STUDENT-CENTRED DECISION SUPPORT SYSTEM FOR TERTIARY INSTITUTION SELECTION IN NIGERIA

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APPROVAL PAGE

This research, titled "**STUDENT-CENTERED DECISION SUPPORT SYSTEM FOR TERTIARY EDUCATION SELECTION**," has been assessed and approved by the Department of Computer Science and Mathematics Committees in the Faculty of Computer Information Technology Godfrey Okoye University, Enugu, Nigeria.

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CERTIFICATION

I certify that I completed the research included therein and that it was primarily based on my observations and investigation. Consequently, I will fully accept the University's decision if I am found to have cheated on the assignment.

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DEDICATION

This project is dedicated to all prospective tertiary students in Nigeria seeking clarity in institutional selection decisions, in the hope that this Decision Support System will empower them to make informed choices aligned with their aspirations and circumstances. I dedicate this work to my parents, Mr. Nsude Ndibuisi and Mrs Nsude Rose, whose unwavering support and encouragement provided the foundation for this achievement. Finally, I extend my dedication to my project supervisor, Prof. I. A. Ajah, whose expert guidance, mentorship, and constructive feedback were invaluable throughout this research.

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ABSTRACT

In the tertiary education sector in Nigeria, there are disjointed sources of information, little institutional comparison tools, and no recommendation system for prospective students to compare various institutions in terms of qualification and preference. This project presents the development of a Student-Centered Decision Support System for Tertiary Institution Selection which uses educational information obtained from various reliable sources such as the National University Commission (NUC), Joint Admissions and Matriculation Board (JAMB), Webometrics Rankings, as well as data from universities' websites as a benchmark for institution evaluation and ranking. This provides prospective students with data-driven recommendations that match their academic profiles and personal preferences. The design employs the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) algorithm as part of the Multi-Criteria Decision- Making (MCDM) technique for recommending tertiary institutions. The system was developed based on the Object-Oriented Analysis and Design (OOAD) approach, adopting a Waterfall Process Model of software development, with full fledged modeling through use case, activity, and class diagrams for UML notation. The implementation was done via three tier architecture involving a Flask REST API backend using Python programming language, MySQL, and HTML5, CSS3, and JavaScript frontend. The system's recommendation engine utilizes a comprehensive database compiled of 87 Nigerian tertiary institution, covering 161 unique academic programs and 1,278 distinct university-course eligibility mappings. The TOPSIS method analyzes the universities ranking, proximity to home town, and facility infrastructure, 100% success rate was achieved during the functional testing of the 14 functional requirements. Performance testing revealed that average time for students to get recommendation is 2 mins and 18s. This decision support system provides objective and consistent personalized recommendations which reduces the problem of fragmented information allowing students to make informed decisions regarding institution choice based on their preferences.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Prospective students face a number of challenges when selecting their institution of study as it has significant implications on future success academically, professionally and socially. However, in Nigeria, the selection process can be even more complex and challenging as there are a number of tertiary institutions such as federal, state and private universities, which each differ in terms of academic performance, cost, accreditation, infrastructure, etc. Therefore, students need to assess many factors simultaneously, which is not an easy task.

It is apparent from various studies that the selection of higher education institution among Nigerian students is a cognitively straining task considering the financial barrier, reputation of educational institutes, and lack of adequate information. Affordability and cost have been listed as some of the most important factors influencing choice of institution. This problem has been compounded by differences in tuition costs, application processes, and course offerings among various institutions.

In addition to financial factors, reputation and academic standing play an important role in students' choice. According to Adeoye *et al*. (2022), students tend to connect reputable institutions with enhanced educational outcomes and job opportunities. These notions may be formed by other people like the fellow students, alumni, as well as institutions, and not necessarily the actual statistics. According to Manishimwe *et al*. (2025), for example, it is true that the social factors like friends, current students, and alumni play a very significant role in the choice of a learning institution.

Structural issues within the Nigerian tertiary education sector cannot be ignored either since these issues are capable of affecting students' choice of institutions indirectly. Issues like insufficient funding, poor facilities, unstable learning schedules due to industrial actions, insecurity, among others are the issues that affect students' choice even when they do not fall under the students' control. It follows that in addition to considering the academic issues associated with the choices made, it is equally important for students to consider the stability of institutions too.

Furthermore, problems such as the institution's accreditation, suitability of the courses offered, facility adequacy, and teacher-student ratio play a great role in the process of making the decision. As noted by Okeke (2022), the lack of information regarding accreditation and suitability may significantly impact your performance and qualification in the course of study. However, information related to these factors is often scattered across multiple platforms and presented in formats that are difficult for prospective students to systematically analyze and compare.

In general, the decision-making processes involved in the choice of tertiary institution in Nigeria are fragmented, unstructured, and devoid of adequate analysis to aid in multi-criteria decision-making. Despite the availability of significant amounts of educational information, very little effort is put into using this information within an integrated system to make personal and informed decisions. Such a scenario makes it a necessity for the creation of a DSS that helps in aggregating relevant institutional information and aiding prospective students in their decision making.

1.2 Statement of Problems

Choosing the right tertiary institution to study in Nigeria is not an easy task for students considering factors such as the accreditation, costs involved and availability of programs.

Unfortunately, this selection is carried out without any adequate analysis of the issues, thus causing poor decisions. The challenges that arise from this system include:

1. One-size-fits-all decision approaches: The majority of choice methods of universities and existing counseling services do not take into account personal factors like qualifications, financial ability, program preference and geography. As a result, there occurs inconsistency in choosing appropriate institutions by future applicants.

2. Lack of verified accreditation and program quality information: There is no system through which students can verify whether their selected institutions are properly accredited and suitable for their studies in terms of providing the right conditions for learning before applying to them. The absence of such information leads to an increased risk of joining institutions that might not offer good programs.

3. Slow and inefficient decision-making process: The process of comparing various universities based on certain standards is quite tedious and requires high cognitive processing ability because information about accreditation, cost of tuition, rankings, and program offerings is scattered across different platforms.

4. Underutilization of available educational data: Even though information about ranking, accreditation, fees, facilities, and entrance requirements can be found, it is not incorporated into one system for analysis and individual guidance of potential students.

These issues indicate the importance of having a Decision Support System that is able to effectively analyze all the pertinent data and take into account personal preferences when making decisions in tertiary institution selection.

1.3 Aim and Objectives of the Study

The aim of this study is to develop a decision support system for prospective students that assists them in making informed and personalized choices when selecting tertiary institutions in Nigeria. The objectives are to:

1. design a system that accounts for individual differences, including academic qualifications, financial capacity, preferred courses and location to improve the match between students and institutions.
2. integrate relevant educational data such as accreditation status, tuition fees, facilities, and rankings into a unified platform for decision making.
3. provide an efficient and user friendly tool that uses algorithmic processes to simplify comparison of multiple tertiary institutions across various criteria.
4. evaluate the operational effectiveness and efficiency of the new system.

1.4 Significance of the Study

This research is significant since it proposes a framework through which tertiary institutions can be selected in Nigeria. The aim of this research is to solve the problem of selecting the more appropriate tertiary institution among a myriad of others. The Decision Support System (DSS) ensures that the differences between one person and another, regarding things like financial capacity, and course preference, are taken into consideration when making decisions.

Moreover, all the significant information regarding education such as accreditation, costs of education, programs, ranking, and amenities will be integrated by the system to create a single database. The purpose behind the integration of this data is to make the entire decision-making process for the students more efficient and effective while ensuring transparency and consistency in decision-making.

1.5 Scope of the Study

The research would revolve around the establishment of a Decision Support System that helps future students in selecting appropriate tertiary institutions in Nigeria. The study would be constrained to considering student variables and institutional variables like qualifications, finance, course preference, career objective, accreditations, tuition charges, facilities offered, among others. The main objective of the research is to develop a Decision Support System that would assist students in making an effective decision on selecting appropriate tertiary institutions.

The survey was conducted among fifty tertiary institutions within Nigeria, which included federal, state, and private universities. The research techniques that have been employed in this research can be used for other decision-making cases concerning education such as the choice of post graduate courses and vocational training institutes. The limitation of this research is that all the information collected is from secondary sources only.

Technical scope of this project includes the use of Python language for developing the multi-criteria decision-making analysis engine, use of MySQL language for incorporation of data from various institutions and finally HTML, CSS, JavaScript languages to make sure the user interface is responsive for prospective students.

1.6 Limitation of the Study

The study is subject to the limitations arising out of the use of secondary data from institutional reports, ranking systems, and available databases, which might lack up-to-date information. While the DSS would take into account various considerations such as academic qualification, financial capability, course preferences, accreditation, and physical distance, other qualitative considerations such as family considerations or personal motivation would be ignored. Moreover, any changes in the cost of tuition, type of courses being offered, and accreditation status of institutions might have implications for the efficacy of the system. Lastly, disparities in access to data as well as possible system-related technical problems could limit the efficacy of the DSS.

1.7 Operational Definition of Terms

For the purpose of clarity and consistency throughout this research, the following key terms are operationally defined as they are used in this study:

Decision Support System (DSS): A computer-based information system that integrates data management, analytical models, and an interactive user interface to assist prospective students in making informed decisions when selecting tertiary institutions. In this study, the DSS refers specifically to the web-based application that aggregates institutional data and applies multi-criteria ranking algorithms to generate personalized university recommendations.

Tertiary Institution: Any post-secondary educational establishment in Nigeria that offers degree-awarding programs and is recognized by the National Universities Commission (NUC). This includes federal universities, state universities, and private universities.

Multi-Criteria Decision-Making (MCDM): A decision-making methodology aimed at selecting, ordering, and prioritizing alternatives according to several conflicting criteria. As applied in this study, MCDM implies the application of weighted evaluation of five criteria (accreditation, cost-effectiveness, ranking, proximity, and facilities) in order to rank universities according to student preferences.

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS): A method of Multi-Criteria Decision Analysis based on geometric distance measurement between alternative solutions and ideal best and worst solutions. As employed in this research project, TOPSIS was applied to generate match scores and rankings of universities.

Status of Accreditation: The certification given to the University program by NUC**.** The status of the university program can either be Fully Accredited, Interim Accredited, or Not Accredited in this algorithm.

Match Percentage: A number in percentage form. It is a measure of similarity between the qualities of the particular university and those of the student. The match score is determined by the TOPSIS algorithm and then displayed in each university's results card.

Institutional Fit: It refers to the extent to which the characteristics of the student such as academic achievements, financial capabilities, desired location, career aspirations, and weights assigned to these criteria match those of the institution.

K-Nearest Neighbors (KNN): This is an algorithm that is utilized in this system as a supplementary recommendation approach in finding out which institutions are closest in matching a student's dream institution in terms of characteristics**.**

Prospective Student: This is a secondary school leaver or a student taking the Joint Admission Matriculation Board (JAMB) examination and who has successfully written the Unified Tertiary Matriculation Examination (UTME).

Affordability Score: A metric whose value is the reciprocal of the tuition at a particular university divided by the highest tuition in the set, with values ranging between 0 and 3. A high affordability score means cheaper tuition.

Proximity Score: A metric measuring the proximity of a particular university to the state that a student prefers. This metric ranges between 1 and 3 depending on whether the university and the preferred state match.

NUC (National Universities Commission): This is the governing body that oversees the accreditation, quality control, and regulation of all the universities in Nigeria. NUC acts as the credible organization in the accreditation process of universities.

JAMB (Joint Admissions and Matriculation Board): The Nigerian body responsible for organizing the UTME examination for university admission purposes. This organization's cut-off points act as the qualifying criteria for filtering the universities.

Geopolitical Zone: One of the six regions in the country (North Central, North East, North West, South East, South South, South West) that has been adopted in this system to aid in location-based filtering and distance calculations**.**

Secondary Data: Data already in existence, which were obtained from official sources such as the NUC accreditation report, JAMB publications, universities' official websites, and ranking organizations. These data were not collected through interviews or surveys. All data utilized in this study are secondary in origin.

Eligibility Screening: The first stage of computation involved in the recommendation engine where institutions which fail to satisfy the minimum eligibility conditions of the student with regards to institutional type choice, budget constraint, JAMB cutoff requirement, course availability, and geographic preference are screened off the list prior to ranking.

