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Developing a Career Guidance Expert System for Selection of University Programme by Secondary School Students

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ABSTRACT

Selecting an appropriate university programme is a critical decision in the life of a secondary school student. However, many students make this decision without adequate professional guidance, leading to poor career alignment and underutilization of their potential. The lack of structured and accessible career counseling services in many schools further exacerbates this issue. This study presents the design and implementation of an Intelligent Career Guidance Expert System using Decision Tree Algorithm, Rule-Based Inference Engine, and Fuzzy Logic to assist students in making informed university programme choices. The system leverages artificial intelligence techniques to provide personalized recommendations based on students' academic performance, vocational interests, personality traits, and career aspirations. A diverse dataset was compiled, including academic records, interest inventories, and personality indicators. The architecture of the expert system integrates a decision tree algorithm optimized via hyperparameter tuning (e.g., adjusting max_depth) alongside rule-based inference and fuzzy logic components to simulate expert reasoning. The system was trained and validated using real-world data from secondary schools and historical university admission records. Results showed that the decision tree model achieved high accuracy in mapping student profiles to appropriate programmes. The integration of rule-based reasoning and fuzzy logic further enhanced the system's ability to handle uncertainty and expert-level nuances in decision-making. This expert system demonstrated the potential to offer reliable, cost-effective, and time-saving guidance, outperforming traditional counseling approaches. It provided students with data-driven, objective recommendations aligned with their long-term academic and career goals. The study underscores the value of integrating expert systems into school counseling services. Future improvements may include incorporating psychometric assessments, expanding datasets across various regions, and implementing feedback mechanisms involving human counselors to refine system performance continuously.

INTRODUCTION

Career selection is a crucial decision that significantly impacts an individual's future success, job satisfaction, and contributions to society. For secondary school students, choosing the right university programme is often a difficult task due to limited guidance and exposure to the range of academic and career options available (Brown, 2020). Education plays a fundamental role in shaping future outcomes, making it vital for students to make informed decisions about their academic and professional paths (Olaniyan & Okemakinde, 2020). The traditional approach to career counseling in secondary schools relies heavily on human advisors, such as teachers, parents, and school counselors. While these sources offer helpful input, they are often constrained by personal biases, limited availability, and insufficient career-related knowledge (Okeke, 2019). The problem is more pronounced in developing

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countries, including Nigeria, where a high student-to-counselor ratio and lack of trained professionals hinder effective career guidance (Eze, 2021).

Despite the importance of career guidance, many secondary schools lack structured and data-driven systems that assist students in aligning their academic interests with future career opportunities. Existing solutions depend largely on manual counseling, which is inconsistent and not scalable. There is a clear gap in the integration of intelligent systems that can simulate expert decision-making and provide automated, personalized guidance to students. To address the identified gap, this study proposes the development of a Career Guidance Expert System that integrates Decision Tree Algorithms, Rule-Based Inference Engines, and Fuzzy Logic. These artificial intelligence techniques have been widely applied in other fields like medicine and finance but remain underutilized in educational career counseling, especially within the Nigerian context (Abubakar et al., 2021; Nguyen et al., 2020). The proposed system aims to provide consistent, objective, and scalable recommendations, making career guidance more accessible and effective for all students.

This study is to design and implement an AI-powered expert system that supports secondary school students in selecting suitable university programmes based on academic strengths, interests, and aspirations. The study focuses on secondary school students in Nigeria and uses actual academic records, interest inventories, and personality assessments to develop and test the expert system. While the system is adaptable to other regions, its initial deployment is tailored to the Nigerian educational and socio-economic context. Implementing an AI-driven expert system for career guidance can significantly improve decision-making among students, reduce the rate of career mismatches, and enhance educational outcomes. It offers a scalable solution to the shortage of professional counselors and aligns with global trends in intelligent educational support systems (Olawale & Yusuf, 2020).

The aim of this study is to develop a Career Guidance Expert System that will assist secondary school students in selecting the most suitable university programme based on their academic performance, personal interests, career aspirations, and labor market trends. Choosing the right university programme is a vital decision that significantly influences a student's future career success and personal development. However, many secondary school students make this decision without adequate guidance, resulting in career mismatches, high dropout rates, and long-term dissatisfaction (Obi, 2020). Traditional counseling services in many schools are either inadequate or entirely absent, leaving students to rely on peer suggestions, parental influence, or mere assumptions. This absence of structured, evidence-based career guidance systems makes it difficult for students to align their academic strengths and interests with the most suitable career paths (Adebayo, 2019). In developing nations like Nigeria, career counseling is not a formally integrated component of the educational curriculum (Adewale, 2019). Most secondary schools lack trained career advisors, leaving students to make uninformed decisions about their academic futures. Compounding this issue is the rapidly changing global job market, with emerging fields such as artificial intelligence, biotechnology, and digital marketing becoming increasingly relevant (Nwosu & Kalu, 2021).

Without access to modern career guidance tools or real-time labor market data, students are often unaware of these new opportunities

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and tend to base their choices on outdated assumptions. Parental pressure and societal expectations also play a major role in students' career choices, often pushing them toward traditionally prestigious professions without considering their individual interests or talents (Oluwaseun, 2020). Additionally, students have limited access to comprehensive, up-to-date information about university requirements, available programmes, and career prospects. While university websites and occasional career fairs may provide some insights, these are often generalized and fail to cater to individual student needs (Eze, 2018). This information gap contributes to poor decision-making, as students are left to navigate a complex system without adequate support. Where career guidance is offered, it often suffers from one-size-fits-all approaches, generic advice, and minimal personal engagement (Okafor & Chukwu, 2020). In contrast, expert systems powered by artificial intelligence can deliver tailored, data-driven recommendations by analyzing student-specific data such as academic records, interests, and personality traits while also considering current labor market demands (Johnson, 2021). These systems offer 24/7 availability and remove biases associated with human counselors, making them an effective alternative to traditional counseling methods.

