness

Challenge: Chart Generation Performance Real-time chart generation for student performance visualization caused interface freezing during processing of large datasets.

Solution Implemented: Asynchronous chart generation was implemented using background worker threads, allowing the user interface to remain responsive during

chart creation. Progress indicators provide user feedback during processing operations.

Challenge: Cross-Resolution Interface Compatibility Educational institutions utilize diverse hardware configurations with varying screen resolutions, causing interface layout issues.

Solution Implemented: Responsive design principles were applied to interface layouts, implementing automatic scaling and control repositioning based on available screen space. The system maintains usability across resolution ranges from 1024x768 to modern high-resolution displays.

Data Integrity and Validation

Challenge: Duplicate Student Creation OCR and PDF import processes occasionally created duplicate student records when name recognition variations occurred.

Solution Implemented: Advanced duplicate detection algorithms were implemented that use fuzzy string matching to identify potential duplicate students before record creation. The system prompts for user confirmation when potential duplicates are detected, offering merge options to maintain data integrity.

Challenge: Invalid Score Data Validation Imported examination data sometimes contained invalid scores outside acceptable ranges or inconsistent with examination parameters.

Solution Implemented: Comprehensive data validation routines were implemented that verify:

- Score ranges within examination parameters (0-20 for most subjects, 0-10 for specific subjects)
- Logical consistency between correct, wrong, and blank answer counts
- Net score calculation accuracy using standard LGS formulas
- Date validation ensuring examination dates fall within reasonable ranges

These solutions demonstrate the iterative development approach utilized throughout the project, with each challenge leading to improved system robustness and reliability.

10. Future Work

The current application implementation provides comprehensive functionality for examination data management and analysis. However, several enhancement opportunities exist that would extend system capabilities and improve user experience.

Advanced Analytics and Machine Learning Integration

Predictive Performance Analysis: Future development could incorporate machine learning algorithms to predict student performance trends based on historical examination data. This capability would enable early identification of students requiring additional support and provide personalized study recommendations.

Comparative Analytics Dashboard: Enhanced analytics functionality could provide institution-wide performance comparisons, identifying high-performing teaching methods and curriculum areas requiring attention. These insights would support administrative decision-making and resource allocation.

Enhanced Mobile Integration

Mobile Application Development: A companion mobile application would enable students to access performance data and add practice test results from mobile devices. This enhancement would increase system engagement and provide convenient access to academic progress information.

Push Notification System: Mobile integration could include push notifications for examination reminders, performance updates, and achievement milestones, increasing student engagement with their academic progress.

Advanced Reporting and Export Capabilities

Interactive Dashboard Creation: Future enhancements could include customizable dashboard functionality allowing users to create personalized views of examination data with drag-and-drop chart creation and filter configuration.

Advanced Export Formats: Additional export formats including Excel spreadsheets, CSV files, and interactive HTML reports would provide greater flexibility for data sharing and external analysis.

Advanced OCR and Document Processing

Handwritten Text Recognition: Enhanced OCR capabilities including handwritten text recognition would enable processing of hand-completed examination forms and student-written practice tests.

Batch Document Processing: Automated batch processing capabilities for multiple document import would streamline data entry for institutions processing large volumes of examination documents.

These enhancement opportunities represent natural evolution paths for the application, each building upon the robust foundation established in the current implementation while addressing emerging needs in educational technology.

11. Conclusion and Evaluation

The LGS Tracking Application represents a comprehensive solution addressing the complex requirements of examination data management in educational environments. Through careful analysis of user needs and systematic implementation of advanced technologies, the project successfully delivers a robust, scalable platform suitable for institutional deployment.

Project Achievement Assessment

Requirement Fulfillment: The application successfully addresses all specified project requirements, implementing both administrative and student user roles with appropriate functionality for each user type. The dual-interface approach ensures that system capabilities match user responsibilities while maintaining appropriate security boundaries.

Technical Excellence: The implementation demonstrates mastery of multiple technical domains including database design, user interface development, document processing, and data visualization. Integration of advanced features such as OCR processing and PDF import showcases technical sophistication beyond basic project requirements.