Weight Assignment: The procedure where a student assigns subjective weights ranging between 1 and 5 for the priority value of each of the five criteria to enable the TOPSIS method produce customized rankings based on individual preferences. A weight value of 1 implies low importance while 5 means high importance.

User Acceptance Test (UAT): A testing method in which prospective users of the system interact with the DSS, fill out their profiles, get recommendations, and submit feedback regarding its usability and accuracy.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter, a review of literatures related to the development of the DSS system has been provided. This literature provides comprehensive insight into the background, development, and deficiencies of previous studies in order to emphasize the importance of this research through determining the achievements and knowledge gaps in this field.

2.2 Decision Support Systems: Concepts, Evolution, and Limitations

Conceptual knowledge of DSSs can be gained from the study conducted by Ismail, Soliman, and Mohamed (2025). According to Ismail *et al*. (2025), DSSs are computer-based tools that use a variety of information sources in combination with analysis and modeling capabilities along with an interactive user interface in order to facilitate decision-making in a complex setting. Over time, the evolution of DSSs led to the integration of AI and MCDM approaches into modern-day DSSs.

The value in this collection of papers can be found in its broad view of the requirements for an efficient DSS and its showing that DSS applications have greatly advanced in their evolution over the years. According to Ismail *et al*. (2025), the use of AI in DSS has increased its ability to handle diverse information, learn from past experiences, and make customized recommendations to the users. The research is pertinent in addressing two issues highlighted in Chapter One as problems one wishes to solve, namely: A DSS capable of automating the comparative evaluation of various institutions on several factors at once, and a DSS that brings together fragmented education information.

Yet, there are certain shortcomings that Ismail *et al*. (2025) identify regarding the current state of DSS designs. Firstly, scalability issues, difficulties with interpretability of the models, and the problem of meeting users' demands are particularly relevant in this regard. Some algorithms can produce satisfactory results in laboratory conditions, yet fail to work effectively in the presence of massive data from different sources and with irregular structures. Additionally, usability and users' confidence in the system are always an issue, which is especially true for a student-oriented product where outputs need to be clear to understand.

2.3 AI-Powered Decision Support System in the Context of Education and Nigerian Universities

In relation to the use of DSS in educational institutions and, more precisely, within the Nigerian universities, the work of Mohammed-Shittu (2025) is notable for the exploration of the application of AI-powered DSS in the context of Nigerian public university administration. This source is especially relevant for the current research considering the topic of focus in terms of the issues faced in the higher education sector in Nigeria, similar to those discussed in Chapter One, such as funding shortages, poor infrastructure, and erratic academic calendar, according to Adekalu and Oludeyi (2013). The study highlights how AI-powered DSS can effectively assist in decision-making processes in various fields, such as the monitoring of students' performance and resource allocation.

The significant strength of the conclusions arrived at in the work by Mohammed-Shittu (2025) is the empirical demonstration that DSS technology can be effectively used within the Nigerian university sector despite the infrastructural problems that characterize it. The research highlights serious challenges, such as the presence of data silos, inconsistencies in data management by different university departments, and inadequate technical infrastructure, which were found to be the greatest impediments to attaining consistent institutional benefits through such a system. This is precisely the challenge of data fragmentation that was identified in Chapter One as being responsible for the difficulty of institutional comparisons by prospective students. Mohammed-Shittu (2025) specifically addresses the issue of administrative decision-making in universities and not that of decision-making by prospective students in choosing an institution.

2.4 Multi-Criteria Decision-Making Techniques in Higher Education

This section of the body of literature includes the use of multi-criteria decision-making (MCDM) approaches in higher education settings. In their study, Muharlisiani *et al*. (2023) describe the use of an educational DSS approach which involved the use of a multi-criteria decision making tool referred to as the Best Worst Method (BWM). They argue that the use of MCDM in educational decision support systems allows for preference-sensitive decision recommendations that go beyond simple rankings of alternatives using single criteria and provide recommendation based on the weightage of various considerations.

This is highly pertinent to the initial problem highlighted in Chapter One, which relates to the widespread application of one-size-fits-all decision making models, without taking into account unique student characteristics. The tertiary institution choice problem is fundamentally a multi-criteria decision making problem, since the prospective students have to make decisions by considering their academic credentials, financial means, preferred courses, accredited status of the college, location, and future career considerations at once. Techniques of MCDM, like the BWM model, provide a strong analytical basis to address these issues, which I applied to the development of the analytical engine for my DSS.

However, according to Muharlisiani *et al*. (2023), there are several weaknesses in this research. The system was tested in just one institutional case, which may make generalization difficult because of the narrow representation of participants. Scalability to other environments is yet to be proven, and the researchers have not considered how the system will work in the presence of massive data from different institutions that can be found in Nigeria's higher education sector. This research must therefore extend this work by designing a system capable of handling data drawn simultaneously from federal, state, and private universities across the country.

2.5 Technology Acceptance and DSS Adoption in Learning Environments

Beyond system design, the success of any DSS depends critically on whether its intended users actually adopt and engage with it. I therefore examine the work of Gao (2024), who conducted a quantitative investigation into the effects of DSS adoption on learning performance, technology satisfaction, and academic self-efficacy among university students. Using structural equation modelling, Gao (2024) finds that DSS adoption produces statistically significant positive effects on learning outcomes, and that technology satisfaction and self-efficacy function as important mediating variables. This means the benefits of DSS use are most strongly realized when users feel confident in their ability to engage with the technology effectively.

This finding is directly relevant to the first and third problems stated in Chapter One. If prospective students cannot navigate the system with confidence, or if its outputs are difficult to interpret, they are unlikely to trust its recommendations, reverting instead to the informal, peer-influenced decision approaches that Chapter One identified as a primary driver of poor institutional fit. Gao's (2024) work therefore compels me to treat usability and output clarity as core design requirements equal in importance to algorithmic accuracy. The suggested DSS needs to be user-friendly and understandable by individuals of different technology abilities.

On the other hand, there is no doubt that Gao (2024) mentions a number of limitations of the current study. Specifically, the research was carried out in only one organization, implying the homogeneity of its participants. Thus, the results may be generalized to a broader audience, namely potential Nigerian learners from different social and educational strata. Furthermore, the research does not address the issue of DSS designed for the benefit of learners who are already enrolled in some institutions but rather focuses on the tools used by potential students to choose institutions.

2.6 Student Decision-Making Behavior in Nigerian Tertiary Education

The fifth set of literature reviews behavioral factors and environmental elements that affect the way Nigerian students choose their tertiary institutions. In this regard, Adeoye *et al*. (2022) did a study focusing on the major determinants that influence institutional selection in Nigeria, with financial capability, reputation of the institution, courses offered, and peer pressure being the leading influencers of the outcomes of the process. Financial ability and affordability are noted to be significant constraints to decision-making, often influencing the decisions of students irrespective of their interest or career goals. It is noteworthy that according to Adeoye *et al*. (2022), the quality of the institutions is perceived based on informal sources like peer influence, alumni perception, and institutional publicity rather than performance metrics such as accreditation status, student-teacher ratio, or course ranking. This is consistent with the challenge stated in Chapter One about decision-making being driven more by social influence than facts.

The subjective nature of the student's choice is emphasized even more by the findings of Manishimwe *et al*. (2025), according to which the social aspect of influence, such as friendships, present students and former students have an important role to play in university choices and thereby make decision-making processes highly biased and ill-founded. Thus, the combined evidence of Adeoye *et al*. (2022) and Manishimwe *et al*. (2025) makes for a powerful empirical illustration that the environment of making choices that the Nigerian students face is a social one. Moreover, according to Okeke (2022), the inability of students to ascertain whether their institution and program are accredited and suitable leads to academic failures and certificates without any form of professional validity. This finding is consistent with the second issue mentioned in chapter one, which states that the lack of proper accreditation and verification leads to poor career and academic prospects.

Adeoye *et al*. (2022) similarly point out an information structure issue which is perfectly consistent with the fourth problem discussed in Chapter One, whereby students have some familiarity with what they need to evaluate but cannot access the pertinent information due to its presence on multiple separate platforms in difficult-to-compare formats. This observation is the most direct empirical justification for the DSS to developed. The gap is not that students lack awareness of what matters, but that they lack a unified tool capable of aggregating and processing that information in a personalized and accessible way.

2.7 Summary of Literature Review

The table below presents a summary of the reviewed literature in this study. It highlights the authors, contributions, methodology and limitations.

Table 2.1 Summary of Literature Review

S/N	Author(s)	Contribution or (Work Done)	Technique or Methodology	Limitations
1	Ismail, Soliman, & Mohamed (2025)	Comprehensive review of DSS evolution; defined core architecture integrating data management, analytical models, and user interface. Showed AI and MCDM expand DSS adaptability.	Literature review / synthesis	Scalability, interpretability, and alignment with user needs remain persistent challenges; many models struggle in real-world, heterogeneous data environments.
2	Mohammed-Shittu (2025)	Investigated AI-driven DSS integration into Nigerian public university administration; found improvements in student outcome monitoring and resource allocation.	Empirical case study / survey	Focused on administrative decisions, not student-facing selection; data silos, inconsistent data management, and infrastructure deficits were major barriers.
3	Muharlisiani *et al*. (2023)	Developed an educational DSS employing the Best Worst Method (BWM) for multi-criteria evaluation of educational strategies, enabling personalized, preference-sensitive recommendations.	MCDM (BWM) applied in a case study	Evaluated within a single institution with limited participant diversity; real-world scalability and cross-institutional application unproven.

4	Gao (2024)	Examined DSS adoption effects on learning performance, technology satisfaction, and academic self-efficacy; confirmed positive outcomes, with satisfaction and self-efficacy as mediators.	Quantitative / Structural Equation Modelling (SEM)	Single institutional setting, homogeneous sample; focused on enrolled students' learning, not pre-enrollment institution selection.
5	Adeoye *et al*. (2022)	Identified key determinants of institutional choice in Nigeria: financial capacity, institutional reputation, program availability, and peer influence. Found students rely on informal sources, not objective data.	Survey / empirical study	Did not propose a technical solution; highlighted the information fragmentation problem but did not develop a decision support tool.
6	Manishimwe *et al*. (2025)	Demonstrated the significant role of social influences (friends, current students, alumni) in shaping university choice, increasing risk of subjective and biased decisions.	Empirical study / survey	Focused on describing social influence; no decision-support intervention was designed or tested.
7	Okeke (2022)	Showed that failure to verify accreditation status and program suitability before enrollment leads to poor academic outcomes and qualifications with limited professional recognition.	Documentary analysis / case evidence	Identified the risk but did not provide a centralized verification platform; solutions remained at policy recommendation level.

This table reveals that DSS research has shown strong structure of design and implementation (Ismail *et al.,* 2025; Mohammed-Shitu, 2025), and MCDM techniques like TOPSIS and BWM are proven to be useful for multi-criteria educational raking (Muharlisiani *et al.,*2023; Gao, 2024). However, the table also reveals gaps: all existing studies focus either on institutional administration or learning support for enrolled students, not pre-enrollment institutional selection. In addition, behavioral research confirms that Nigerian students currently rely on social influence and incomplete information rather than objective data (Adeoye *et al.,* 2022; Manishimwe *et al.*, 2025; Okeke, 2022), yet no technical solution has been proposed. Most significantly scalability limitations are evident across all studies, they are single-institution or multi-institutional system unaddressed.

2.8 Research Gap

From the critical review of the foregoing literature, it is clear that DSS research has advanced considerably and produced robust frameworks for technical design and educational application. However, significant gaps persist that this study is specifically positioned to address.

First, as demonstrated across all five reviewed bodies of literature, there is no existing DSS developed specifically to support prospective students in selecting tertiary institutions. DSS applications in education have focused predominantly on personalized learning support and institutional administration (Mohammed-Shittu, 2025; Muharlisiani *et al*., 2023), leaving the pre-enrollment, institution-selection decision entirely unsupported by existing technology. This directly corresponds to the one-size-fits-all problem and the slow, inefficient decision-making process identified in Chapter One.

Second, while technology acceptance research confirms that usability and user confidence are decisive factors in DSS effectiveness (Gao, 2024), existing systems are rarely designed with the accessibility needs of a diverse prospective student population in mind. Students with limited technological experience, a significant proportion of Nigeria's prospective student population given the structural inequalities documented by Adekalu and Oludeyi (2013), are effectively excluded from benefiting from existing DSS tools.