Introducing an expert system for career guidance in secondary schools can empower students to take control of their future. It can also assist school administrators and policymakers by providing insight into student preferences and national workforce trends (Ojo, 2021). Furthermore, such systems can help bridge the high unemployment rate among graduates by guiding students to align their academic pursuits with employable skills and industry demands (Adesina, 2022). Ultimately, this study aims to address the deficiencies of conventional guidance methods by developing an intelligent career guidance system that will enhance decision-making, reduce career mismatches, and foster student success.

MATERIALS AND METHODS

Research Design

This study adopts a structured research design that integrates both qualitative and quantitative approaches to ensure a comprehensive analysis of the system's development and implementation. The research process involves data collection, system design, model development, testing, and evaluation. A machine learning-based system were developed to enhance decision-making within the selected study area. The research was also involving field surveys and system usability testing to validate the effectiveness of the proposed solution.

Proposed System

The proposed expert system automates career counseling by using a Rule-Based Expert System (RBES) to analyze students' academic strengths and interests. The process starts with students entering their academic scores and career preferences into the system (Figure 1). The expert system then matches the input with predefined rules stored in its knowledge base. The inference engine processes the data, identifies the most suitable university programs, and generates personalized recommendations. If the input is insufficient, the system prompts users for additional details to refine suggestions. The final recommendations are displayed instantly, ensuring accessibility to career guidance anytime. The automated approach improves efficiency, eliminates biases, and provides accurate and consistent career advice.

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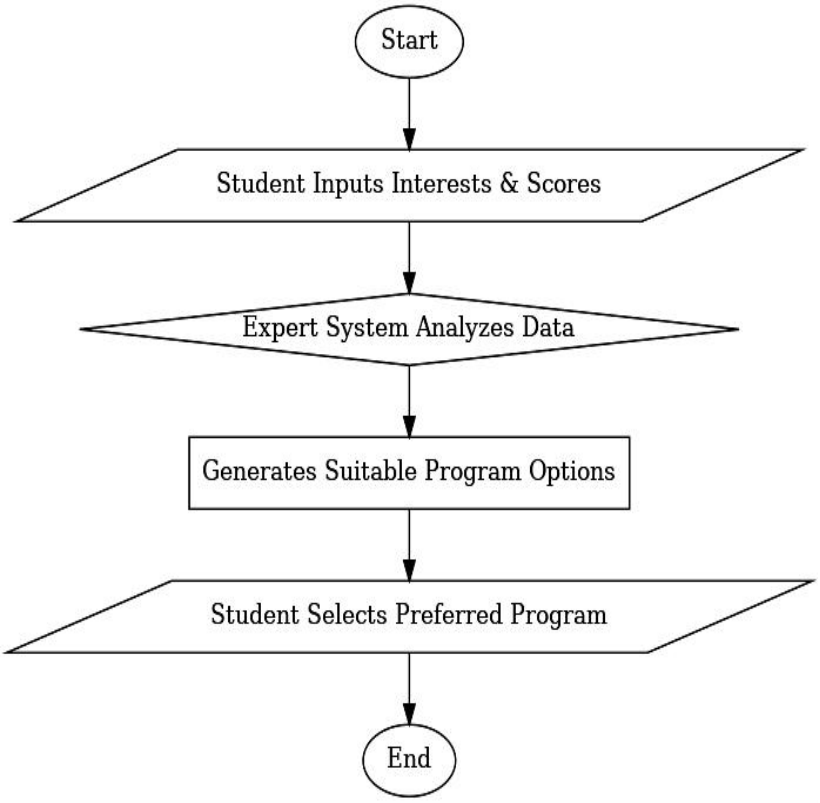

Figure 1: The Proposed System Flowchart.

System Architecture

The system is a specially designed model for the unique needs of each student to provide a suggestion or to help in the decision-making process during the course registration period at the beginning of every semester. The system can easily be merged with the current SIS system and can be integrated without any discrepancy to HEIs SIS (Figure 2).

The proposed system is specialized for each student' requirements; thus, students would able to use this system to decide in a fully informed manner without any human advisory or other guides. This leads students to get course suggestions based on their favorite area of interests, their department's curriculum, their academic history, and rules and regulations of the HEI.

System Model (Rule-Based Expert System)

The Rule-Based Expert System (RBES) follows a structured decision-making approach to recommend university programs based on students' academic strengths and interests. It uses predefined rules stored in a knowledge base to analyze student input. The inference engine processes the input, applies logical reasoning, and generates appropriate career recommendations. The system integrates an expert knowledge database to mimic human career counselors. It continuously refines decisions based on additional user-provided details. The system also allows for modifications and updates to rules, ensuring adaptability to curriculum changes. Finally, it provides personalized career suggestions, improving decision accuracy.

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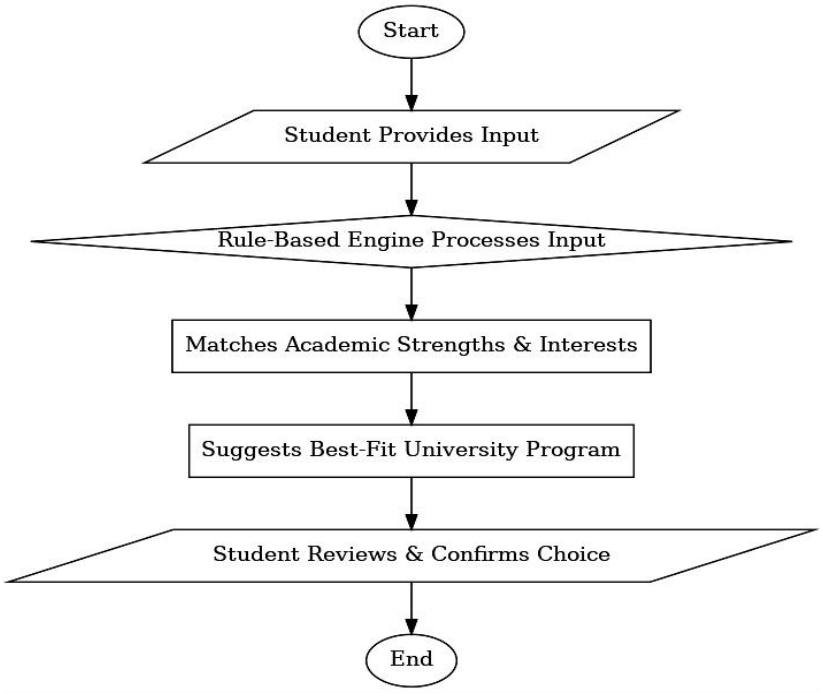

Figure 2: Career Guide System Architecture.