Innovation in Educational Technology: The application introduces innovative approaches to examination data management, particularly through automated data entry methods that reduce administrative burden while maintaining data accuracy. The gender-based interface theming demonstrates attention to user experience details that enhance engagement.

System Architecture Strengths

Scalability and Maintainability: The modular architecture ensures that system components remain maintainable while providing clear extension points for future

enhancement. Database normalization and proper separation of concerns support long-term system evolution.

Security and Data Integrity: Implementation of role-based access control, encrypted password storage, and comprehensive data validation ensures that the system meets security requirements appropriate for educational data management.

User Experience Design: Careful attention to interface design creates intuitive user experiences that minimize training requirements while maximizing functionality access. The responsive design approach ensures compatibility across diverse hardware configurations commonly found in educational settings.

Educational Impact Potential

Administrative Efficiency: The system significantly reduces manual effort required for examination data management through automated import capabilities and streamlined data entry processes. This efficiency improvement enables educational administrators to focus on analysis and decision-making rather than data processing.

Student Engagement Enhancement: Personal performance tracking capabilities encourage student engagement with their academic progress while providing insights that support targeted improvement efforts. The self-service capabilities empower students to take ownership of their academic tracking.

Data-Driven Decision Making: Comprehensive analytics and reporting capabilities enable evidence-based decision making at both individual and institutional levels. Performance trend analysis supports early intervention strategies and resource allocation optimization.

Technical Learning Outcomes

Full-Stack Development Proficiency: The project demonstrates comprehensive understanding of desktop application development, from database design through user interface implementation and advanced feature integration.

Third-Party Library Integration: Successful integration of multiple specialized libraries (Tesseract OCR, PdfSharp, iTextSharp) showcases ability to leverage existing solutions while implementing custom integration logic.

Problem-Solving and Optimization: The development process required creative solutions to complex technical challenges, demonstrating analytical thinking and systematic problem-solving approaches.

Project Success Metrics

Functional Completeness: All specified features have been successfully implemented and tested, with additional enhancements beyond minimum requirements demonstrating commitment to excellence.

Code Quality and Documentation: Implementation follows industry best practices for code organization, naming conventions, and documentation, ensuring long-term maintainability and team collaboration capability.

User Experience Achievement: Interface design successfully balances functionality with usability, creating efficient workflows that minimize user effort while maximizing capability access.