Third, and most importantly, no existing DSS has been designed to account for the unique structural characteristics of the Nigerian tertiary education landscape. The wide variation in accreditation status, tuition costs, and institutional stability across federal, state, and private universities; the fragmentation of institutional data across disconnected sources; and the documented tendency of students to rely on social rather than evidence-based information (Adeoye *et al*., 2022; Manishimwe *et al*., 2025) together constitute a decision environment that generic, internationally-designed DSS frameworks do not address. This further reinforces the serious nature of the gap that exists in the context of ignoring such information, as highlighted by Okeke (2022).

It is this combination of all the gaps that have been identified the absence of a student-centered DSS, Nigeria-based design, integration of data aggregation on multiple criteria, and the established risks associated with decision making on the part of students lacking any kind of assistance - that motivates this study. In this case, the development of the Decision Support System which seeks to solve the four problems identified in chapter one and takes the usage of the DSS further in its application adds value through the provision of an innovative solution to one of the major problems faced by students in Nigeria.

CHAPTER THREE

METHODOLOGY AND SYSTEM ANALYSIS AND DESIGN

3.0 Introduction

This chapter focuses on an analysis of the methodologies employed in the study alongside a detailed evaluation of the current system. In addition, a review of the strengths and weaknesses of the current system has been conducted. The new system has been analyzed in detail to evaluate its features and the likelihood of success in the implementation of the project.

3.1 System Analysis

In this section, there is be a comprehensive analysis of the existing process, limitations of the current system, and how the proposed system mitigates these issues.

3.1.1 Analysis of the Existing System

At the moment, there is no systematic decision support system available to assist Nigerian students in choosing their tertiary institutions. Based on the direct observations done within the context of this research, it has been discovered that the decision-making process is disjointed, informal, and manually executed. This observation corresponds with the findings presented in the literature review chapter, which indicated that the current process does not incorporate a systematic approach towards making the necessary decision. According to Adeoye *et al*. (2022), students depend on random and unrelated sources of information, whereas, according to Manishimwe *et al*. (2025), social factors play a significant role in the final decision. Okeke (2022) corroborated that students do not cross-check information before making their application decision.

Utilizing the above information, the following subsections explain the current process as experienced and verified in this research.

A. The Way the Current Process Functions

From the results obtained in this research, the normal process of choosing an educational institution for prospective students from Nigeria would involve:

1. Data Collection from Diverse Unconnected Sources:

The initial step involves collection of data from diverse sources that do not coordinate with each other. As noted by Adeoye *et al*. (2022), these may consist of independent websites of universities (of varying quality in terms of the amount of information and ease of access), JAMB brochure (which mentions only institutions and courses with little qualitative information available), websites of the NUC (that involve manual search of PDF documents to find out about accreditation of programs), peer communities, alumni forums, social networking sites, and university ranking websites like Webometrics and Times Higher Education.

2. Manual Comparison Across Criteria:

After gathering piecemeal data, students try to make comparisons between schools on different aspects including tuition cost, availability of programs, accreditation status, physical location, and school reputation among others (Adeoye *et al*., 2022). It was noted that this comparison is typically performed using handwritten lists, mental recall, or basic spreadsheet tables created by the student or their guardians. There are no analytical tools used for such comparisons.

3. Decision Making with Insufficient and Biased Information:

In line with the results of Manishimwe *et al*. (2025) who found that peer influence through the involvement of friends, current students, and even alumni can have great impact on university selection decisions, in this research it was noted that students' decisions could be made under the influence of peer recommendations, university marketing activities (advertising campaigns), geographical location (as an attempt to save money by selecting universities located near their place of residence), and prestige (on the basis of prestige but not accreditation or program quality data).

4. Post-Decision Verification (Often Too Late):

Many times, students end up validating crucial details like the NUC recognition of the school or tuition costs even after applying or gaining admission, making it impossible to change their minds due to the high financial cost involved (Okeke, 2022). This statement is an affirmation of the risk outlined in chapter one, which is associated with the failure of having pre-admission mechanisms to validate institutions.

B. Users and Stakeholders in the Current System

The main beneficiaries of the existing system, as highlighted by the results of the study conducted, are:

i. **Aspiring students**: Senior secondary school students who need to prepare for JAMB and university admission.

ii. **The parents/guardians of students**: These people offer financial and general assistance but lack means to assess institutional quality and cost-effectiveness.

iii. **Secondary school counselors**: These offer general advice on admission but lack updated institutional information.

iv. **The JAMB and university admissions officials**: These conduct application and admissions but do not assist candidates with decision-making prior to application.

C. Current System Workflow

From the analysis carried out above, the workflow for the current system can be depicted in the following manner:

[Students complete O-Level and JAMB]

↓

[Students seek information from peers and other sources]

↓

[Manual comparison of various institutions using limited information]

↓

[Choice-making is made through subjective considerations]

↓

[Affiliation to chosen institutions via JAMB]

↓

[Knowledge acquisition of vital details (cost, accreditation) after affiliation]

↓

[Affiliation with the institutions regardless of possible mismatch]

From the above study, it is clear that the current "system" cannot even be considered a proper one since it is more of an ad hoc approach that is prone to information asymmetry and suboptimal decision making. This finding supports the studies of Adeoye *et al*. (2022) and Manishimwe *et al*. (2025).

3.1.2 Limitations of the Existing System

The current fragmented approach towards tertiary education institution choice in Nigeria faces numerous shortcomings which are similar to those discussed in Chapter One. Below are the main weaknesses identified during system analysis and supported by relevant sources in literature.

Limitation 1: One-Size-Fits-All Information Presentation

It is seen from this study that the existing system does not take into account the uniqueness of the individuals as far as students are concerned. The brochures and website portals of the JAMB and universities present information that focuses on what the institution offers, regardless of what the student seeks. For example, the individual who can afford up to ₦300,000 per year, prefers Computer Science as a program of study, and wants to join an institution in the South East region will have to sort out hundreds of institutions to find those that fit into all three categories at once.

The problem occurs in three distinct ways:

i. **No personalized filtering:** Students cannot filter institutions by budget, location, and program availability in a single integrated query.
ii. **Uniform presentation:** All institutions are presented with equal prominence regardless of whether they meet a student's financial, academic, or geographic constraints.
iii. **No prioritizing:** The student cannot state which one matters more to him – whether it is the factor of affordability that trumps ranking, or accreditation is more essential than the location of the school.

Limitation 2: Lack of Centralized Accreditation and Quality Verification

As stated by Okeke (2022) and corroborated in the process of data collection for this study, there is no one-stop student-friendly web resource from which applicants can get accurate information regarding the NUC accreditation of their desired course of study prior to application. The accreditation reports are published on the NUC website as lengthy PDF documents categorized under the year of accreditation and the institution concerned. This means that the applicants must go through the trouble of downloading several PDF documents (each one with over 200 pages).

The tedious process mentioned above produces the following:

i. **Students unknowingly applying to unaccredited programs:** Because verification is so difficult, many students rely on the assumption that if a program is listed on a university's website, it must be accredited.

ii. **Post-admission shocks:** Students realize the problem of accreditation once they have resumed, after realizing that their degree will not be recognized by professional bodies like the Medical and Dental Council of Nigeria and the Council for the Regulation of Engineering in Nigeria, as well as for admission into postgraduate programs.

iii. **Comparison challenges:** Although there are many accredited programs, students are unable to differentiate between programs that are under "Interim Accreditation" status and those which enjoy "Full Accreditation."

Limitation 3: Slow, Inefficient, and Cognitively Demanding Process

Making comparisons across various universities along several dimensions can be tedious and taxing on the brain. From the observation made in the existing system, there are some specific ways through which this weakness has been observed to manifest itself:

i. **Sequential, manual comparison:** Students must visit each university's website individually, extract relevant information, record it, and then repeat for the next institution. A comparison of 10 universities based on 5 parameters involves visiting more than 87 WebPages.

ii. **Varying format of data provided:** Information provided by the universities about the fees structure, courses, and facilities offered is provided in varying formats (tables, written texts, pdf download and image), making comparisons difficult.

iii. **Cognitive overload:** The task of comparing different organizations and their qualities together along with analyzing alternatives goes beyond the capabilities of many students, causing decision fatigue and overdependence on simplistic rules like selecting the organization which one's friends attend. This finding corresponds well with the results of Manishimwe *et al*. (2025) on the effects of social networks on student selection decisions.

This relates directly to Problem 3 in Chapter One – slow and ineffective decision-making resulting from disconnected data sources.

Limitation 4: Underutilization of Existing Educational Data

Although there are very comprehensive databases available with NUC , JAMB, and ranking agencies, these databases are never combined to form a unified recommendation system. The findings from this research show that:

i. **Data exists but is inaccessible in useful form:** NUC accreditation data, JAMB cut-offs, university rankings, and tuition fee information are all publicly available but scattered across disconnected websites, PDF reports, and institutional pages.

ii. **No intelligent aggregation:** No existing tool consolidates these datasets, cross-links them by institution and program, and presents them in a student-centered, queryable format.

iii. **No Recommendation Logic:** Even assuming that a student were able to collect all data on his own, he would still need to decide on how much weight he would give each factor in deciding what colleges are better than others, something that demands skills in decision science that most students do not have.

This list of limitations serves as a powerful reason to design the proposed DSS because it covers all the identified gaps.

3.1.3 Analysis of the Proposed System

The objective of the proposed system is to design a Decision Support System (DSS) that aids future students in making decisions regarding their selection of institutions in Nigeria.

Objective 1: to design a system that accounts for individual differences, including academic qualifications, financial capacity, preferred courses and location to improve the match between students and institutions.

A. **Solving the "One-size-Fits-All":** instead of forcing a student to manually sift through hundreds of university pages, the proposed system introduces a personalized Student Profile Form. This form captures variables such as the user's JAMB score, O-Level sittings, preferred location, and strict annual tuition caps. The system immediately runs these inputs through Eligibility Filtering to instantly shorten the search space, saving hours of manual labor eliminating the cognitive load.

Objective 2: to integrate relevant educational data such as accreditation status, tuition fees, facilities, and rankings into a unified platform for decision making.

A. **Centralizing Scattered Educational Records:** to counter the issue of scattered, unverified institutional data, the system relies on an integrated MySQL. The database centralizes information by linking previously separate files, such as official NUC accreditation reports, directly to the corresponding university profiles. JAMB institutional cut-offs, and true tuition parameters. On the user interface, this manifests as intuitive, colour coded verification badges (e.g., green for Fully Accredited, orange for Interim) directly built into the recommendation view, preventing late post-admission shocks.

Objective 3: to provide an efficient and user friendly tool that uses algorithmic processes to simplify comparison of multiple tertiary institutions across various criteria

A. A major bottleneck in the existing system is that students cannot easily calculate the trade-offs between competing priorities like cost versus institutional ranking. The proposed system provides Priority Weighting Sliders. These sliders allow users to dynamically assign value scales (1 to 5) to individual preferences. The system then applies the TOPSIS algorithm to seamlessly normalize these values, execute distance vector math, and deliver an interactive, side-by-side comparison table of the top three matching choices.

3.2 System Requirements Specification

System requirement specification is what determines what the system can do and the expected performance of the system. Both functional and non-functional requirements are specified below:

3.2.1 Functional Requirements

Functional requirements determine what a system can do and what operations can be performed by it.

Authentication and Session Management

The system includes an interface for logging into the application where the user enters their credentials (Username/password) in order to successfully log in to the system. Inactive for thirty minutes, a new login process would have to be initiated after the thirty-minute period elapses. There is a logout option which enables users to end their session whenever they want to. System operations require active sessions.