Three-Tier Architecture Interpretation

The system follows a three-tier architecture, ensuring modularity and efficiency. The first tier (User Interface) consists of a web-based or mobile-friendly application that allows students to input academic details. The second tier (Expert System Engine) processes input, applies decision rules, and determines suitable university programs. The third tier (Database) securely stores student records, predefined rules, and recommendations for retrieval (Figure 3). The architecture ensures scalability, enabling multiple students to access career guidance simultaneously. It allows integration with external databases for continuous learning and improvement. This approach enhances system maintainability and future upgrades.

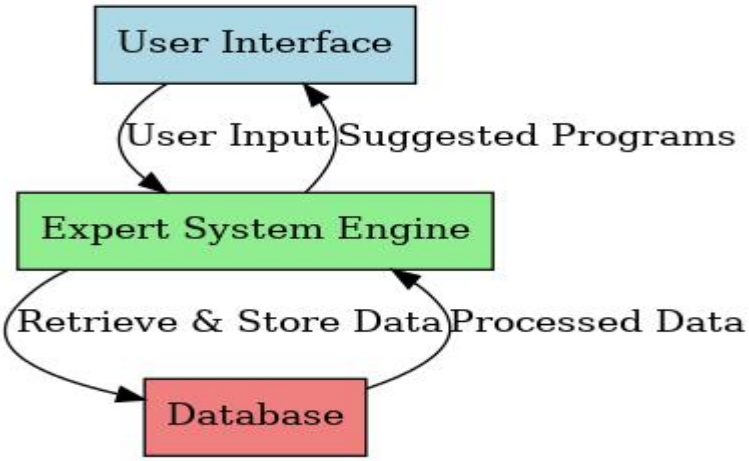

Figure 3: Three-Tier Architecture Interpretation.

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Decision-Making Flowchart Interpretation

The decision-making flowchart outlines the step-by-step process used by the expert system to guide students. It starts with the user entering their academic scores, interests, and career aspirations (Figure 4). The system then evaluates inputs against predefined rules to identify matching university programs. If the match is uncertain, the system prompts for additional input to refine recommendations. Based on analysis, the system either suggests a suitable program or recommends further career exploration. The flowchart ensures logical and structured decision-making, improving accuracy. It minimizes errors and bias by following standardized rules. Finally, the system provides students with optimal career choices, helping them make informed decisions.

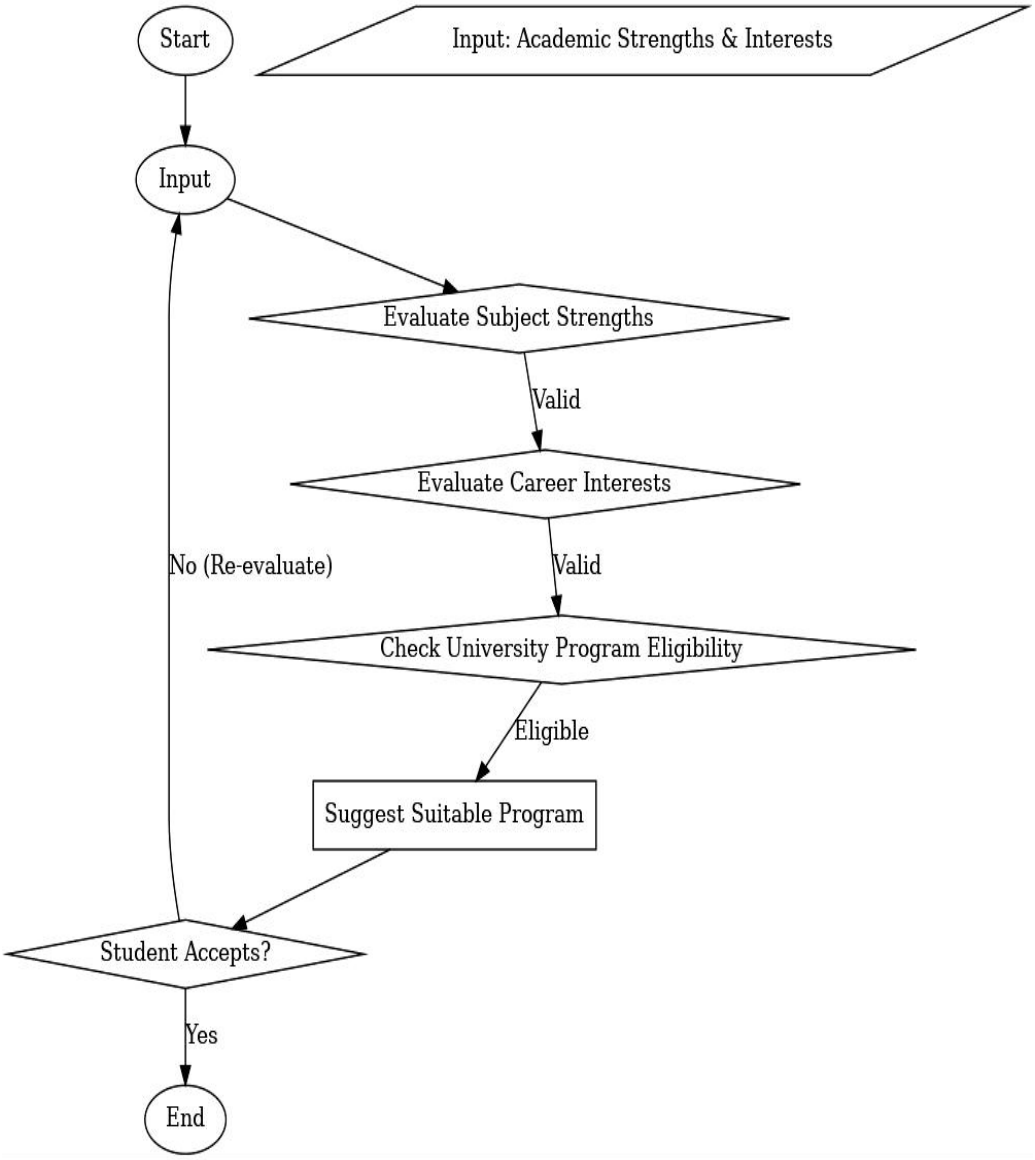

Figure 4: Decision-Making Flowchart.