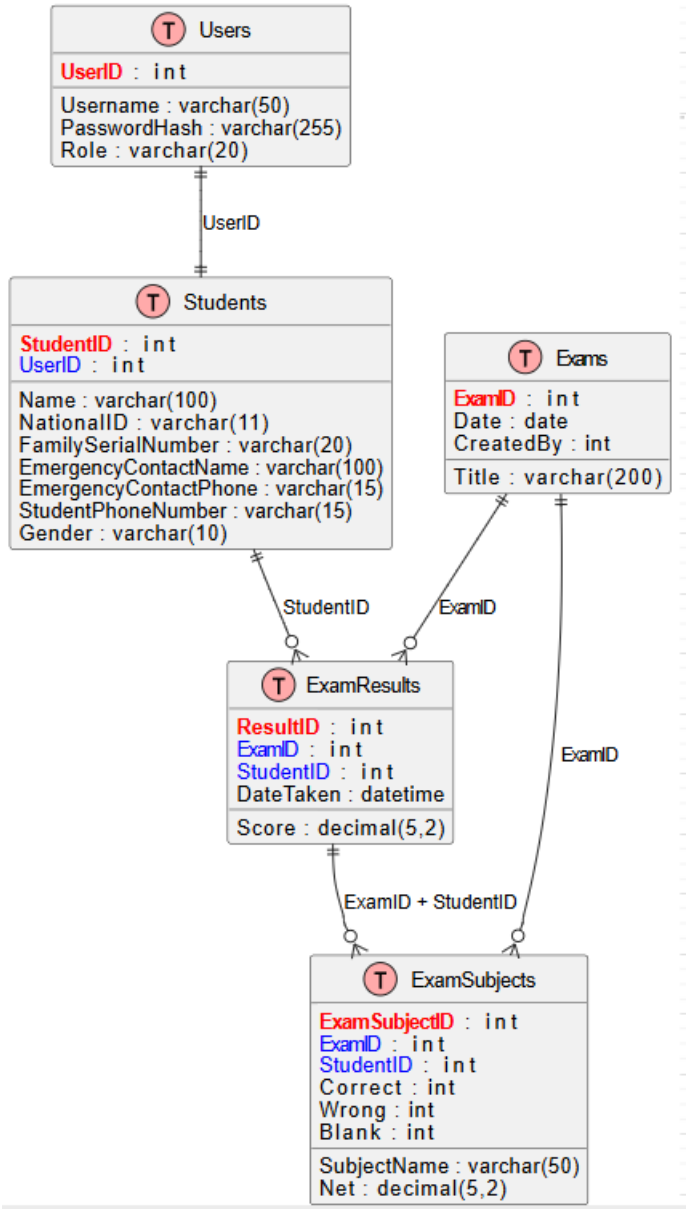
Professional Development Impact

This project provides valuable experience in enterprise application development methodologies, including requirements analysis, system architecture design, implementation planning, and quality assurance processes. The comprehensive nature of the solution demonstrates ability to manage complex projects from conception through deployment.

The LGS Tracking Application stands as a testament to effective software engineering practices applied to educational technology challenges. Through systematic development and careful attention to user needs, the project delivers a solution that addresses real-world requirements while demonstrating technical proficiency and innovative thinking in educational software development.