FR1 Students Profile Input

The system provides a web-based form where students can input their academic and personal information which include:

i. Full name
ii. State of origin
iii. Preferred location for study
iv. JAMB/UTME score
v. Number of O-Level sittings

vi. O-Level results

vii. Preferred course of study

viii. Preferred faculty (backup option if preferred course is unavailable)

ix. Type of institution

x. Mode of study (full-time or part-time

xi. Maximum annual tuition budget

xii. Willingness to relocate (yes/no)

xiii. Accommodation preference

FR2 Priority Weighing Input

The system enables students to prioritize their preference for decision making using five slides showing the level of importance of each criteria, namely;

i. Accreditation of program offered (scale 1-5)

ii. Tuition cost (scale 1-5)

iii. Ranking/reputation of institution (scale 1-5)

iv. Distance from home (scale 1-5)

v. Campus facilities (scale)

FR3 Form Validation

System validates all required fields prior to submission as well as displaying specific error message for:

i. State of origin field not filled

ii. JAMB score not within range 0 – 400

iii. Less than 5 O-level subject-grade fields

iv. Preferrred course not entered

v. No institution type selected

vi. Budget amount is zero

FR4 Institutional Eligibility Filtering

Prior to ranking institutions, filtering excludes those that do not fulfill the minimum eligibility criteria of student:

i. Type of institution should correspond to the preferred category of student (Federal, State or Private)

ii. Preferred Course of student should be available in the institution offered courses

iii. Annual tuition should not be more than students budget (Budget > 0)

iv. Location of University should fall under student location filters

v. JAMB cut off score in institution for preferred course should be ≤ Student JAMB Score.

vi. Student's O-Level subjects and grades meet the minimum requirements for the preferred course at the institution.

FR5 TOPSIS Multi-Criteria Ranking

The model uses the TOPSIS method to rank the eligible institutions according to:

i. Create a decision matrix with weightages assigned to each of the five criteria (accreditation, cost-effectiveness, rankings, proximity, facilities).

ii. Multiply the weights for each criteria with the students' priority weights.

iii. Determine the distance between the alternative institutions and the ideal best A+ and the ideal worst A-

iv. Calculate the closeness coefficient for each institution.

v. Rank the institutions on the basis of their match scores.

FR6 Display Ranked Results

The system shows the most ranked universities in the form of result cards containing:

i. The university name, short name, and university type.

ii. Match rate in percentage along with colors (green for 80% or more, gold for 60%-79% and red for below 60%).

iii. A badge indicating accreditation status (Fully Accredited/Interim Accredited/Not Accredited).

iv. Availability badge of program (✓Available/xNot Listed).

v. Annual tuition estimate.

vi. Ranking in the country.

vii. JAMB cut off of the selected course.

viii. Facilities available at the university shown in form of pills or icons.

ix. Two buttons "View Full Profile" and "Compare”

FR7 Filter and Sort Results

The system offers students the ability to interactively filter and sort the search results using:

i. Checkbox filter to select institutions according to their types.

ii. Dropdown menu to filter states.

iii. Min/max inputs for filtering institutions based on their tuition.

iv. Radio button selection for filtering based on accreditation status: Any, Fully Accredited Only, Interim and Not Accredited.

v. The results can be sorted as follows:

Best Match (default)

Tuition Low-to-High

Tuition High-to-Low

Ranking Best-First

FR8 Display Institution Detail Page

Upon clicking the option "View Full Profile," the system displays the following profile for that institution which includes:

i. Coherent data about the institution (institution name, institution type, address, date of establishment, motto)

ii. The complete list of courses offered alongside their accreditation status

iii. Detailed tuition fee structure based on faculties

iv. JAMB cutoff mark per subject/courses

v. List of facilities available along with their availability

vi. Ranking at the national, continental and international levels

vii. Contact information and website address of the institution

viii. Buttons for going "Back to Results" and also "Add to Compare."

FR9 Institution Comparison

The system enables students to analyze up to 3 universities against each other based on:

i. Similarity score

ii. Type of institution

iii. Campus location

iv. National ranking

v. Institution accreditation

vi. Affiliated programs

vii. Tuition fee

viii. JAMB cut-off

ix. Facilities available Coloring makes it easy for users to see the best deal (green), worst deal (red), and normal deal (white).

FR10 Comparison Table PDF Download

The tool offers a "Comparison Table PDF Download" button, which automatically prints the comparison table using an optimal CSS style print layout.

FR11 Modify Search

The search engine offers a button titled "Modify Search" on the results page, which takes the user back to the profile input page, retaining the previously entered data, so that they can change the parameters and run the search again.

FR12 Storing Search Session Data

The search engine stores search session data temporarily using the browser's sessionStorage mechanism, such that the user can navigate through different pages in the same session without losing data (result page → details page → comparison page → results page). The sessionStorage is emptied after closing the browser tab.

FR13 Failure to Return Any Results

If the filters remove all options for institutions (such as no university fitting within the student's budget and location parameters), a notice will be generated stating "No universities match your current criteria." This will also be accompanied by a "Reset Filters" button.

FR14 RESTful Backend API Endpoint

There is an available RESTful API endpoint /api/recommend which:

i. Receives a POST request with student profile JSON

ii. Validates the provided data

iii. Carries out filtering based on eligibility criteria

iv. Implements the TOPSIS algorithm for ranking

v. Responds with ranked institutions, matching scores, and search results.

3.2.2 Non-Functional Requirements

Non-functional requirements identify the quality characteristics, constraints, and performance requirements that the system needs to fulfill. Below are the listed non-functional requirements:

NFR1 Performance and Responsiveness

A student profile is analyzed, and the corresponding recommendations are generated within 5 seconds from the datasets of a maximum size of 100 universities. The execution time of the TOPSIS algorithm must be less than 2 seconds on a conventional web server with 2GB RAM and dual core processors.

NFR2 Usability and Accessibility

This system was developed with simplicity in mind:

i. All forms have field labels that are descriptive and concise

ii. Errors have specific explanations, such as "Please provide your JAMB score between 0 and 400" as opposed to "Invalid input"

iii. The interactive components have a touch area of at least 44px × 44px

iv. The interface is in simple terms without technical jargon

v. The smallest font size used in the application is no less than 14 pixels on mobile devices

NFR3 Responsiveness and Mobile Compatibility

The system was fully functional and responsive through:

i. Desktop screens (width ≥ 1200px)

ii. Tablet screens (768px-1199px)

iii. Mobile phones (320px-767px) All layout will adapt without horizontal scrolling; also, the navigation bar must collapse into a hamburger on screens less than 768px width.

NFR4 Data accuracy & currency

The dataset for institutions is updated at least once every academic year to account for:

i. NUC accreditation status updates

ii. JAMB cut-off mark updates

iii. Tuition fee updates

iv. Addition of new programs/institutions Each dataset update will be stamped, and the system will show the statement "Data last updated [insert date]" on the result page.

NFR5 Confidentiality and Privacy

The system secures the privacy of the student's data through:

i. Never saving any information related to student profiles in the server

ii. Not using cookies or databases on the server side but instead relying on sessionStorage to save student inputted data

iii. Having a statement of confidentiality, which says, "your data will only be used to formulate recommendations and not be saved"

iv. Publishing the application through HTTPS to protect data transfer

v. Input validation to avoid SQL injections and XSS attacks

NFR6 Scalability

The system architecture supports:

i. Expansion of the dataset from 87 universities (current prototype) to 200+ universities without requiring algorithm redesign
ii. Concurrent access by up to 100 simultaneous users without performance degradation
iii. Introduction of additional factors into the algorithm (such as teacher-student ratio and amount of research) via alteration of the existing TOPSIS weighting matrix without changing its basic mechanism.

NFR7 Reliability and Availability

The system provides:

i. 95% availability during the JAMB registration period (March – August)
ii. Efficient fault tolerance: In case the API server becomes unavailable, the front-end should display a proper error message stating “Connection to recommendation engine is not established.” This should be done instead of crashing or returning error codes
iii. An automatic retry mechanism in case of API failure

NFR8 Maintainability and Code Quality

The system codebase is:

i. Modularized into separate files (HTML, CSS, JavaScript, Python) for ease of maintenance
ii. Documented with inline comments explaining the purpose of each function
iii. Managed via Git version control with detailed commit history
iv. Architected according to best practices in software engineering

NFR9 Portability and Deployability

The application can be deployed on:

i. Local development server (localhost) using Python Flask framework and web browser.

ii. Cloud environment providers such as Heroku, Render, or PythonAnywhere with little modification.

iii. Any computer platform supporting Python 3.10 and above together with web browsers.

NFR10 Ethical Standard Compliance

The system:

i. Has referenced the source of its data (NUC, JAMB, Webometrics) properly on the footer and About Us section.

ii. Is recommended to display a disclaimer saying: “Information obtained from NUC, JAMB, and institution’s websites. This recommendation serves as a guide. You should always confirm information from institutions directly before using it.”

iii. Should not promise any certainty about results, as in saying "the best university for you," but recommend using probabilities, such as "Match Score: 92%".

3.3 System Design Methodology

The creation of the decision support system adhere to a structured hybridization of the Waterfall Model of the software development lifecycle and Object Oriented Analysis and Design (OOAD) paradigm. While the waterfall model governed the sequential, phased progression of the project management lifecycle, the OOAD approach dictated the specific methodologies used to analyze system workflows and structure software blueprint.

3.3.1 Justification for Methodology

Waterfall development methodology and Object-Oriented Analysis and Design was chosen for the following reasons:

Waterfall Model: system requirements are fully defined and static, meaning there is no need for iterative, agile changes. Since this is a solo undergraduate project using stable secondary data sources, waterfall's linear progression makes the workload easy to manage.

Object-Oriented Analysis and Design: it converts complex real world education entities into modular code objects. Using OOAD principles via ensures a clean separation of concerns by isolation the eligibility filters from the mathematical matrices of the TOPSIS engine. This modular design guarantees the system satisfies its scalability requirement.

3.3.2 Method of Data Collection

This research uses secondary sources. Data was collected as follows:

1. Document Analysis and Systematic Extraction: Accreditation report documents and admissions figures were sourced online through the (NUC) website (www.nuc.edu.ng) and JAMB website (www.jamb.gov.ng). The relevant information, such as accreditation details, approved programmes, and cut-off scores, was captured in a well-structured table format.

2. Web Scraping and Manual Content Analysis

Fee structure, facility details, information on the location of the campuses, and subject area details were gathered from the official websites of federal, state, and private universities. Python-based software like BeautifulSoup and Requests were used for web scraping of the structured sites, while manual data entry was used for unstructured sites.

3. Published Rankings and Performance Indices

The national and continental rankings of universities were obtained from the webometrics Ranking of World Universities (www.webometrics.info) as objective criteria for use in the TOPSIS ranking model.

4. Academic Literature

Academic research through Google Scholar, IEEE Xplore, and ResearchGate were used to guide the system's design and implementation of the DSS.

5. Government Reports

Data obtained from reports by the Federal Ministry of Education and the National Bureau of Statistics of Nigeria were reviewed to give background knowledge of the enrolment pattern and geopolitical distribution.

3.4 System Modeling Using UML

UML was adopted for designing the DSS for the choice of a tertiary institution. By applying OOAD principles via UML, the project's requirements were translated away from traditional step by step data flows. Instead, they were mapped into independent, modular system components.

3.4.1 Use Case Diagram

The Use Case Diagram illustrates the actors that use the system and the functions (use cases) provided by the system for each actor. The system boundary is defined in the use case diagram.

Actors:

i. **Prospective Student (Primary Actor):** The person looking for university recommendations. All core functions are triggered by this actor.

ii. **(Optional) System Administrator:** The actor who updates information about institutions in the database and ensures the optimal performance of the system. (In the prototype version of the software, data update is done manually by the developer but included here for future scalability.)

Prospective Student Use Cases:

i. Login/Authenticate: Students are expected to log into the system before performing any action within it.

ii. Input Profile: Student provides information regarding their academics, finances, preferences, and priorities.

iii. Assign Priority Weights: Student define what criteria are most important to them.

iv. Ranked List of Universities: The system presents students with a list of universities that meet their profile and criteria.

v. View Ranked Results: Student access their personalized list of institutions.

vi. Comparison of Universities: The student chooses up to three universities to compare.

vii. View Institution Details: The student receives complete information about a university.

viii. Save Comparison: The student downloads their comparison table in PDF format.

ix. Modify Search: The student revisits their earlier inputted information in order to edit the search criteria.

x. Logout: Student terminates the session.

