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Implementation of a Rule-Based Expert System in the Web-Based SMK Boarding and Semi Boarding Admission System by the Central Java Government

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Abstract— The student admission process for boarding and semi-boarding vocational schools involves complex administrative, academic, and socio-economic criteria, which often lead to inefficiencies and inconsistencies when handled manually. This study proposes a web-based student admission system integrating a rule-based expert system to automate multi-stage selection processes in vocational high schools managed by the Central Java Provincial Government. The system was developed using a Research and Development approach with the Agile Scrum methodology. Knowledge representation is implemented through IF–THEN rules derived from officially verified admission guidelines, enabling automated scoring, ranking, and admission decisions. The proposed system was applied across three boarding schools and fifteen semi-boarding schools during the 2024 admission period. The results indicate that the system reduces processing time, improves scoring consistency, and enhances transparency and accountability in decision-making. This study demonstrates that integrating a rule-based expert system with official admission regulations provides an effective and scalable solution for large-scale student selection processes.

Keywords: Student Admission System, Rule-Based Expert System, Decision Support System, Boarding School, and Agile Development.

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1. Introduction

The admission of new students is a critical process in educational institutions, particularly in vocational high schools that implement boarding and semi-boarding schemes. These institutions must evaluate prospective students based on multiple criteria, including academic performance, socio-economic conditions, health assessments, and aptitude tests. Conventional admission processes often rely on manual verification and calculation, which can result in inefficiencies, data inconsistencies, and potential bias [1].

Various online admission systems have been developed to address these challenges by digitizing registration and data management processes. However, most existing systems function primarily as data collection platforms and still require significant human intervention during evaluation and decision-making stages, which limits objectivity and transparency [2].

In recent years, the application of intelligent decision support systems in educational administration has gained increasing attention, particularly to address issues of fairness, transparency, and efficiency in student selection processes. Several studies have highlighted that automated admission systems integrated with formal decision models can significantly reduce administrative workload while improving the consistency and objectivity of selection outcomes [3]. Furthermore, the integration of expert system–based decision logic within web-based educational platforms has been shown to enhance accountability and traceability, which are critical requirements for public-sector education systems [4].

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These findings reinforce the relevance of adopting rule-based expert systems for large-scale vocational school admission processes.

Expert systems have been widely adopted as decision support tools in complex problem domains due to their ability to emulate expert reasoning using structured knowledge representations. Rule-based expert systems are particularly effective when decision logic can be explicitly defined through formal IF–THEN rules [5]. Previous studies have applied expert systems in recruitment and educational decision-making contexts, demonstrating their potential to improve consistency and decision accuracy [2], [6].

This study addresses this gap by proposing a web-based student admission system that integrates a rule-based expert system with officially issued admission guidelines from the Central Java Provincial Government [7]. Unlike prior admission systems or standalone expert system implementations, the proposed system supports automated multi-stage selection, including administrative verification, scoring, ranking, and final admission decisions across multiple institutions. The main contributions of this study are threefold: (1) the integration of rule-based reasoning with government-validated admission criteria, (2) the implementation of a scalable system deployed across multiple boarding and semi-boarding vocational schools during the 2024 admission period, and (3) empirical evidence of improved efficiency and consistency in the student selection process.

Unlike previous studies that focus on generic admission systems or standalone expert systems, this study introduces a rule-based expert system that is explicitly integrated with officially verified admission system assessment guidelines issued by the Central Java Provincial Government. The proposed system supports multi-stage selection processes across multiple boarding and semi-boarding vocational schools, enabling automatic scoring, ranking, and admission decisions based on predefined institutional rules. This integration and large-scale implementation distinguish the proposed system from existing admission system platforms and prior expert system applications.

2. Method

This study employed a Research and Development (R&D) approach to design, develop, and evaluate a web-based student admission system integrated with a rule-based expert system. The R&D method is widely used in information system and software engineering research because it emphasizes iterative development, validation, and refinement based on user and stakeholder feedback [8]. This approach is particularly suitable for developing institutional information systems that must comply with formal regulations and operational procedures.