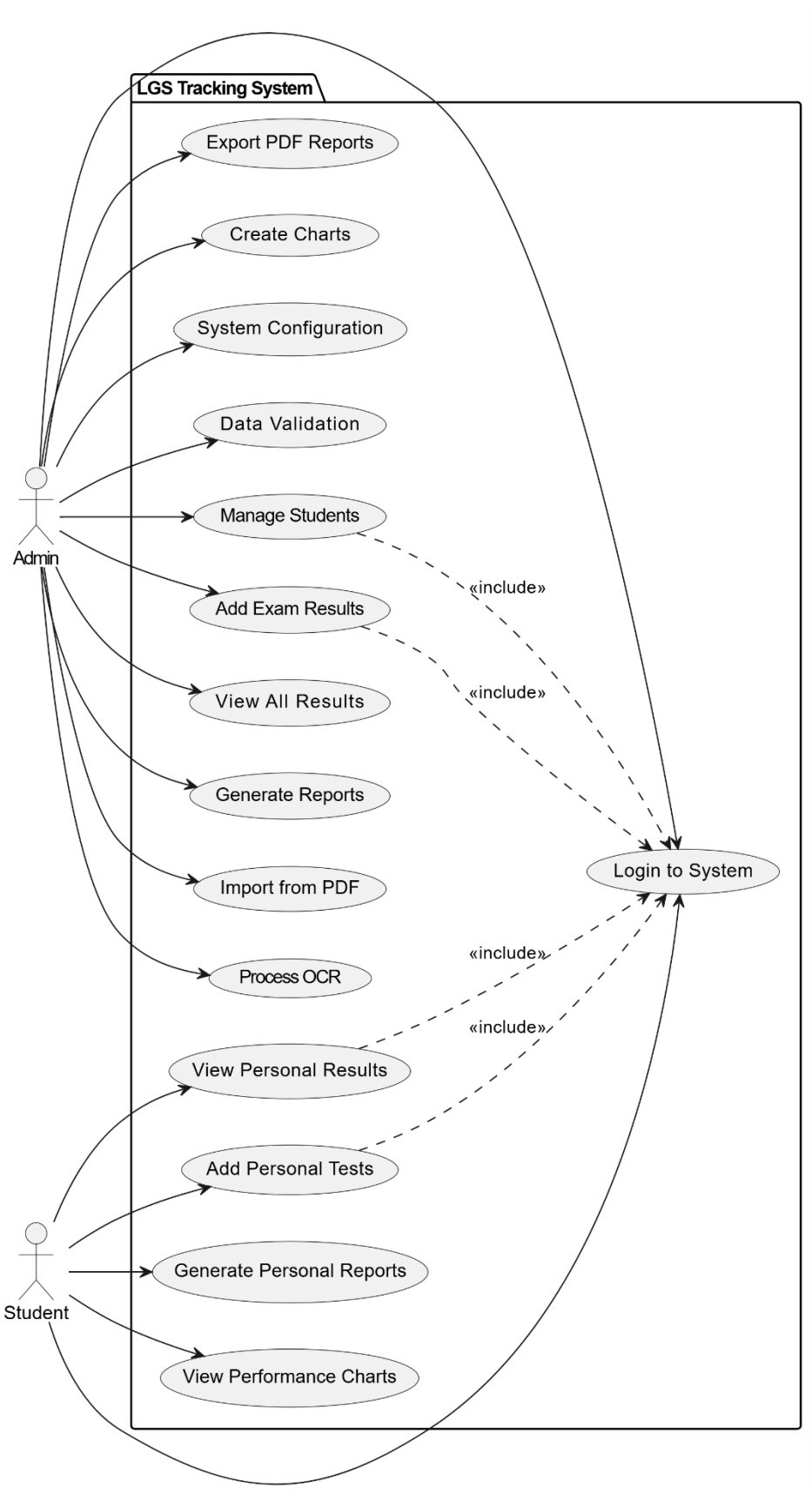
12. Technical Diagrams

Database Entity Relationship Diagram



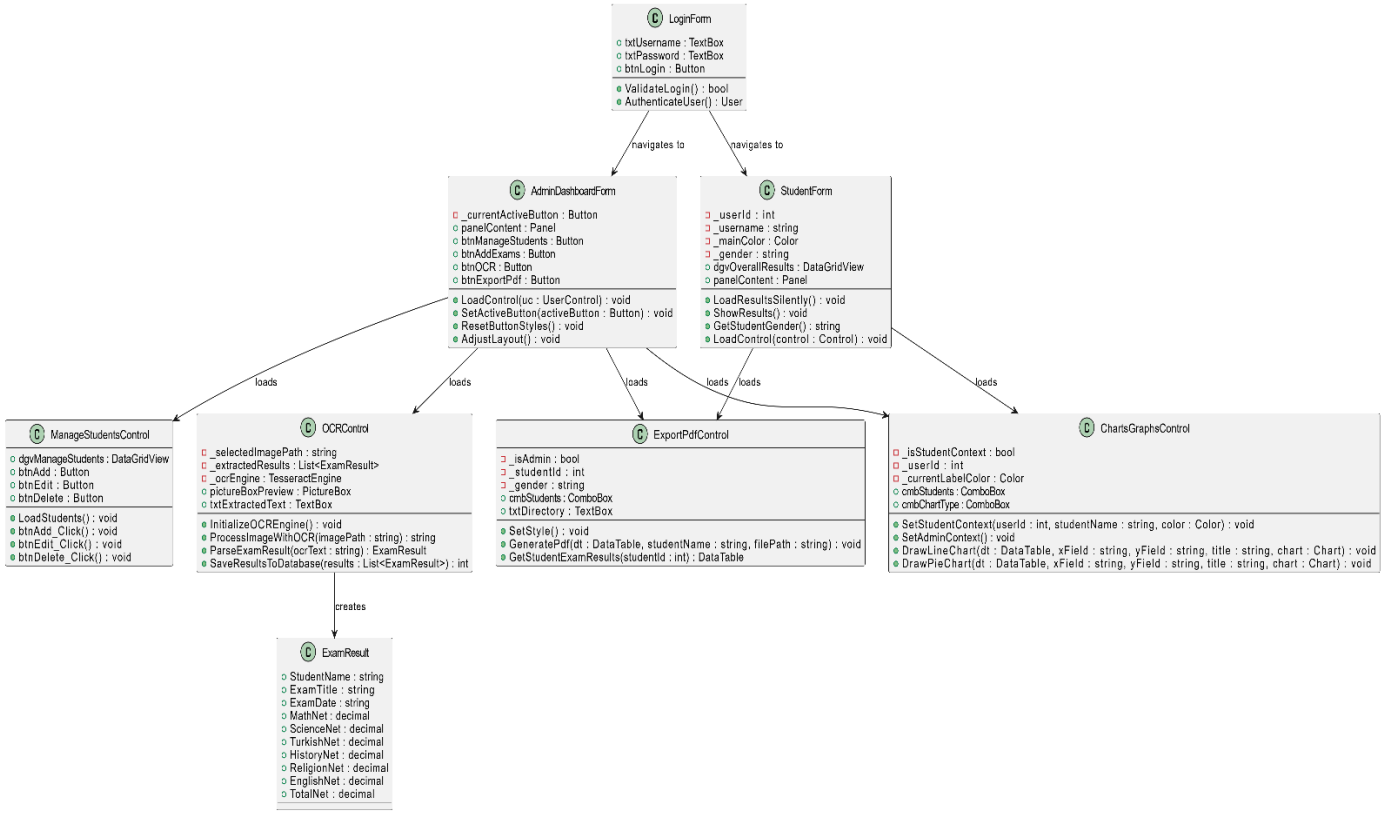
The database follows a normalized relational structure ensuring data integrity and efficient querying. The central Users table manages authentication, while Students extends user information with academic details. Exams define test instances, ExamResults store aggregate scores, and ExamSubjects provide detailed subject-wise breakdowns. Foreign key relationships maintain referential integrity across all tables.