System Administrator Use Cases:

i. Manage University Records: This involves creating, updating, and deleting the primary data profiles for all participating universities, such as their type (federal, state, private) and rankings.

ii. Update Accreditation Status: Ensuring the critical data regarding the accreditation of individual program and faculties is current.

iii. Update JAMB Cut-offs: Modifying the required admission benchmarks, which often change from session to session.

iv. Update Tuition Fees: Maintaining accurate, current fee structures, as this is typically a high-priority criterion for students.

v. Monitor System Performance: A background technical task to ensure the server and TOPSIS engine are operating within acceptable performance paramaters.

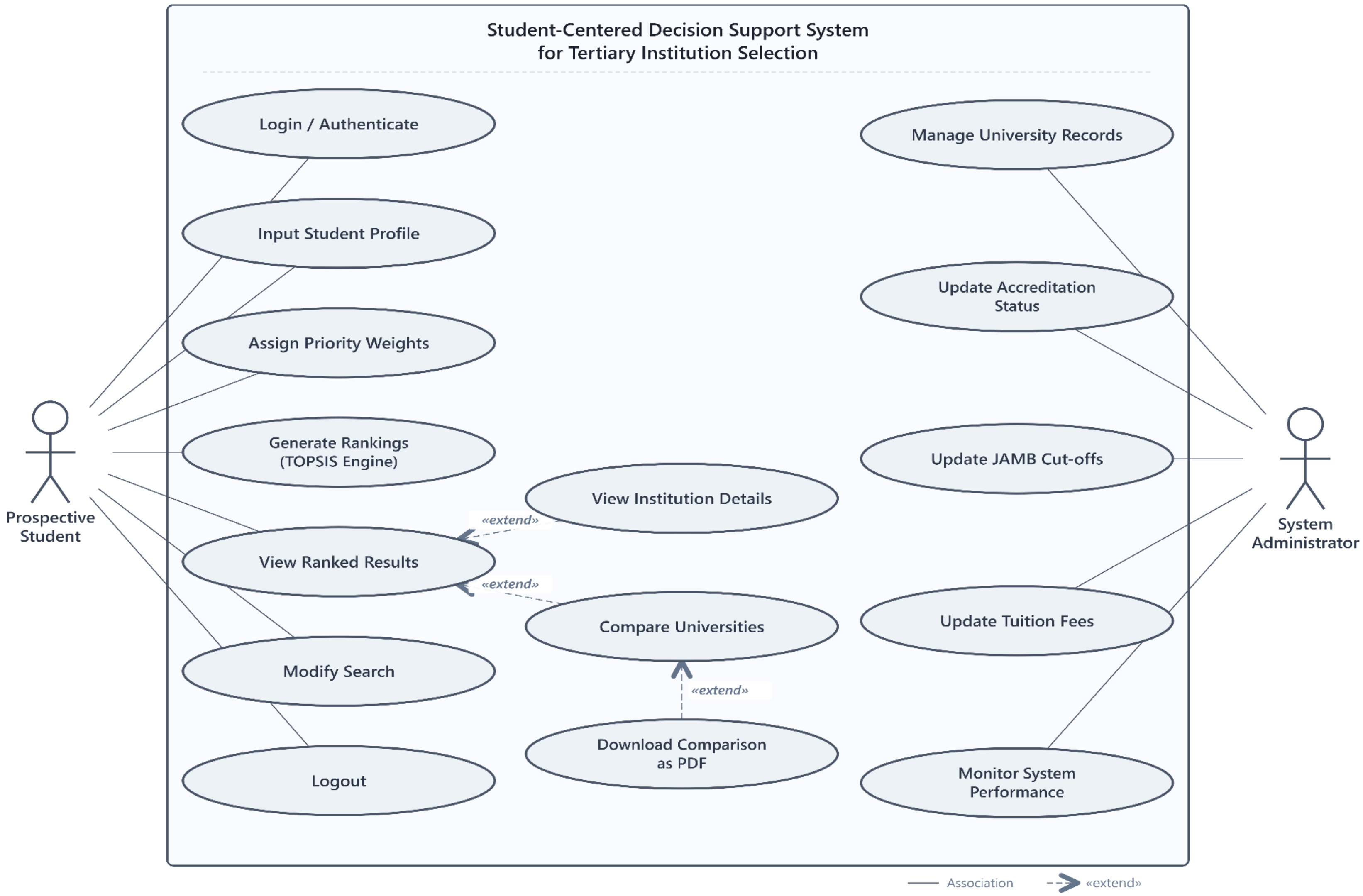


Figure 3.1: Use Case Diagram - DSS System Boundar

3.4.2 Activity Diagram

The activity diagram represents the sequence of activities involved in the recommendation process.

Diagram Description (Textual Flow):

1. **Initial Node:** Student navigates to the DSS login page
2. **Action:** Student enters username and password in the login page.
3. **Decision node**: Is the student successfully authenticated?
    i. If not authenticated, display error "Invalid Username or Password" and navigate back to the login page.
    ii. If authenticated, start new user session and navigate to the profile input form.
4. **Initial node:** Student chooses "Get Recommendations" on the homepage.
5. **Action:** The system loads the profile input form.
6. **Action:** Student fills out form fields (JAMB score, O Level, preference, budget, and weighting of priorities).
7. **Action:** Student submits the form.
8. **Decision node**: Form validation check.
    i. If form is invalid, go back to form and notify the user with relevant error message.
    ii. If form is valid, continue.
9. **Action**: Eligibility criteria (institution type, course offering, tuition <= budget, preferred location, JAMB cut-off <= student score).
10. **Decision node**: Is there any eligible university left?
    i. If none is left, show "No universities match your criteria" message with recommendations and provide a "Modify search" link.

ii. If there are still some universities left, continue

11. **Process step:** System builds the decision matrix for TOPSIS using the five decision attributes (accreditation, affordability, ranking, proximity, facilities), along with priority values assigned by the user.
12. **Process step:** TOPSIS algorithm calculates the ideal positive and negative solutions, generating the closeness coefficients which provide a match value for each matching institution.
13. **Process step:** System ranks institutions based on the match score, in descending order.
14. **Process step:** Results page displays ranked institutions, coloured according to the match score, along with sorting and filtering options.

End Node: User sees the output and interacts with the system further.

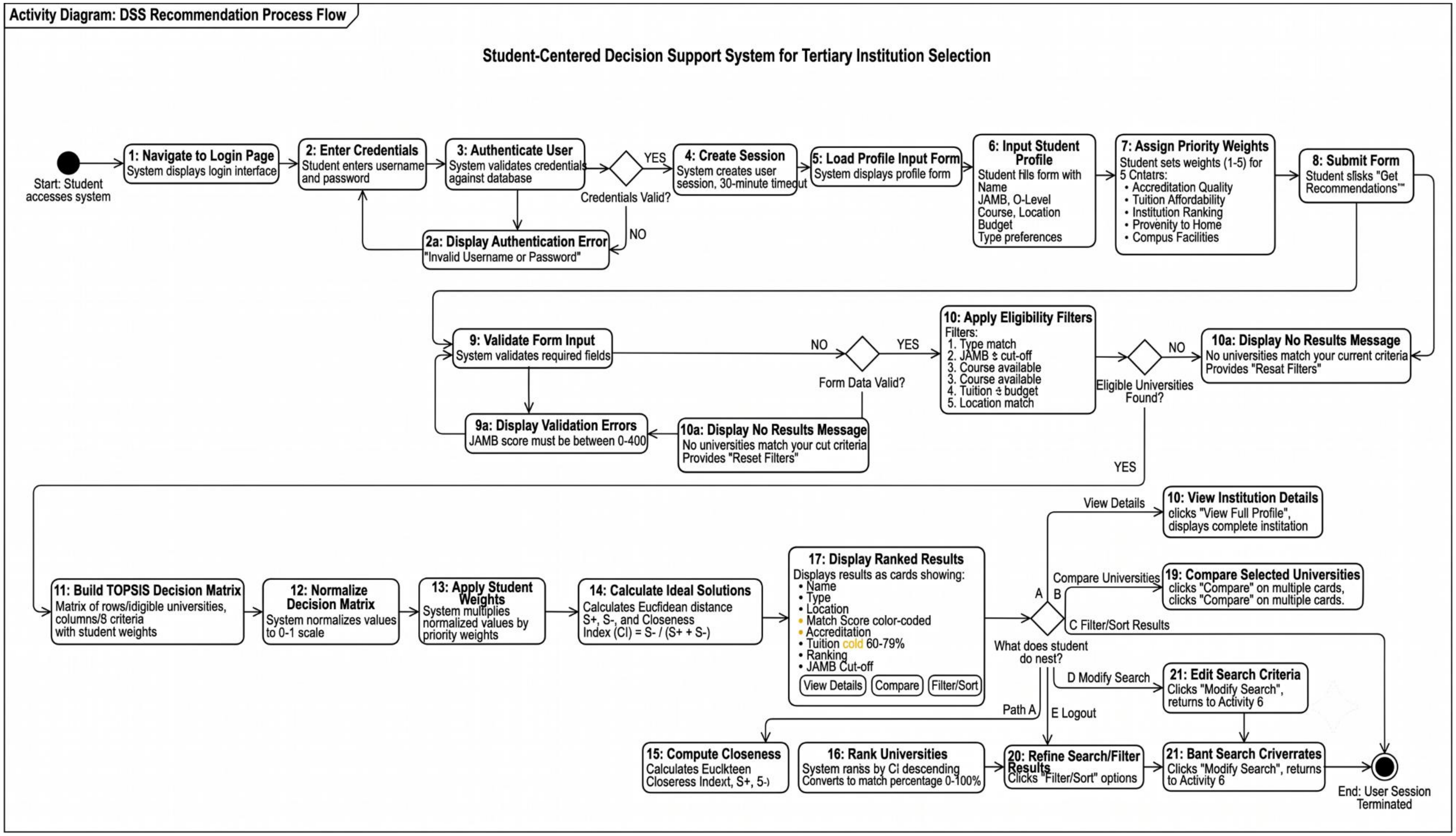


Figure 3.2: System Architecture Diagram - Three-Tier Design

3.4.3 Class Diagram

Class Diagram demonstrates the static view of the system which includes the main entities of data, the properties of those entities, the operations, and the relationship between them. This diagram is the base of designing the database and object modeling of the back end.

Description

i. Authentication validates StudentProfile (1:1 relationship via "Validates" dependency), ensuring only authorized users access the system. One Authentication instance validates one StudentProfile. StudentProfile uses TOPSISEngine in a 1:1 relationship meaning one student profile triggers one ranking execution.

ii. TOPSISEngine (1:0 *) uses multiple Universities and Program, indicating one engine processes zero or many institutions and programs from the database. This engine accesses Database (1:1), where one engine instance connects to one database for all institutional queries. TOPSISEngine returns Results (1:1), producing one ranked result set per execution.

iii. University contains Program (1:1 *), meaning one university houses one or many programs. Each program belongs to exactly one university.

iv. Result (1:1 *) uses Comparison, indicating one result can be used by multiple comparison operations. Students can create zero or many comparison from a single result set.

v. The Database (1:1) maintains a one to one connection with TOPSISEngine, providing consistent access to university, program, accreditation, tuition, and facility data throughout the ranking process.