The system development process adopted the Agile Scrum methodology to ensure flexibility, adaptability, and continuous improvement throughout the development lifecycle. Agile methods have been proven effective in developing complex information systems by promoting incremental development, continuous evaluation, and close collaboration among stakeholders [9], [10]. Scrum organizes development activities into short, iterative cycles known as sprints, where each sprint produces a functional system increment that can be reviewed and refined. The system development process in this study follows the Scrum framework. Figure 1 shows the Scrum life cycle, including product backlog preparation, sprint planning, sprint execution, and iterative evaluation phases.



Figure 1. Scrum Life Cycle (Adopted from [11])

Recent empirical studies indicate that Agile Scrum improves development transparency, reduces project risk, and enhances software quality, particularly in institutional and distributed development environments [9], [10], [12]. Furthermore, the use of Scrum supports disciplined project management and rapid response to changing requirements, making it suitable for large-scale public-sector information systems [11]. Based on these advantages, Scrum was selected as the development framework for this study.

The decision-making component of the proposed system is implemented using a rule-based expert system, in which knowledge is explicitly represented through IF–THEN rules. Rule-based reasoning is particularly appropriate for decision-making scenarios governed by standardized regulations and clearly defined criteria, such as public education admission systems [5].

In this study, the rules were derived from officially verified student admission guidelines issued by the Central Java Provincial Government for the 2024 admission period [7]. Each rule evaluates specific criteria, including academic performance, socio-economic conditions, administrative completeness, and supporting documents. The inference engine processes validated input data and automatically generates scores, rankings, and selection outcomes.

Previous studies have demonstrated that rule-based expert systems provide transparent, explainable, and consistent decision support, especially in administrative and educational domains where accountability and fairness are essential [6]. By applying uniform rules across all participating schools, the proposed system minimizes subjectivity, reduces human error in scoring and ranking, and ensures consistent evaluation across multiple boarding and semi-boarding vocational schools.

In this study, knowledge representation is implemented using a rule-based expert system, where decision logic is expressed through a set of IF–THEN rules derived from validated admission criteria. This approach enables consistent evaluation of prospective students by automating decision-making processes based on predefined conditions, thereby reducing subjectivity and human error. The logical structure of the decision-making component is implemented using a rule-based expert system. Figure 2 illustrates the structure of the rule-based expert system, consisting of the knowledge base, inference engine, and user interface components.

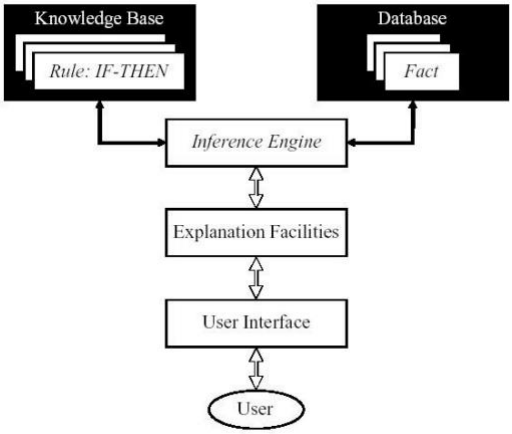


Figure 2. Structure of a Rule-based Expert System

For instance, if the traffic light is red, then stop; if the traffic light is green, then go. In this case, the system understands how a traffic light operates. This structure links information in the "IF" part—known as the premise or condition—to an action or inference in the "THEN" part. A rule may include multiple conditions connected by keywords like AND (for conjunction) and OR (for disjunction). Operators such as is, are, is not, and are not can also be used to assign a value to an object in the condition. Rules can represent various types of logic [6]:

1) **Relations**
   IF academic_score ≥ 85 (weight = 40%)
   AND socio_economic_score ≥ 70 (weight = 30%)
   AND document_verification = valid (weight = 10%)
   THEN total_weighted_score = (0.40 × academic_score) + (0.30 × socio_economic_score) + (0.10 × document_score).
2) **Recommendations**
   IF total_weighted_score ≥ 75
   THEN candidate_status = "Eligible for Ranking."
3) **Directives**
   IF candidate_status = "Eligible for Ranking"
   AND ranking_position ≤ program_quota
   THEN final_status = "Accepted (P1 or P2 based on preference priority)."