Use Case Diagram



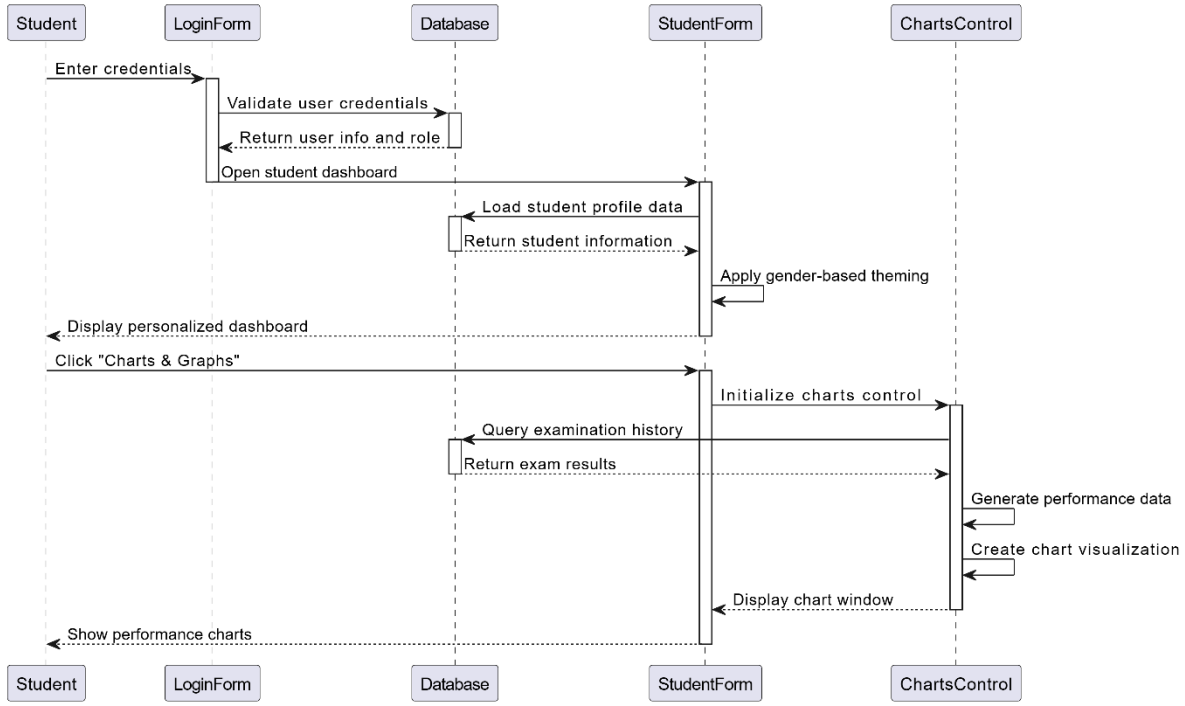
This diagram illustrates the two primary actors (Admin and Student) and their respective system interactions. Administrators have comprehensive system access including data management and configuration, while students have focused access to personal data and self-service features. Both user types must authenticate through the login system before accessing role-specific functionality.