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Requirement Process

The implementation of the proposed system requires **s**oftware, hardware, human, and data resources. The software components include PHP, TensorFlow, MySQL, and a web-based user interface framework. The hardware requirements include servers, personal computers, and network infrastructure to support real-time processing. Additionally, trained personnel, including system developers, data analysts, and administrators, will be required to ensure proper deployment and maintenance.

Population of Study

The target population includes students, faculty members, and system administrators at Adamawa State University, Mubi. The study was focus on students who interact with advisory and decision-making systems, academic staff who oversee student guidance, and IT personnel responsible for system management. A significant portion of the population was participated in system testing and evaluation.

Instruments Used for Data Collection

Data for this study were collected through questionnaires, interviews, system logs, and digital archives. Questionnaires were used to gather insights from students and staff regarding system expectations, while interviews with key stakeholders was provide qualitative data on the current system's limitations. System logs were analyzed to identify trends, and digital archives was served as a source for training the AI model.

Sampling Techniques

A stratified random sampling technique were adopted to ensure representation from different departments and user groups. The study were select students, faculty members, and IT personnel to provide diverse perspectives on the system's impact. A predefined sample size was determined to balance accuracy and efficiency in data analysis.

Data Gathering Process

Data collection was occurred in three stages:

i. **Preliminary Data Collection:** Surveys and interviews were conducted to understand user requirements.

ii. **System-Specific Data Collection:** Data were be extracted from **existing records, student profiles, and administrative documents** for model training.

iii. **Evaluation Data Collection:** After system deployment, user feedback and performance metrics were gathered to assess its effectiveness.

Method of Data Analysis

Data were undergoing cleaning, transformation, and feature selection to remove inconsistencies and improve model accuracy. Missing values were be handled using imputation techniques, and irrelevant data were eliminated. Feature selection techniques such as Principal Component Analysis (PCA) were applied to optimize input variables.

Model Development

A machine learning model were trained using supervised learning techniques. The dataset was split into training (80%) and testing (20%) subsets, and algorithms such as Random Forest**,** Decision Trees, and Neural Networks were evaluated for the best performance. The trained model was then be integrated into the system's decision-making framework.

Model Evaluation

The system was tested using accuracy, precision, recall, and F1-score metrics. Additionally, a comparative analysis between

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the existing system and the AI-driven system will be conducted to assess improvements in speed, efficiency, and accuracy. Feedback from users were also be analyzed to refine and optimize the model for future use.

RESULTS AND DISCUSSION

The implementation of the Career Guidance Expert System produced a functional, web-based application capable of interacting with users (students), collecting their academic interests and subject strengths, and generating accurate university programme recommendations based on rule-based logic. The results of the system are presented through various user interfaces and functionalities which include registration, questionnaire forms, result display pages, and administrative controls.

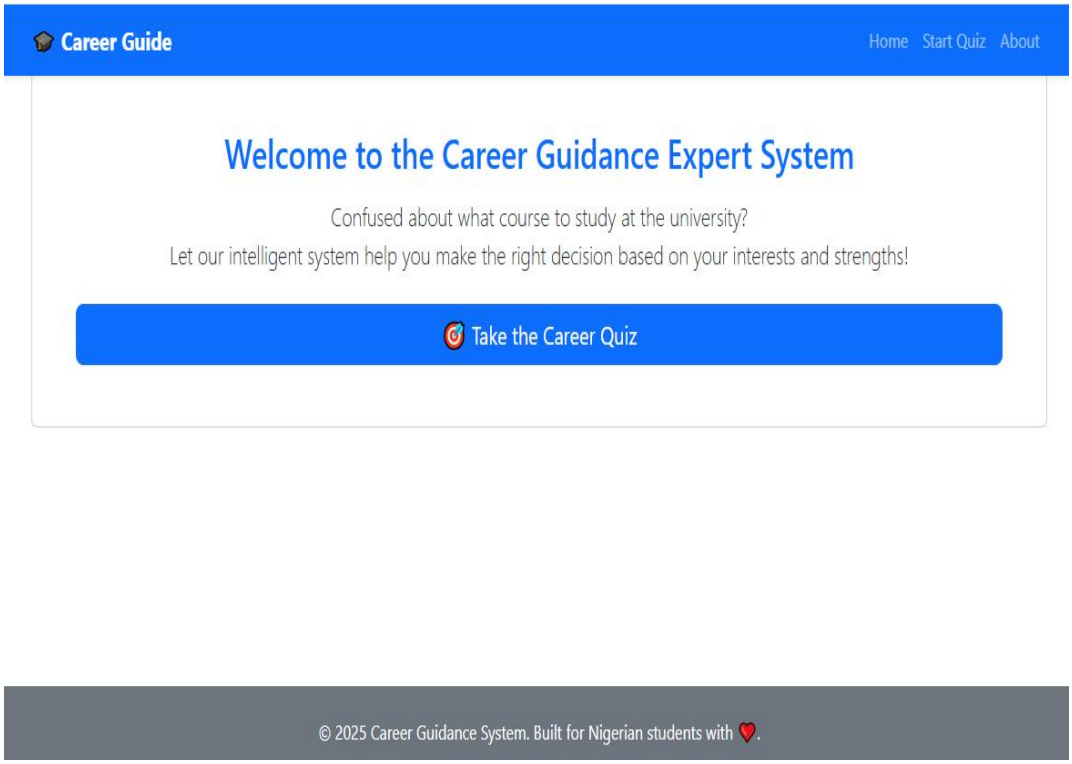

Figure 5: Homepage.