2.1 Data Collection

The data collection phase is crucial for understanding the requirements and nuances of the boarding school selection process with three boarding schools and fifteen semi-boarding schools in the Central Java province, the institutions include SMK Negeri Jateng di Semarang, SMK Negeri Jateng di Pati, SMK Negeri Jateng di Purbalingga, SMKN 1 Wirosari, SMKN 1 Randudongkal, SMKN 1 Tonjong, SMKN 2 Rembang, SMKN 2 Wonogiri, SMKN 2 Wonosobo, SMKN 1 Alian, SMKN 1 Demak, SMKN 1 Jepon, SMKN 1 Kalibagor, SMKN 1 Kedawung, SMKN 1 Punggelan, SMKN 1 Tulung, SMKN 2 Cilacap, SMKN 1 Purworejo. This phase primarily utilized the interview method for requirement gathering, ensuring a comprehensive and accurate compilation of necessary information.

Interviews were conducted with key stakeholders, including school administrators, selection committee members, and technical staff involved in the boarding school selection system. These interviews aimed to extract detailed insights into the existing selection criteria, challenges faced in previous implementations, and specific requirements for the new system. By engaging with these stakeholders, the researchers could identify and document both functional and non-functional requirements critical to the development of the expert system.

Furthermore, the data collection process was aligned with the guidelines set forth by the Acceptance of New Students for SMKN Boarding Schools in Central Java for the year 2024 [7]. This alignment ensured that the requirements gathered were up-to-date and compliant with the latest regulations and standards. The guidelines provided a structured framework that helped in framing the interview questions and analyzing the responses, ensuring that the developed system would meet all the necessary legal and educational criteria.

2.2 Design

2.2.1 Entity Relationship Diagram (ERD)

The database structure of the proposed admission system is modeled using an Entity Relationship Diagram. Figure 3 presents the ERD, describing the relationships among personal data, family data, achievement data, socio-economic data, and selection status entities.

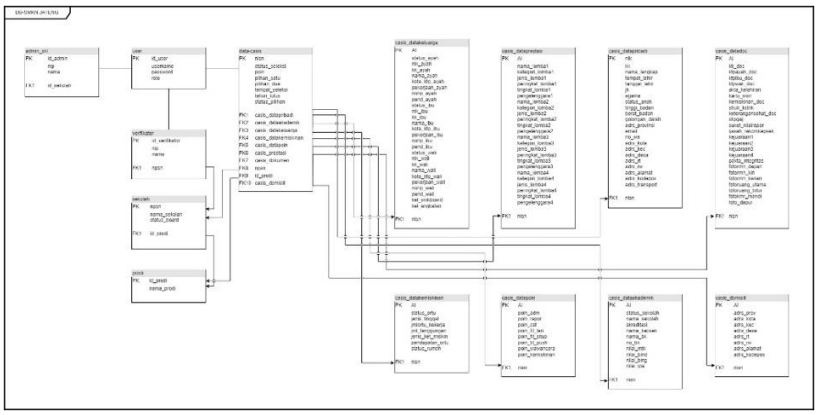


Figure 3. Entity Relationship Diagram Admission of New Students Information System

Below is the description of the Entity-Relationship Diagram (ERD) for the new student admission information system, which consists of the following tables:

1. Personal Data Table
   Contains personal information of prospective students such as name, address, date of birth, gender, and contact number.
2. Achievement Data Table
   Includes information about the academic and non-academic achievements of prospective students, such as report card grades, awards, and extracurricular activities.
3. Family Data Table
   Contains information about the family of prospective students, such as the names of parents or guardians, their occupations, education, and emergency contacts.
4. Poverty Data Table
   Stores information about the economic condition of the prospective students' families, such as income, number of dependents, and poverty category.
5. Requirement Documents Data Table
   Contains details about the required documents that must be submitted by prospective students, such as scans of ID cards, birth certificates, and other documents.
6. Application and Selection Status Data Table
   Stores information about the registration status of prospective students and their selection status, including the stages of selection they have passed.
7. School and Program of Study Data Table
   Contains information about the schools and study programs available for the prospective students' choices, including descriptions, entry requirements, and quotas.

The ERD will depict the relationships between each table, such as the one-to-one relationship between the Personal Data Table and the Family Data Table (each prospective student has one set of personal data and one set of family data), as well as the one-to-many relationship between the Application and Selection Status Data Table and the Personal Data Table (one prospective student can have many selection status entries, but each selection status entry is related to only one personal data record).

2.2.2 Architectural Diagrams

Infrastructure also plays an important role in information systems. Information technology infrastructure includes all the hardware, software, networks, servers, and data centers needed to process, store, and manage data in information systems. The following illustrates the supporting infrastructure for information systems. The overall infrastructure and deployment model of the proposed system are described through the system architecture. Figure 4 shows the architectural design, including the web application layer, database server, and user access roles.

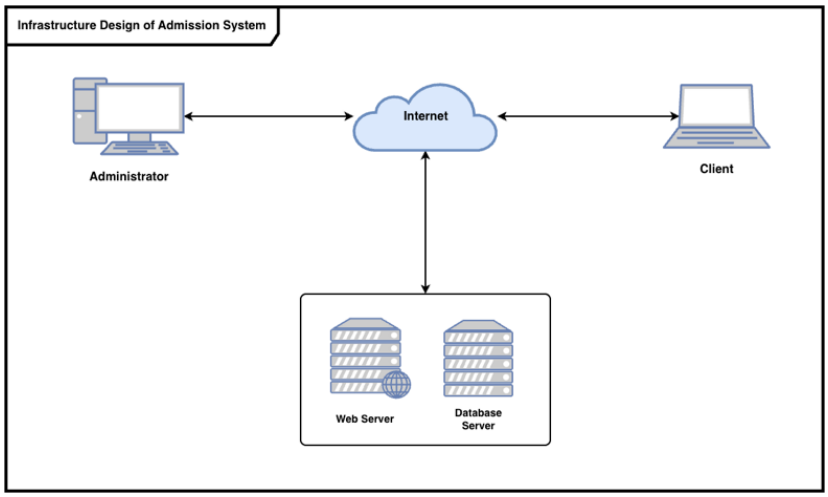


Figure 4. Architectural Diagrams

2.2.3 Information Systems Framework

The integration between data input, rule-based evaluation, and output generation is conceptualized in the system framework. Figure 5 illustrates the information systems framework, demonstrating how input data are processed through rule-based reasoning to generate admission decisions.