UML Class Diagram



This class diagram demonstrates the object-oriented architecture of the application. Main form classes (AdminDashboardForm, StudentForm, LoginForm) control navigation and user interface management. Specialized control classes handle specific functionality domains like OCR processing, PDF operations, and chart generation. The ExamResult class serves as a data transfer object for examination information across system components.

Sequence Diagram - Student Login and Performance Analysis



This sequence diagram illustrates the interaction flow when a student logs in and accesses performance charts. The process demonstrates authentication validation, personalized interface loading with gender-based theming, and dynamic chart generation based on the student's examination history. The diagram shows the separation of concerns between authentication, data access, and visualization components.

13. User Stories and Use Cases

User Stories

Administrative User Stories

US001: Student Management *As an administrator, I want to add new students to the system so that I can track their examination performance.*

Acceptance Criteria:

- Administrator can create new student records with complete personal information
- System validates required fields and prevents duplicate entries
- New students automatically receive system login credentials

- Student records include contact information and emergency contacts

US002: Bulk Examination Data Entry *As an administrator, I want to input examination results for multiple students efficiently so that I can minimize data entry time.*

Acceptance Criteria:

- Administrator can select examination and enter results for all students
- System provides validation for score ranges and data consistency
- Bulk operations include progress indicators and error reporting
- Changes can be reviewed before final database commitment

US003: PDF Import Automation *As an administrator, I want to import examination results from PDF files automatically so that I can reduce manual data entry errors.*

Acceptance Criteria:

- System accepts PDF files through drag-and-drop or file selection
- Automatic text extraction identifies student names, scores, and examination details
- Import process provides data validation and error correction opportunities
- Successfully imported data populates student examination records

US004: OCR Processing for Scanned Documents *As an administrator, I want to process scanned examination sheets using OCR so that I can digitize physical documents efficiently.*

Acceptance Criteria:

- System accepts image files in common formats (PNG, JPG, TIFF)
- OCR processing recognizes Turkish and English text accurately
- Extracted data maps to appropriate database fields automatically
- Processing results allow manual verification and correction before saving

Student User Stories

US005: Personal Performance Tracking *As a student, I want to view my examination history and performance trends so that I can identify areas for improvement.*

Acceptance Criteria:

- Student dashboard displays recent examination results prominently
- Historical data shows performance trends over time with visual indicators
- Subject-wise breakdowns highlight strengths and weaknesses

- Performance metrics include net scores and comparative analysis

US006: Self-Service Test Entry *As a student, I want to add my personal practice test results so that I can maintain comprehensive performance records.*

Acceptance Criteria:

- Students can independently add practice test results through intuitive forms
- System validates score ranges and calculates net scores automatically
- Personal test entries integrate with overall performance analytics
- Data entry forms provide guidance and validation feedback

US007: Personal Report Generation *As a student, I want to generate PDF reports of my performance so that I can share progress with parents and tutors.*

Acceptance Criteria:

- Students can generate comprehensive PDF reports of examination history
- Reports include visual charts and performance trend analysis
- PDF format ensures portability and professional presentation
- Report generation provides customization options for date ranges and content

US008: Performance Visualization *As a student, I want to see my performance data in charts and graphs so that I can easily understand my progress patterns.*

Acceptance Criteria:

- Multiple chart types available (line graphs, pie charts, bar charts)
- Interactive charts allow examination of different time periods and subjects
- Visual representations update automatically when new data is added
- Charts integrate seamlessly with overall student dashboard experience

US009: System-Wide Analytics *As an administrator, I want to view comparative analytics across all students so that I can identify institutional performance trends.*