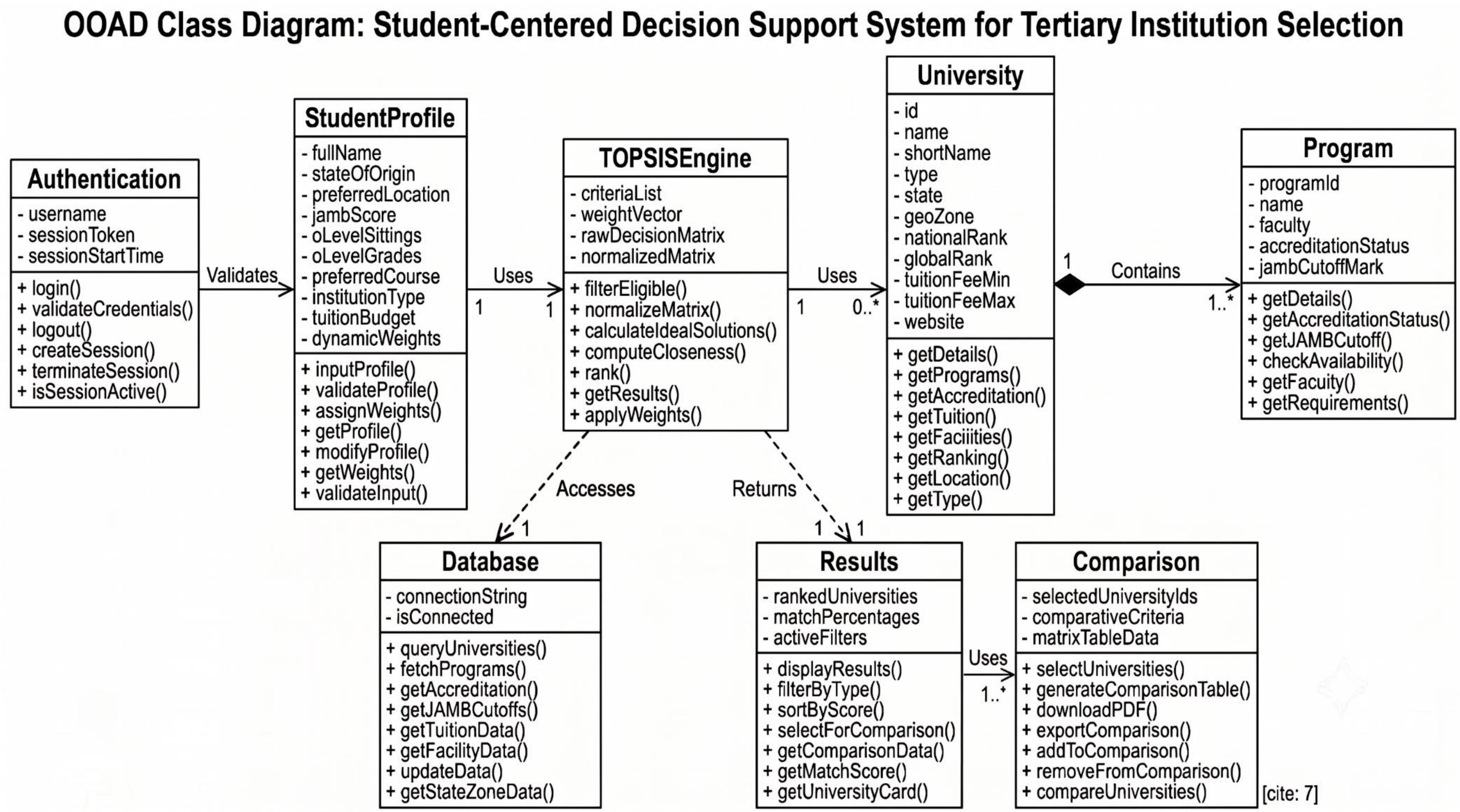


Figure 3.3: Class Diagram - Complete Data Model

3.5 System Design

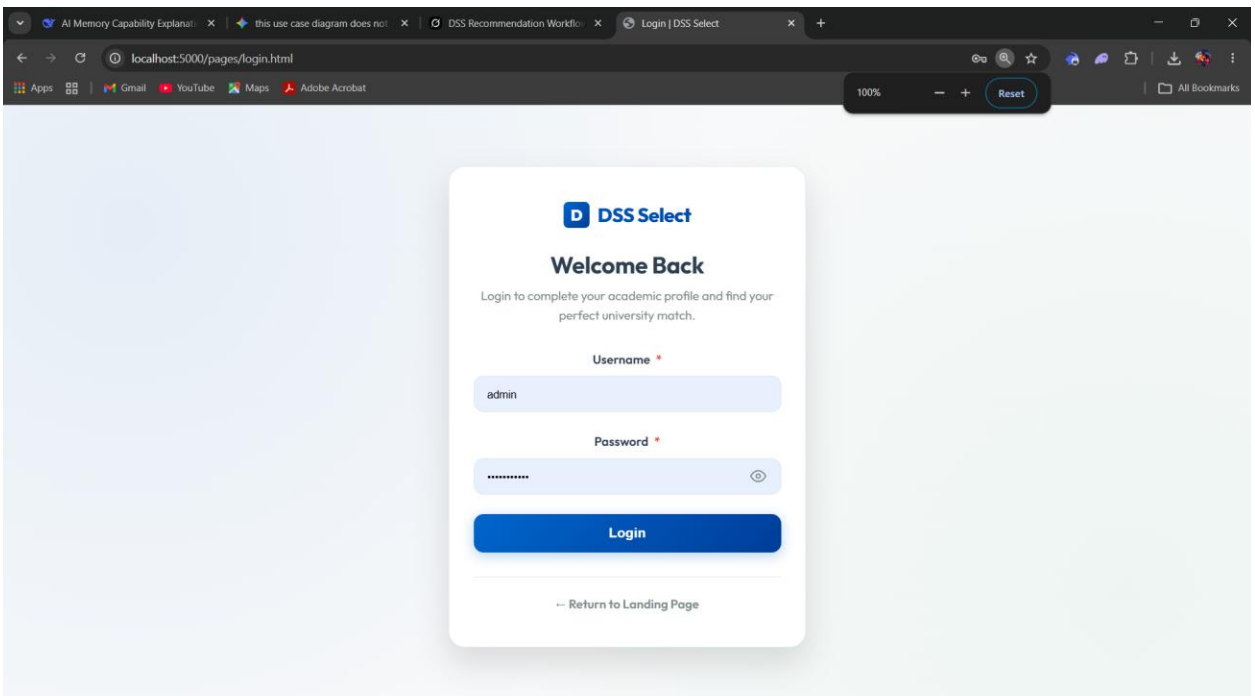
System design converts the requirements and models into a plan that can actually be implemented. Because the Waterfall methodology is followed, all decisions regarding the design will be taken at this stage before going ahead with any coding. The design section will discuss the input and output interfaces, database design, and system architecture.

3.5.1 Input Design

Input design defines how the user inputs his data and what type of data he inputs into the system.

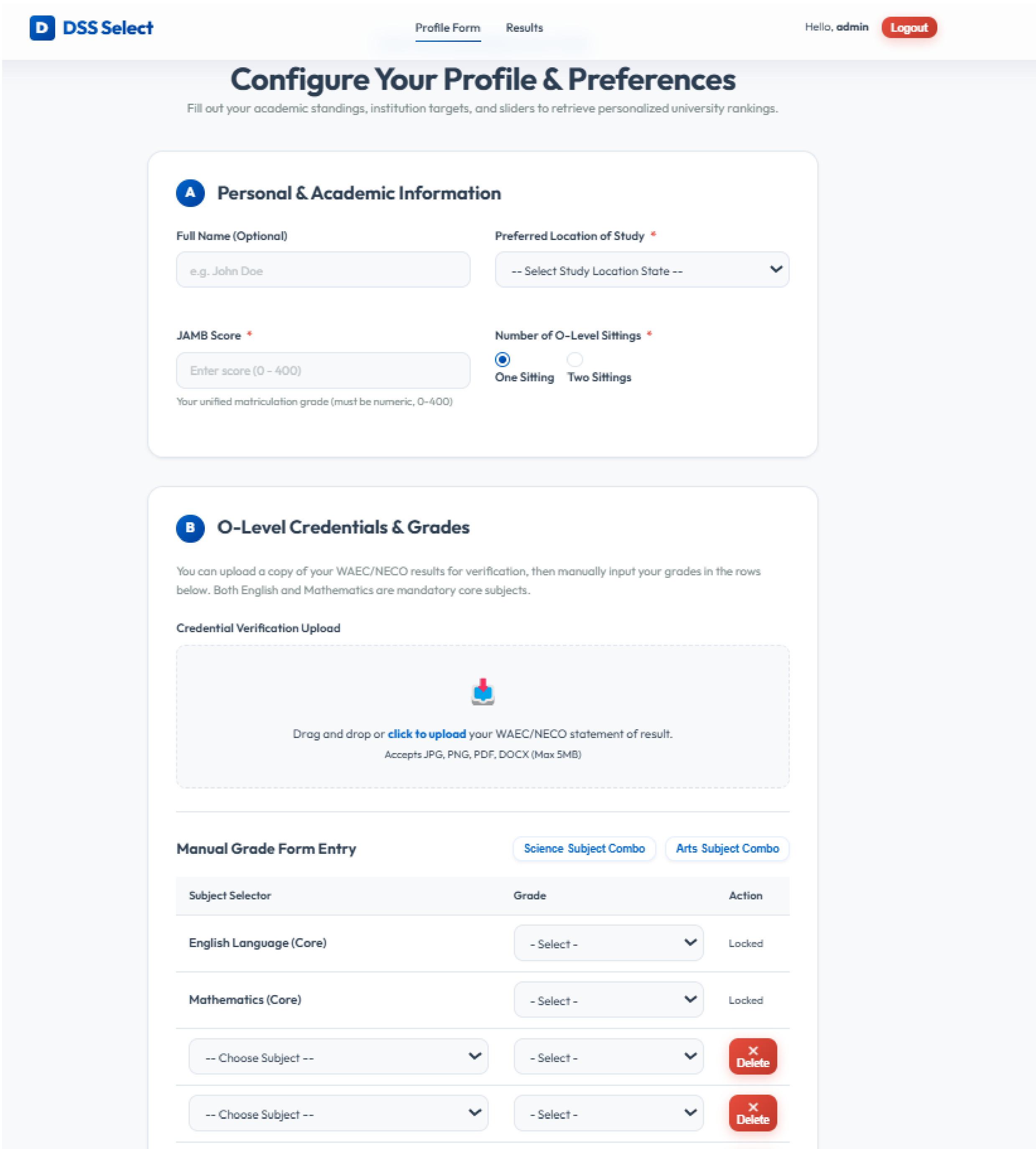
A. Login Form

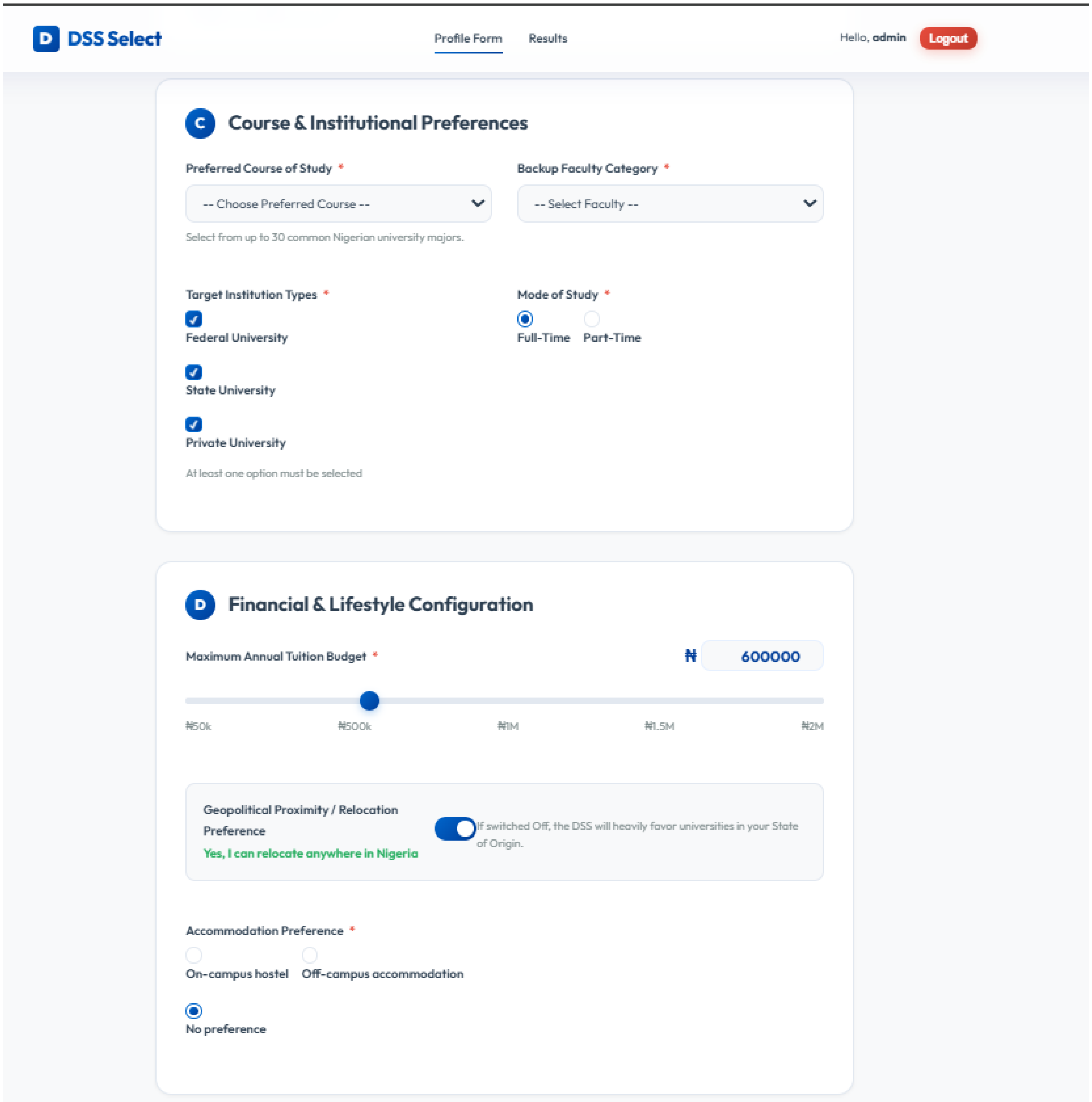
The login form is the first form displayed to all users. The following is the login form:



B. Profile Input Form

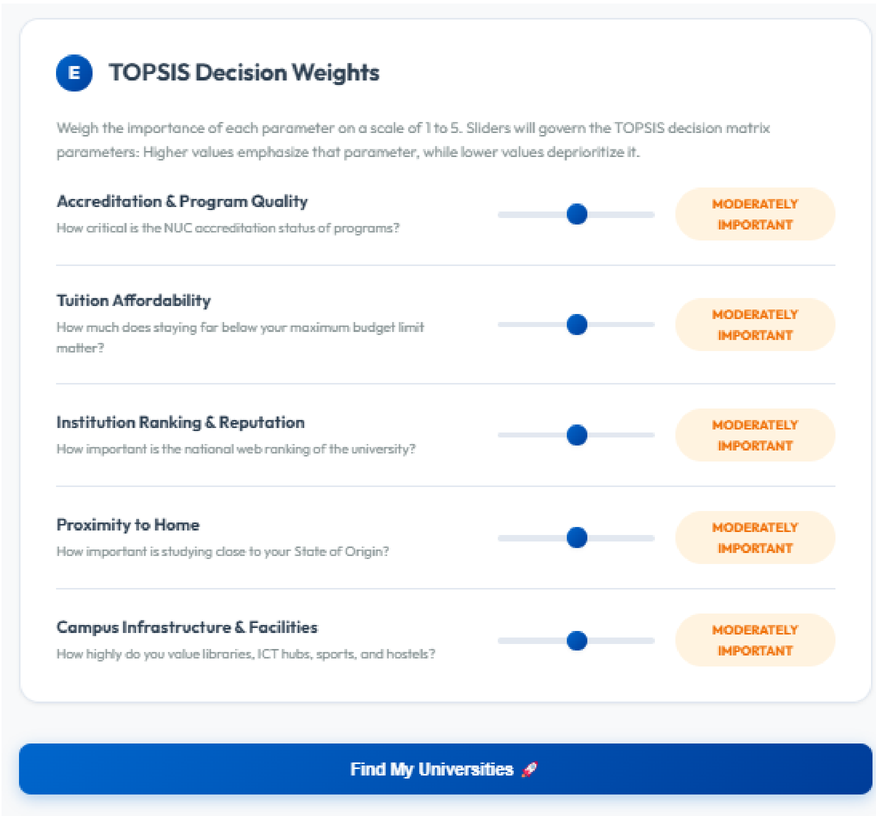
The primary input form is a web page where the profile of the candidate regarding academics, finances, location, and decision-making preferences is entered. The following is the profile input form:


D DSS Select
Profile Form
Results
Hello, admin
Logout
Configure Your Profile & Preferences
Fill out your academic standings, institution targets, and sliders to retrieve personalized university rankings.
A Personal & Academic Information
Full Name (Optional)
e.g. John Doe
Preferred Location of Study *
-- Select Study Location State --
JAMB Score *
Enter score (0 - 400)
Your unified matriculation grade (must be numeric, 0-400)
Number of O-Level Sittings *
One Sitting
Two Sittings
B O-Level Credentials & Grades
You can upload a copy of your WAEC/NECO results for verification, then manually input your grades in the rows below. Both English and Mathematics are mandatory core subjects.
Credential Verification Upload
Drag and drop or click to upload your WAEC/NECO statement of result.
Accepts JPG, PNG, PDF, DOCX (Max 5MB)
Manual Grade Form Entry
Science Subject Combo
Arts Subject Combo
Subject Selector
Grade
Action
English Language (Core)
- Select -
Locked
Mathematics (Core)
- Select -
Locked
-- Choose Subject --
- Select -
Delete
-- Choose Subject --
- Select -
Delete


D DSS Select
Profile Form
Results
Hello, admin
Logout
C Course & Institutional Preferences
Preferred Course of Study *
-- Choose Preferred Course --
Select from up to 30 common Nigerian university majors.
Backup Faculty Category *
-- Select Faculty --
Target Institution Types *
Federal University
State University
Private University
At least one option must be selected
Mode of Study *
Full-Time
Part-Time
D Financial & Lifestyle Configuration
Maximum Annual Tuition Budget *
₦ 600000
₦50k
₦500k
₦1M
₦1.5M
₦2M
Geopolitical Proximity / Relocation Preference
Yes, I can relocate anywhere in Nigeria
If switched Off, the DSS will heavily favor universities in your State of Origin.
Accommodation Preference *
On-campus hostel
Off-campus accommodation
No preference

B. Priority Weighting Panel

Under the profile field, there are five sliders that allow the students to decide on the level of importance to each decision criterion:



Default is set to 3.

C Validation

vi. Validation on client side: Input is validated using JavaScript prior to form submission. User-friendly validation errors are provided against the input fields that contain incorrect data (for example, “JAMB score must be within 0-400”).

vii. Validation on server side: The backend API performs additional validation of the input data to ensure security. On unsuccessful validation, the server will respond with status code 400 with errors for each input.

viii. Captured data format: Data will be submitted to the endpoint /api/recommend as JSON. Sample data format is:

3.5.2 Output Design

This section highlights how recommendations and comparisons will be provided to the student using the proposed system.

A. Results Page

The student will be directed to a results page that will display:

i. Summary Bar ("Showing X of Y universities matching your profile")

ii. Filters & Sort Options ("By Institution Type | By State | By Tuition Range | By Accreditation Status" and "Sort by: Best Match / Tuition Low to High / Ranking").

iii. A Result Cards Grid.

Result Card Content:

i. Name of university, nickname, and logo type (Federal, State, or Private)

ii. Score match (big, color-coded: green for ≥80%, gold for 60%-79%, and red for <60%)

iii. Affiliation logo (green for "Fully Accredited", orange for "Interim", and red for "Not Accredited")

iv. Program availability (Available)

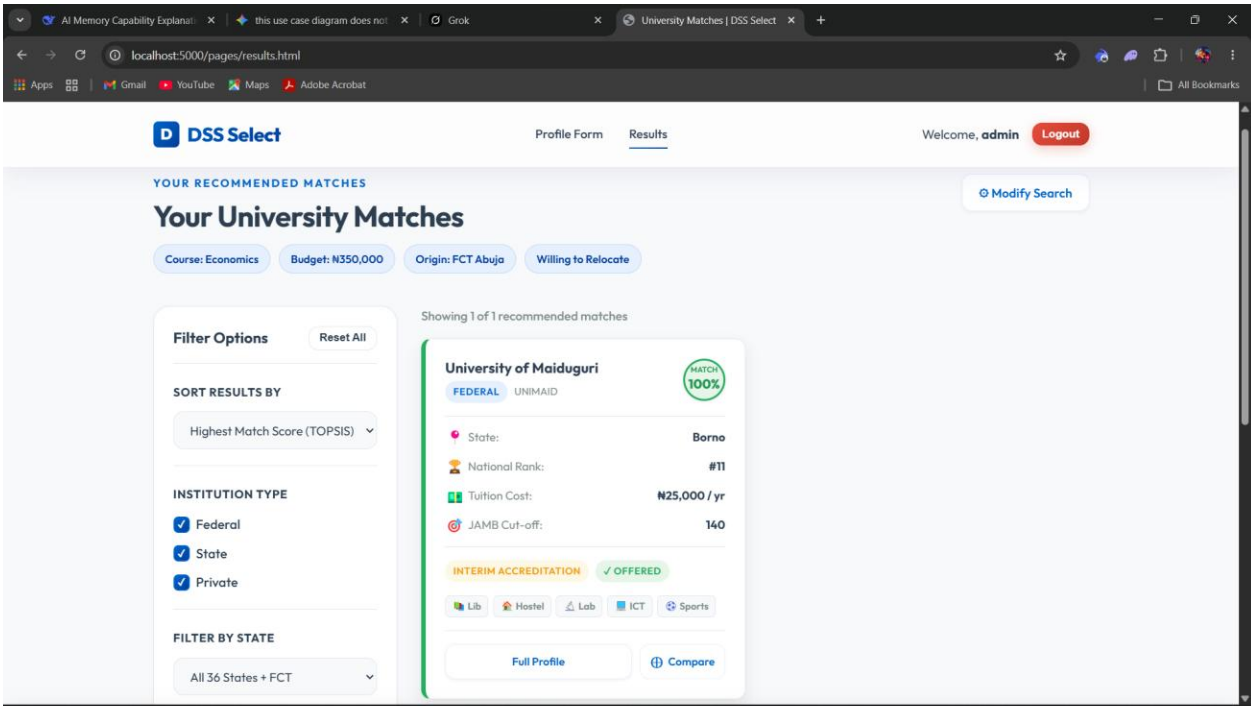
v. Tuition cost per year

vi. Ranking nationally

vii. JAMB cut-off point for

viii. Two buttons: “View Full Profile” and “Compare”.

See image of the result card below:



B. Institution Detail Page

Opened when the student clicks “View Full Profile”. Displays:

i. Full institutional information (location, year established, motto, website)

ii. Complete list of programs with individual accreditation statuses (colour-coded)