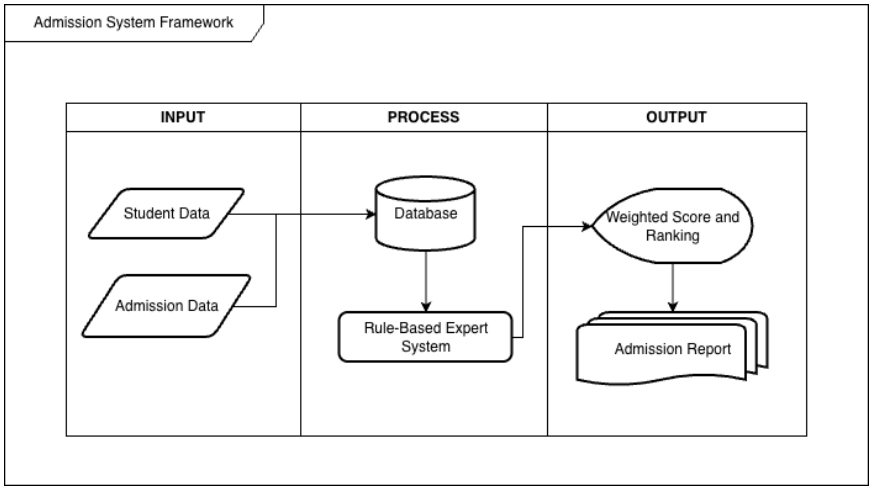


Figure 5. Information Systems Framework

The new student admission selection information system is a framework designed to manage the selection process efficiently and accurately. This framework functions by collecting participant data, such as personal information and educational history, as well as selection result data, such as test scores and other assessment criteria. All this data is processed in an organized manner in a specially designed database. In this database, the system uses a rule-based expert system to analyze data and make decisions based on predetermined rules. This expert system allows the system to evaluate the qualifications of new students automatically, reducing human error and increasing consistency in the selection process.

2.2.4 System Design

1) Use Case

The following is a use case description of a new student admissions information system involving various actors, including prospective students, administrators, verifiers, and super admins:

a. Actor: Prospective Student
    1. Use Case Name: Fill in Personal Data
       Description: Prospective students access the system to fill in their personal information such as name, address, date of birth, and contact information.
    2. Use Case Name: Fill in Academic and Achievement Data
       Description: Prospective students enter their academic data, such as report cards or transcripts, as well as relevant academic or non-academic achievements.
    3. Use Case Name: Fill in Family Data
       Description: Prospective students fill out information about their family, including parent or guardian data, parent's occupation, and emergency contact information.
    4. Use Case Name: Fill in Poverty Data
       Description: Prospective students who come from poor families fill in information related to their family's economic conditions, such as income and number of dependents.
b. Actor: Administrator
    1. Use Case Name: Managing Admission System Configuration
       Description: Administrators have access to manage the Admission system configuration, including setting registration deadlines, managing student admission categories, and making other settings.
    2. Use Case Name: Administering CBT (Computer Based Test)
       Description: Administrators are responsible for managing online entrance exams, including creating question banks, managing exam schedules, and supervising the exam implementation process.
c. Actor: Verifier
    1. Use Case Name: Validation of Prospective Student Input
       Description: Verifiers validate the data entered by prospective students to ensure the accuracy and validity of the information provided.
d. Actor: Super Admin
    1. Use Case Name: User Management
       Description: Super admin has full access to manage system users, including creating, deleting, or changing user access rights such as administrators and verifiers.

User interactions within the admission system are represented using a use case diagram. Figure 6 shows the use case diagram, identifying system actors such as prospective students, administrators, verifiers, and super administrators along with their respective system interactions.