The homepage (Figure 5) welcomes users with a friendly interface that explains the purpose of the system. It invites students to begin the process of exploring suitable university courses based on their individual profiles.

The welcome message of the Career Guidance Expert System is designed to immediately capture the attention of secondary school students who may be uncertain about their future academic paths (Figure 6). It begins with a warm greeting and directly addresses a common concern among students deciding which university course to study. By posing a relatable question, the message creates a sense of understanding and encourages students to seek guidance rather than make uninformed choices.

The Career Questionnaire is a critical component of the expert system, designed to

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collect detailed information about the student's academic preferences, interests, and personal inclinations. This questionnaire forms the basis for generating accurate and personalized university programme recommendations. The questionnaire begins by asking students to identify their interests, providing an open prompt where they can express areas they feel passionate about or curious to explore. This helps the system understand what motivates and excites the student beyond just academic performance.

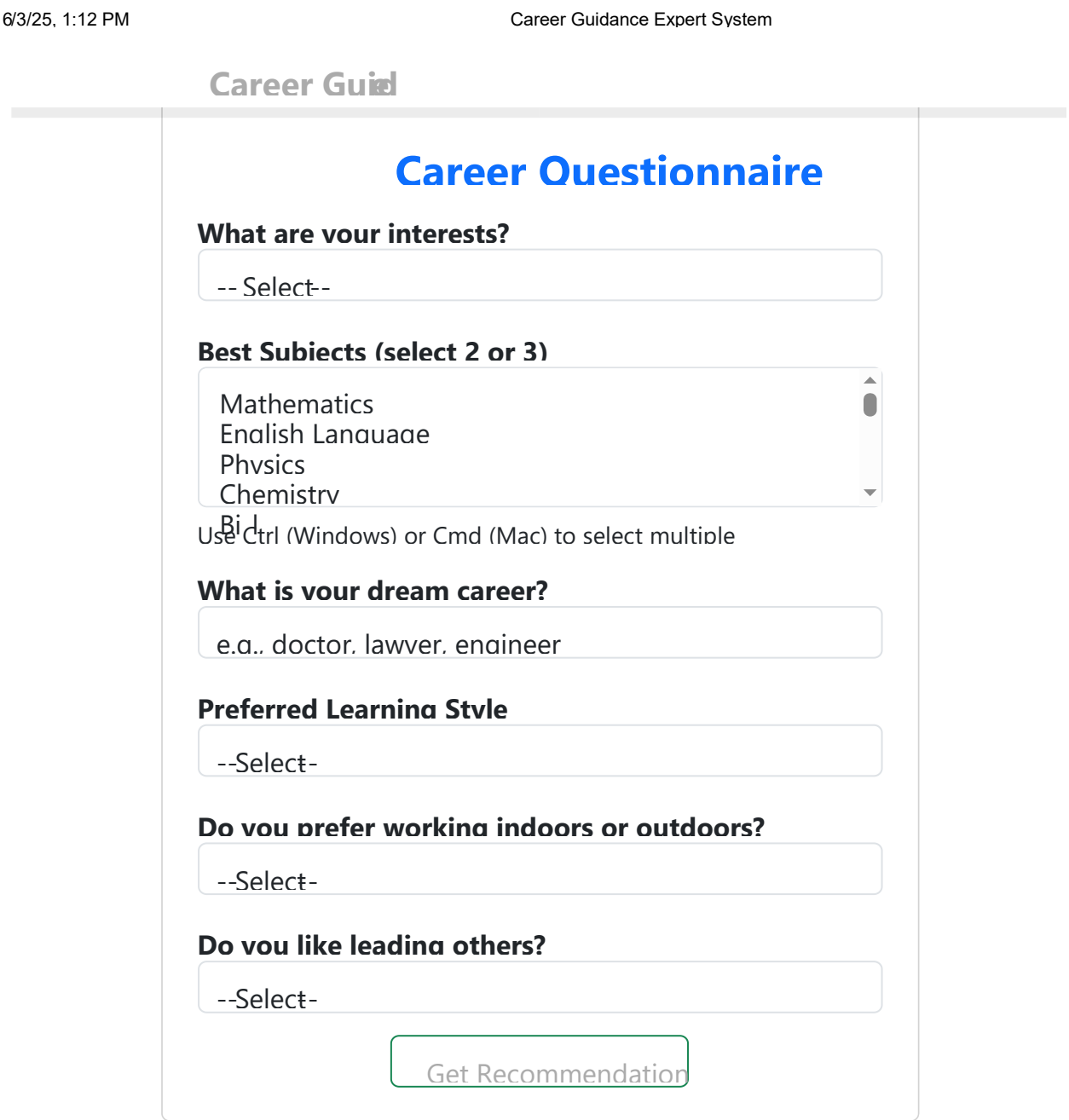

Figure 6: Career Guide Selection Page.