Acceptance Criteria:

- Dashboard displays aggregate performance statistics
- Comparative charts show class averages and individual performance ranges
- Filter capabilities allow analysis by time period, examination, or student groups
- Export functionality provides institutional reports for stakeholders

US010: Advanced PDF Report Customization *As an administrator, I want to customize PDF report formats so that reports meet institutional branding and requirements.*

Acceptance Criteria:

- Report templates allow header/footer customization with institutional logos

- Multiple report layouts accommodate different stakeholder needs
- Batch report generation processes multiple students simultaneously
- Professional formatting includes charts, tables, and summary statistics

US011: Data Backup and Recovery *As an administrator, I want to backup and restore system data so that institutional records remain secure.*

Acceptance Criteria:

- Automated backup schedules ensure regular data protection
- Manual backup triggers allow on-demand data export
- Restoration procedures recover data from backup files
- Backup validation confirms data integrity and completeness

US012: Multi-Language Interface Support *As a user, I want to use the system in Turkish or English so that language barriers don't impede system usage.*

Acceptance Criteria:

- Complete interface translation between Turkish and English
- OCR processing supports both language sets simultaneously
- Report generation adapts to selected language preferences
- Help documentation available in both languages

Detailed Use Cases

Use Case 1: Administrator Processes OCR Document

Primary Actor: Administrator

Goal: Extract examination data from scanned document using OCR

Preconditions: Administrator is logged in, has scanned examination document

Success Scenario:

1. Administrator selects OCR Scanner from navigation menu
2. System displays OCR processing interface with file selection option
3. Administrator selects image file containing examination results
4. System displays selected image in preview panel
5. Administrator clicks "Process OCR" button
6. System processes image using Tesseract OCR engine with Turkish/English support
7. System extracts text and displays raw OCR output
8. System parses extracted text to identify examination data fields
9. System populates structured data grid with parsed information

10. Administrator reviews extracted data for accuracy
11. Administrator makes corrections if necessary
12. Administrator clicks "Save Results" to commit data to database
13. System validates data and creates/updates student and examination records
14. System displays success confirmation with summary of saved records

Alternative Scenarios:

- 6a. OCR processing fails due to poor image quality
    - System displays error message with image quality recommendations
    - Administrator can retry with improved image or use manual entry
- 9a. Text parsing fails to identify required data fields
    - System displays warning about incomplete data extraction
    - Administrator can manually complete missing fields or cancel operation

Use Case 2: Student Views Performance Charts

Primary Actor: Student

Goal: View personal examination performance in graphical format

Preconditions: Student is logged in, has examination data in system

Success Scenario:

1. Student clicks "Charts & Graphs" from navigation menu
2. System loads charts control with student context pre-configured
3. System displays chart type selection options (Total Nets, Subject Breakdown)
4. Student selects "Graph/Chart for Exams Total Nets"
5. Student chooses display type (Chart or Graph)
6. Student clicks "Show" button
7. System queries database for student's examination history
8. System generates performance data for chart creation
9. System opens new window with generated chart
10. Chart displays student name, examination names, and performance trends
11. Student can interact with chart elements for detailed information
12. Student can close chart window to return to main interface

Alternative Scenarios:

- 7a. No examination data exists for student
    - System displays message indicating no data available
    - Student can choose to add personal practice test results
- 8a. Student selects subject-specific chart

- System requires examination selection for subject breakdown
- Student selects specific examination from dropdown list
- System generates subject-wise performance pie chart

Use Case 4: Student Generates Personal PDF Report

Primary Actor: Student

Goal: Generate and export personal examination performance report in PDF format

Preconditions: Student is logged in, has examination history in system

Success Scenario:

1. Student navigates to "Export PDF" section from main menu
2. System displays PDF export interface with student information pre-populated
3. System shows directory selection for PDF output location
4. Student clicks "Browse" to select output directory
5. Student selects desired folder location for PDF file
6. Student clicks "Save PDF" button to initiate report generation
7. System queries database for complete student examination history
8. System retrieves all examination results with subject-wise breakdowns
9. System calculates summary statistics (total exams, average performance)
10. System generates professional PDF using PdfSharp library
11. PDF includes formatted tables with examination results, subject scores, and dates
12. System adds performance summary section with calculated averages
13. System saves PDF file with student name and timestamp
14. System displays success confirmation with file location
15. Student can open generated PDF or continue with other operations