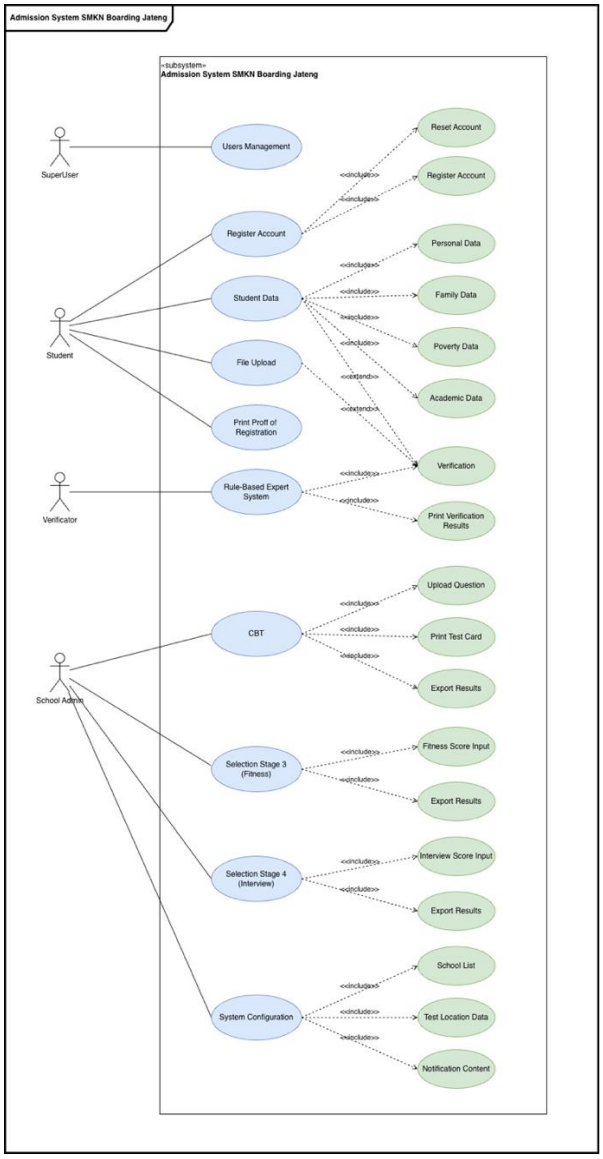


Figure 6. Use Case

Each use case describes the interaction between actors and the information system for accepting new students in meeting their functional needs. By using use cases, systems can be designed and implemented according to the needs of the users and stakeholders involved.

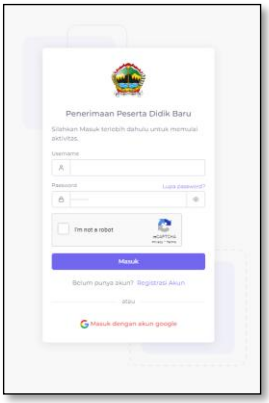
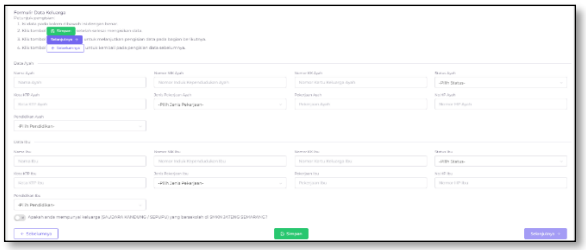
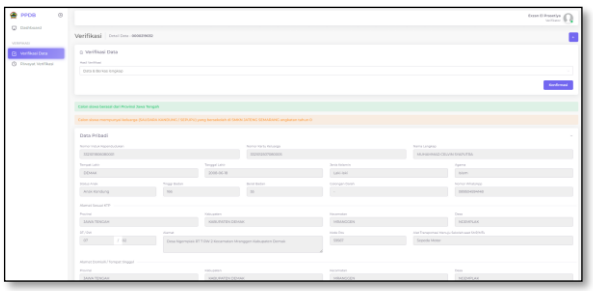
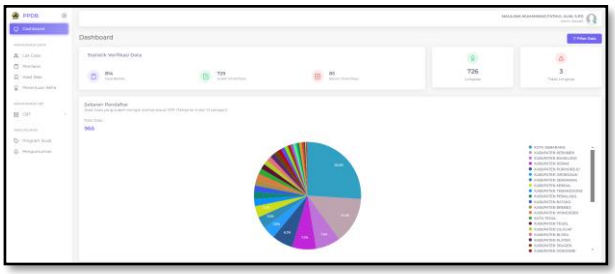
3. Result and Discussion