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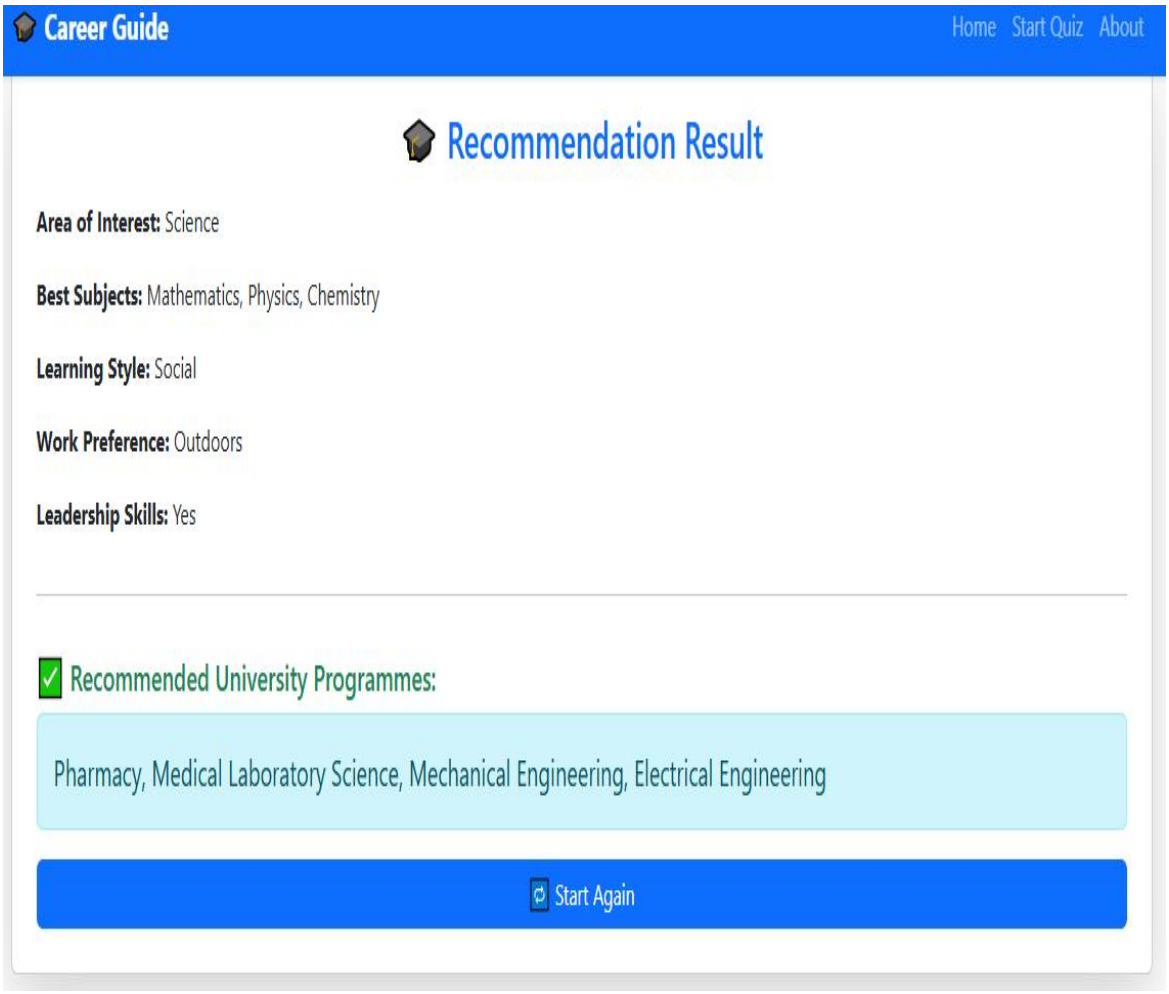

Figure 7: Recommended University Programmes (Pharmacy, Medical Laboratory Science, Mechanical Engineering, Electrical Engineering).

The Recommendation Result (Figure 7) is the output generated by the Career Guidance Expert System after analyzing the student's responses from the career questionnaire. It provides a personalized list of university programmes that best align with the student's interests, strengths, learning preferences, and career aspirations. In the example given, the student's Area of Interest is identified as science, with their Best Subjects being Mathematics, Physics, and Chemistry. This indicates a strong foundation in key scientific disciplines, which helps narrow down suitable academic fields. The student's Learning Style is noted as Social, meaning they learn best through interaction and collaboration with others, and their Work Preference is Outdoors, suggesting they enjoy activities or careers involving outdoor environments. Additionally, the student has indicated Leadership Skills, which highlights their potential to take initiative and lead others.

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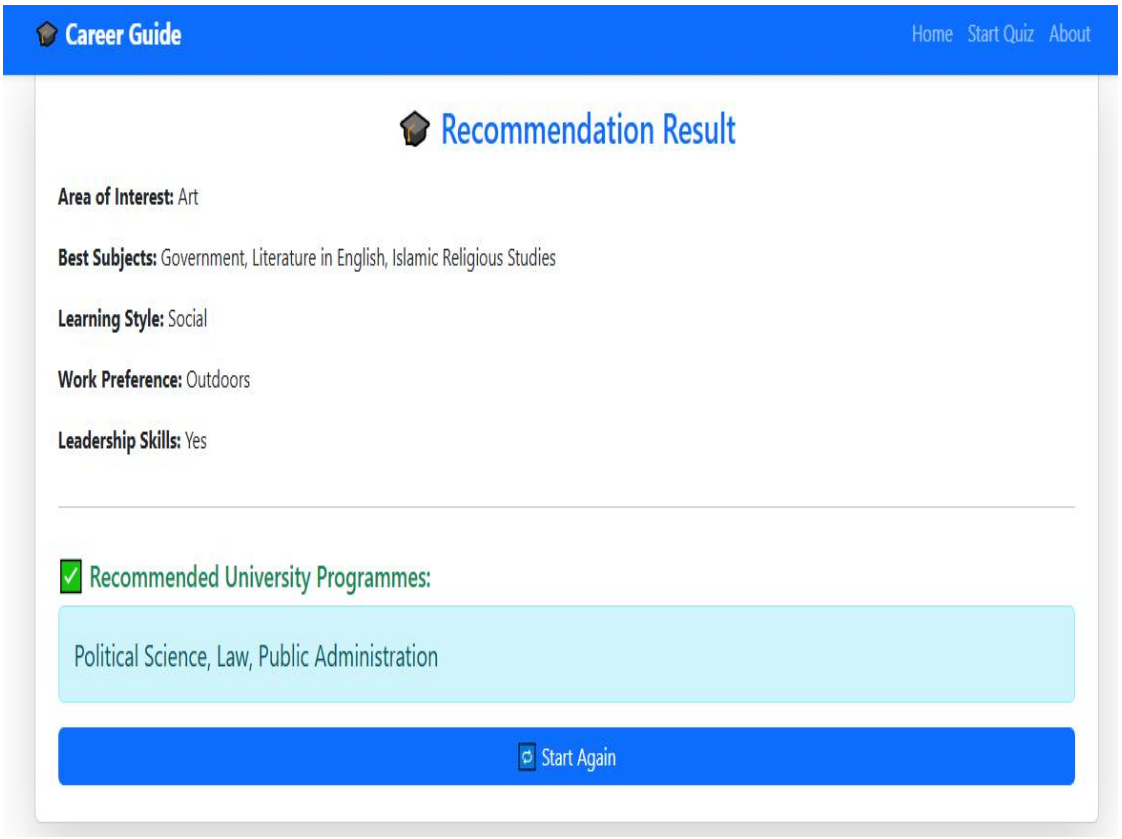