Alternative Scenarios:

- 5a. Student cancels directory selection
  - System returns to export interface without changes
  - Student can retry directory selection or cancel operation
- 7a. No examination data exists for student
  - System displays informative message about missing data
  - Student directed to add examination results before generating reports
- 11a. PDF generation fails due to file system permissions
  - System displays error message with suggested solutions
  - Student can retry with different directory or contact administrator

Use Case 5: Administrator Performs Bulk Student Management

Primary Actor: Administrator

Goal: Manage multiple student records efficiently through batch operations

Preconditions: Administrator is logged in with appropriate permissions

Success Scenario:

1. Administrator selects "Manage Students" from navigation menu
2. System displays comprehensive student list with management controls
3. Administrator uses search functionality to filter student records
4. System displays filtered results matching search criteria
5. Administrator selects multiple students using checkbox selection
6. Administrator chooses bulk action from available operations menu
7. System confirms bulk operation with detailed summary of affected records
8. Administrator confirms operation after reviewing impact summary
9. System processes bulk operation with progress indication
10. System validates each individual operation within bulk process
11. System commits successful operations while logging any failures
12. System displays completion summary with success/failure statistics
13. Administrator reviews results and addresses any failed operations
14. System updates student list display to reflect all changes

Alternative Scenarios:

- 6a. No students selected for bulk operation
    - System displays warning message about empty selection
    - Administrator must select students before proceeding
- 9a. Bulk operation encounters validation errors
    - System continues processing valid records while collecting error details
    - System provides detailed error report for administrator review
- 11a. Database constraint violations during bulk operation
    - System rolls back problematic operations while preserving successful ones
    - Administrator receives detailed report of constraint violations

Use Case 6: Administrator Configures System Settings

Primary Actor: Administrator

Goal: Configure system-wide settings and preferences

Preconditions: Administrator has system configuration privileges **Success Scenario:**

1. Administrator accesses system configuration menu
2. System displays configuration categories (Database, OCR, Reports,)
3. Administrator selects specific configuration category
4. System displays current settings with modification options
5. Administrator modifies configuration parameters as needed
6. System validates configuration changes for consistency and compatibility
7. Administrator previews configuration impact before applying changes
8. System applies validated configuration changes to active system
9. System creates backup of previous configuration for rollback capability
10. System notifies all active users of configuration changes if applicable
11. Administrator tests modified functionality to ensure proper operation
12. System logs configuration changes for audit trail purposes

Alternative Scenarios:

- 6a. Invalid configuration parameters provided
    - System displays validation errors with corrective guidance
    - Administrator must resolve validation issues before proceeding
- 8a. Configuration changes require system restart
    - System notifies administrator of restart requirement
    - Administrator can schedule restart or apply changes immediately

Use Case 7: System Performs Automated Data Validation

Primary Actor: System (Automated Process)

Goal: Validate data integrity and consistency across all system records

Preconditions: System has accumulated examination data requiring validation

Success Scenario:

1. System initiates scheduled data validation process
2. System examines all student records for completeness and consistency
3. System validates examination result calculations against stored values
4. System checks referential integrity between related database tables
5. System identifies orphaned records or missing relationships
6. System validates score ranges against examination parameters
7. System generates comprehensive validation report with findings
8. System automatically corrects minor inconsistencies where possible

9. System flags major issues requiring administrative attention
10. System sends validation report to designated administrators
11. System schedules next validation cycle based on configuration
12. System maintains validation history for trend analysis

Alternative Scenarios:

- 4a. Significant data integrity issues discovered
    - System immediately alerts administrators of critical issues
    - System may suspend certain operations until issues are resolved
- 8a. Automatic correction fails for identified issues
    - System documents failed correction attempts in detailed logs
    - System escalates issues to administrative review queue

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