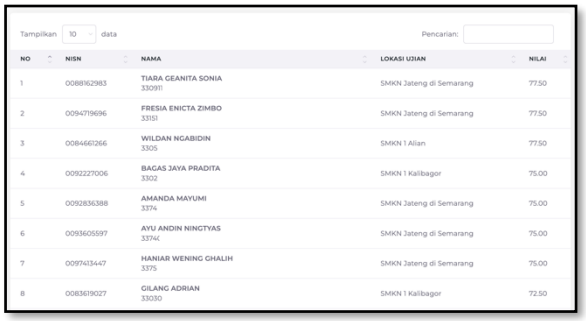
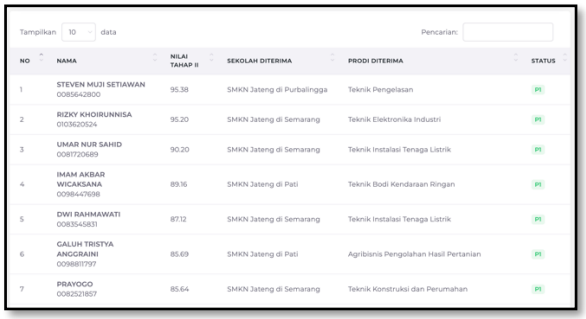
Based on the design results of the new student admission information system that integrates a rule-based expert system with assessment guidelines and weightings predetermined by the committee, a system was developed that can present data on the dashboard to assist decision-makers in determining strategic steps during the selection process. This system helps convert the verified registration data entries into scores for each prospective new student.

After the scores are obtained, ranking is done according to the school and department in each vocational high school and integrated with other scores, such as academic test scores, health test scores, psychometric test scores, fitness test scores, and interview scores. Once the rule-based expert system process is completed, the candidates who have passed the entire selection process are identified and granted the right to pursue their education at the selected school. To evaluate the functionality of the developed admission system, black-box testing was conducted on several main system features. The

testing focuses on verifying whether each function operates according to the specified requirements. Table 1 shows the results of the black-box testing performed on the system.

Table 1. Black-Box Testing Results of the Admission System

No	View	Sub Test	Test Result
1		Enter the system with username, password, and captcha	If the username and password are correct, the system will display a unique main page based on the user's role. If they are incorrect, the system will remain on the login page
2		Add personal data, family data, upload document for prospective students' actor.	Data stored in the database is equipped with validation of numbers, dates, text. The document upload feature requires certain document formats with file size limitations
3		Verification of data and files of prospective students by school verifier actors	If the data is declared complete, the system will lock the data and continue to calculate the number of points using a rule based expert system. If any data is declared incomplete, then the data is open to data changes by prospective students.
4		Managing prospective student data, assessing the results of implementing rule based expert systems, computer-	The system can display data according to the available features, with visualizations in the form of graphs and data summaries.

No	View	Sub Test	Test Result
		based tests, and study programs in school admin actors.	
5		Computer Based Test	The results of the academic tests using CBT have been integrated into the selection system.
6		Scoring, ranking, and selection status	Displaying the scores from the application of a rule-based expert system with the established evaluation guidelines. These scores serve as the basis for ranking and determining admissions according to the quotas set for each program of study. The graduation status is categorized into two types: P1 (First Choice) for admission to the primary choice and P2 (Second Choice) for admission to the alternative.

System evaluation was conducted through functional testing and user-based evaluation involving administrators and verifiers. Functional testing confirmed that all system modules operated according to predefined requirements, including data validation, rule execution, and ranking generation. User feedback indicated that the system improved usability and reduced administrative workload, particularly during peak admission periods.

The implementation of the proposed system significantly improved the efficiency of the admission process. Compared to the previous manual-based system, the average selection processing time was reduced by approximately 40–50%, particularly during the scoring and ranking stages. In addition, automated rule-based calculations minimized inconsistencies in score computation, resulting in more consistent admission outcomes across different schools. These findings indicate that the proposed system enhances both operational efficiency and decision accuracy in large-scale student admission processes.

4. Conclusion

This study presents a web-based student admission system that integrates a rule-based expert system to support boarding and semi-boarding vocational school selection processes. The system successfully automates multi-stage evaluation using officially validated criteria, reducing processing time and minimizing human error. The findings confirm that rule-based expert systems can serve as reliable decision support tools in educational admission contexts. Future work may incorporate machine learning techniques to further enhance adaptability and predictive accuracy.

Acknowledgment

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