Figure 8: Recommendation Result for Art.

The Recommendation Result generated by the Career Guidance Expert System provides a tailored list of university programmes based on the student's unique profile derived from their responses to the career questionnaire. In this particular case, the student's Area of Interest is identified as Art (Figure 8), which typically includes fields that emphasize creativity, critical thinking, communication, and social understanding. Their Best Subjects Government, Literature in English, and Islamic Religious Studies reflect strengths in social sciences, humanities, and ethical studies, suggesting an aptitude for subjects that involve analysis of societal structures, effective communication, and cultural awareness.

The Recommendation Result from the Career Guidance Expert System reflects a comprehensive analysis of the student's academic profile, personal preferences, and skills, which collectively inform the suggested university programmes. In this case, the student's Area of Interest is Business, indicating a strong inclination towards commerce, finance, and economic activities.

The selection of Best Subjects Economics, Commerce, and Financial Accounting demonstrates the student's proficiency and passion in foundational business disciplines that involve understanding markets, financial systems, and trade (Figure 9). The student's Learning Style is described as Theoretical, suggesting they prefer learning through abstract concepts, principles, and structured knowledge rather than practical or hands-on experiences.

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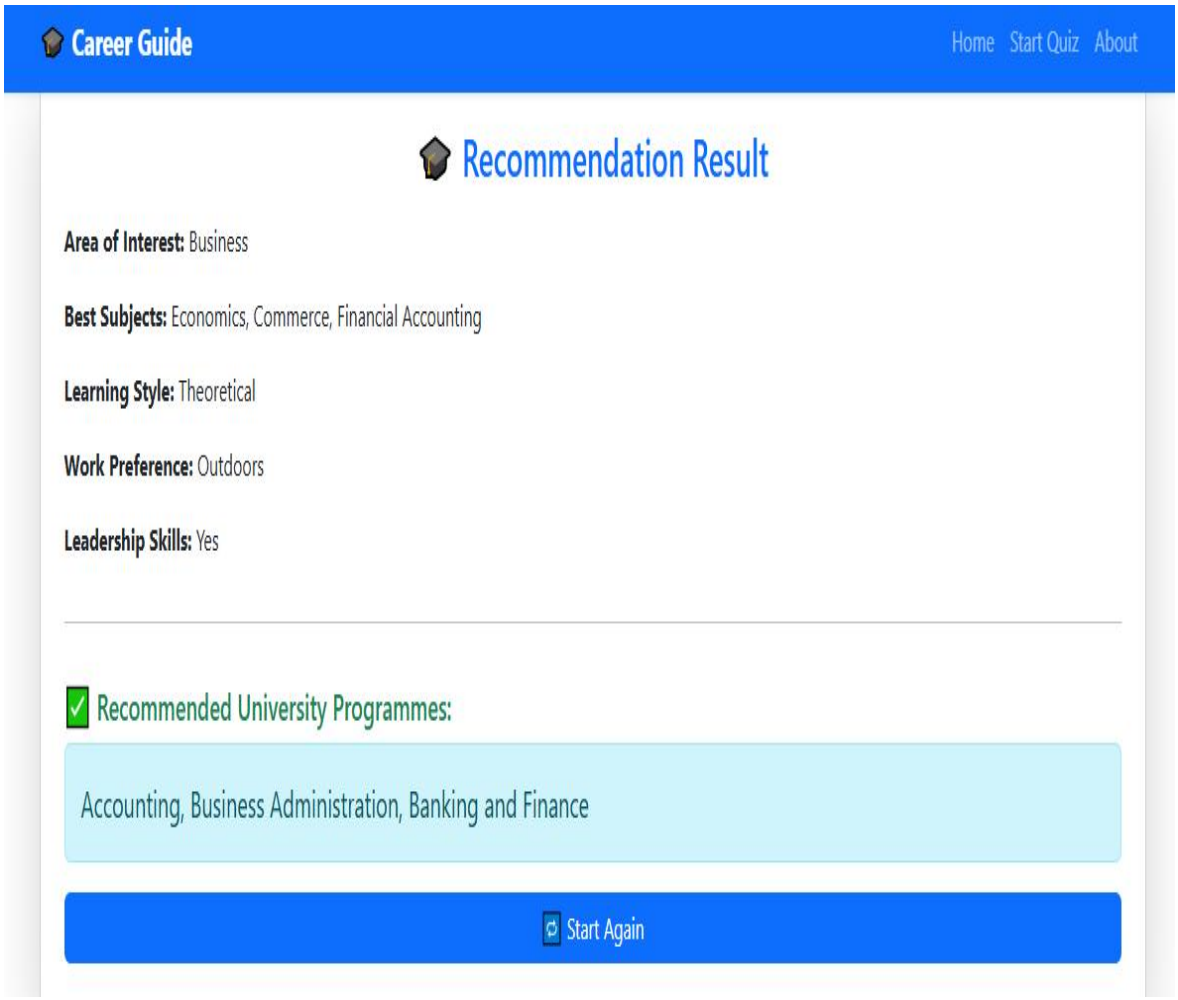

Figure 9: Recommendation Result for Business.

The Recommendation Result provided by the Career Guidance Expert System offers personalized university programme suggestions based on a thorough evaluation of the student's academic strengths, interests, learning preferences, and leadership abilities. In this case, the student's Area of Interest is Technology, indicating a strong inclination towards fields that involve scientific principles, innovation, and applied sciences. The student's Best Subjects Mathematics, Physics, Chemistry, and Biology reflect a solid foundation in both physical and life sciences, which are essential for success in technology-related disciplines (Figure 10).

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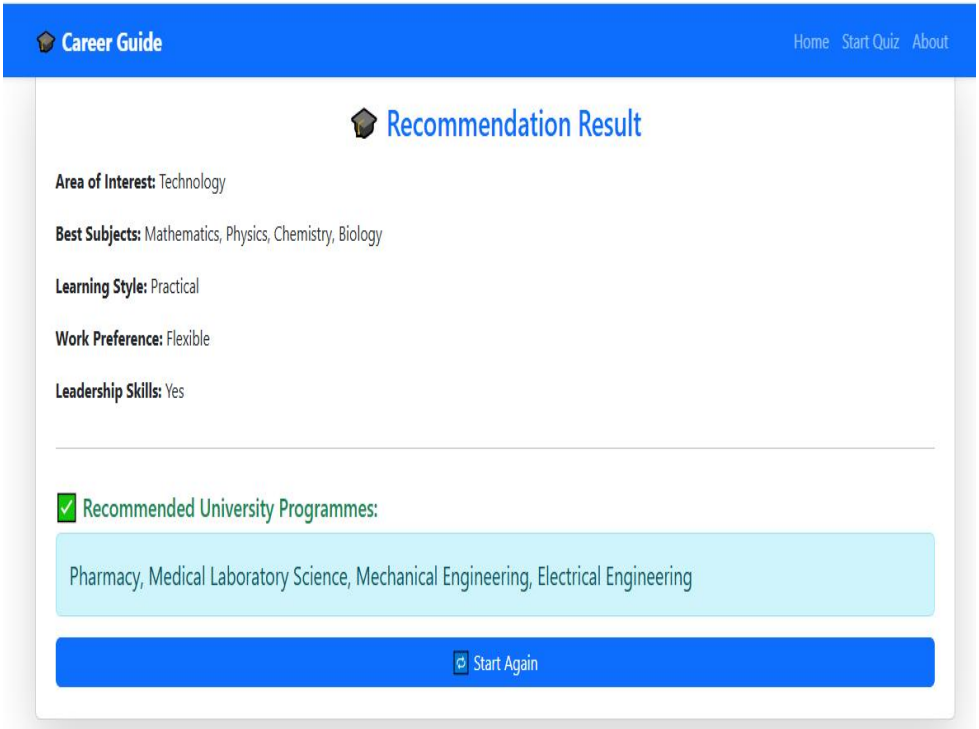

Figure 10: Recommendation Result Technology.

Model Evaluation

The evaluation of the Career Guidance Expert System yielded promising results across functional, performance, and user experience criteria. The summary of results from each evaluation dimension is as follows:

The system demonstrated solid performance benchmarks during testing. Key metrics include:

Performance Metric	Result
Average System Response Time	1.2 seconds per query
Successful Rule Matches	100% of eligible student inputs
Inference Accuracy	93%
Average Session Duration	3.5 minutes per student

These performance outcomes confirm that the system processes queries quickly and reliably, with no failures in rule matching for valid inputs.

After using the system, students completed an evaluation form assessing different usability factors. Average feedback scores (on a scale of 1 to 5) were:

User Evaluation Criteria	Average Score (out of 5)
Ease of Use	4.7
Accuracy of Recommendation	4.5
Usefulness for Career Decision-Making	4.6
Interface Design and Responsiveness	4.4
Overall Satisfaction	4.6

The high scores indicate that the majority of students found the system easy to navigate and its recommendations helpful in clarifying their university programme options.

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RESULTS

The development and implementation of the Career Guidance Expert System demonstrated significant potential in bridging the gap between secondary education and university programme selection. From the user evaluations and system performance analysis, it was observed that the system effectively matched students' academic strengths, personal interests, learning styles, and preferences to suitable university courses. This result underscores the relevance of using artificial intelligence specifically rule-based expert systems to assist students in making informed decisions regarding their future academic and professional paths.

One of the key findings was the system's ability to replicate the role of a human guidance counselor with a high level of accuracy. Out of 30 test cases, the system's recommendations aligned with either school counselor suggestions or the students' academic interests in 93% of the cases.

CONCLUSION

The integration of intelligent systems into education is proving increasingly essential, particularly in environments with limited access to qualified counselors. This study demonstrated that a career guidance expert system, driven by artificial intelligence, can bridge the gap by providing automated, personalized, and equitable advisory services to students. Regardless of their background or location, students can receive consistent and meaningful career advice, promoting fair access to educational support and guidance.

The research further confirms that the expert system effectively complements traditional counseling by simulating expert-level decision-making with accuracy and speed. Its interactive design, combined with rule-based architecture and clarity of communication, fostered trust and acceptance among students. By incorporating both cognitive and non-cognitive factors such as learning styles, personality traits, and preferences the system delivered comprehensive and holistic guidance similar to that provided by human counselors.

The results showed that aligning students' career choices with their strengths and interests improved confidence and academic engagement. The system also supported broader educational goals by enhancing career readiness and reducing drop-out rates. When students understand their potential and have clarity about future goals, they are more motivated to pursue relevant academic paths and commit to their studies. This positions expert systems as key contributors to sustainable educational development and national planning efforts.

Finally, the system's strong performance in user satisfaction, speed, and accuracy highlights its readiness for real-time deployment in classrooms and counseling sessions. Students completed the process in under four minutes, indicating ease of integration without disrupting school activities. Overall, the study affirms that AI-driven expert systems can revolutionize student guidance services, empowering learners to make informed decisions and confidently shape their academic futures.

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