iii. Tuition breakdown by faculty

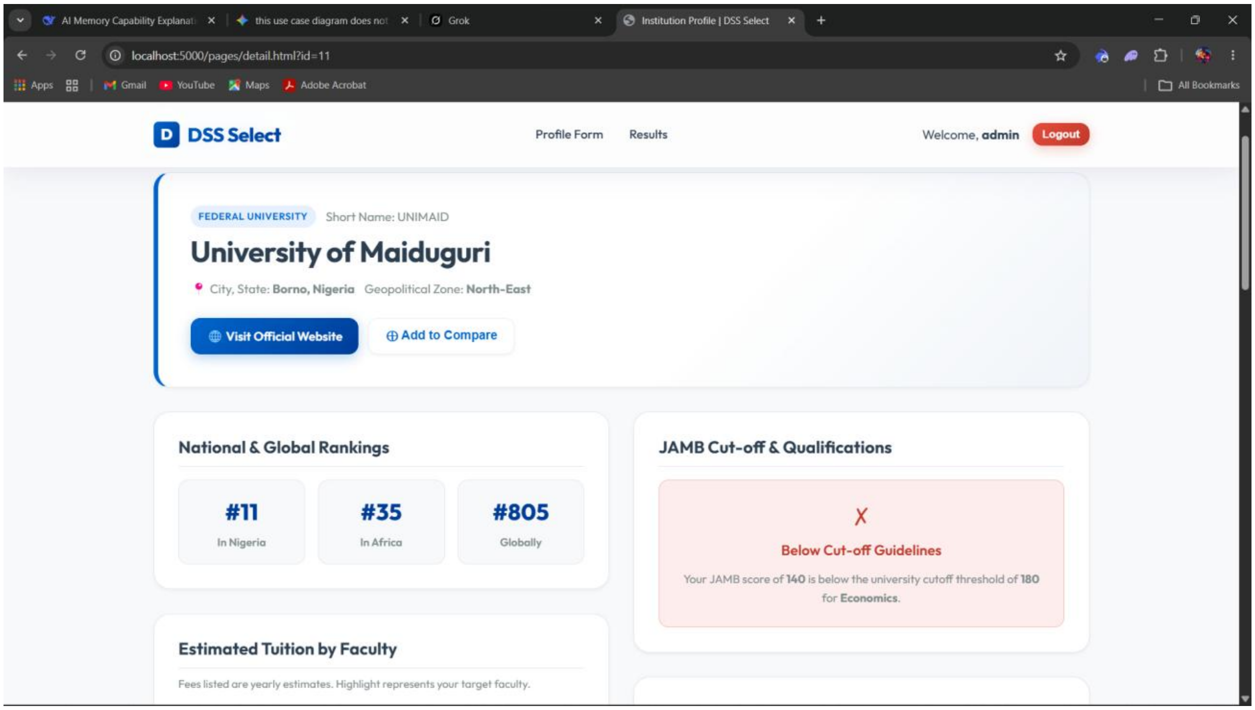
iv. JAMB cut-off marks by course

v. Facility checklist

vi. National, continental, global rankings

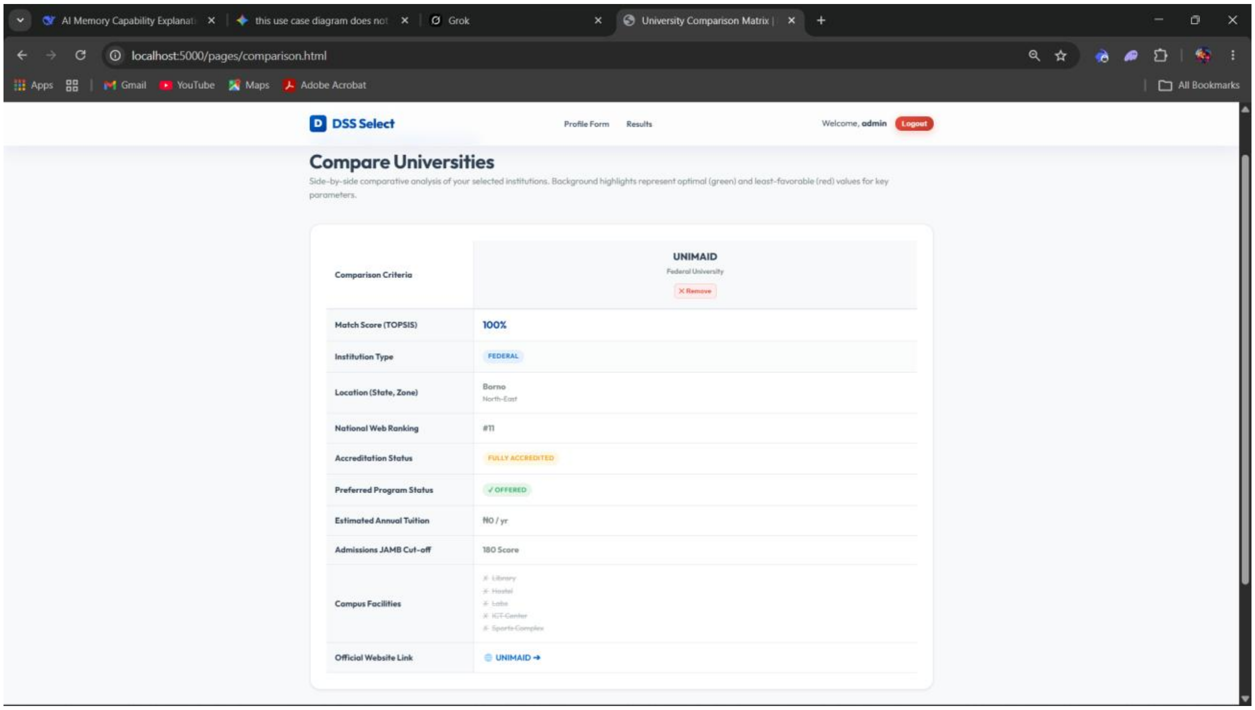
vii. “Back to Results” and “Add to Compare” buttons

See institution detail page below:



C. Comparison Page

Up to 3 institutions can be compared side-by-side in a table. Columns: criteria (Match Score, Type, Location, Ranking, Accreditation, etc.), rows: each university. Cells are colour-coded: green for best value, red for worst. A “Download as PDF” button triggers browser print with print-friendly CSS. See comparison page below:



D. Logout Function

The logout button is available in the top-right corner of every page in the navigation bar. When clicked, the logout function: (1) Displays confirmation: "Are you sure you want to log out?"; (2) Upon confirmation: Clears the user session and deletes stored session token; (3) Redirects user to login page with message: "You have been logged out successfully"; (4) All user data from the session is cleared (profile is not saved for future login).

3.5.3 Database Design

The database stores all institutional and reference data needed for filtering and ranking. MySQL was used, with the following tables derived from the class diagram.

Table 3.1 Presents the database schema.

Column	Type	Constraints
id	INT	PRIMARY KEY, AUTO_INCREMENT
name	VARCHAR(150)	NOT NULL
short_name	VARCHAR(20)	
type	ENUM('Federal','State','Private')	NOT NULL
state	VARCHAR(50)	NOT NULL
geo_zone	ENUM('North Central','North East','North West','South East','South South','South West')	NOT NULL
national_rank	INT	
global_rank	INT	
website	VARCHAR(255)	
year_established	YEAR	
motto	VARCHAR(255)	

Column	Type	Constraints
Id	INT	PRIMARY KEY, AUTO_INCREMENT
university_id	INT	FOREIGN KEY REFERENCES university(id) ON DELETE CASCADE
program_name	VARCHAR(150)	NOT NULL
faculty	VARCHAR(100)	
accreditation_status	ENUM('Fully Accredited','Interim','Not Accredited','Not Listed')	NOT NULL

Column	Type	Constraints
id	INT	PRIMARY KEY, AUTO_INCREMENT
university_id	INT	FOREIGN KEY REFERENCES university(id) ON DELETE CASCADE
course_name	VARCHAR(150)	NOT NULL
min_score	INT	NOT NULL (0–400)

Column	Type	Constraints
id	INT	PRIMARY KEY, AUTO_INCREMENT
university_id	INT	FOREIGN KEY REFERENCES university(id) ON DELETE CASCADE
faculty_category	VARCHAR(100)	
annual_fee_min	DECIMAL(10,2)	
annual_fee_max	DECIMAL(10,2)	

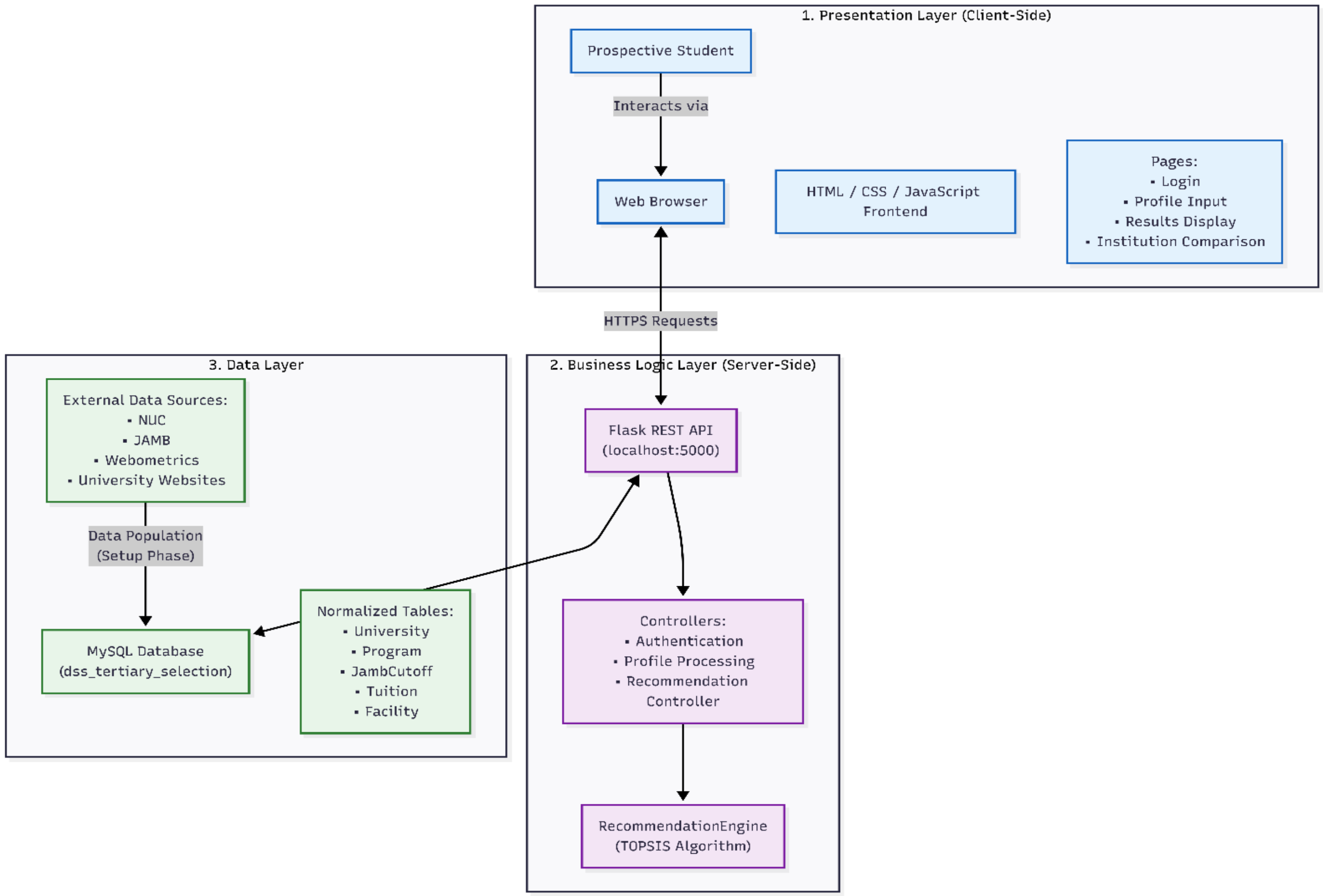
Column	Type	Constraints
id	INT	PRIMARY KEY, AUTO_INCREMENT
university_id	INT	FOREIGN KEY REFERENCES university(id) ON DELETE CASCADE
facility_name	VARCHAR(100)	(e.g., 'Library','Hostel','ICT Centre')
available	BOOLEAN	DEFAULT TRUE

Column	Type	Constraints
state_name	VARCHAR(50)	PRIMARY KEY
geo_zone	ENUM(...)	NOT NULL

3.5.4 System Architecture Design

The DSS follows a three-tier, web-based client-server architecture.

A. Architecture Overview


1. Presentation Layer (Client-Side)
Prospective Student
Interacts via
Web Browser
HTML / CSS / JavaScript Frontend
Pages:
▪ Login
▪ Profile Input
▪ Results Display
▪ Institution Comparison
HTTPS Requests
3. Data Layer
External Data Sources:
▪ NUC
▪ JAMB
▪ Webometrics
▪ University Websites
Data Population (Setup Phase)
MySQL Database (dss_tertiary_selection)
Normalized Tables:
▪ University
▪ Program
▪ JambCutoff
▪ Tuition
▪ Facility
2. Business Logic Layer (Server-Side)
Flask REST API (localhost:5000)
Controllers:
▪ Authentication
▪ Profile Processing
▪ Recommendation Controller
RecommendationEngine (TOPSIS Algorithm)

B. Component Descriptions

1. **Presentation Tier (Frontend):**

   i. Static HTML5, CSS3, and vanilla JavaScript (or a lightweight framework if needed).

   ii. Runs entirely in the student's browser.

   iii. Communicates with the backend exclusively via asynchronous HTTP requests (AJAX / Fetch API).

   iv. No business logic – only input validation, UI rendering, and session storage.

2. **Application Tier (Backend):**

   i. Python 3.10+ running on Flask framework.

   ii. Provides a RESTful API endpoint (POST /api/recommend), which takes the student's profile as a JSON object and gives recommendations.

   iii. Modules:

      1. Validator: Validates the student's data.
      2. EligibilityFilter: Queries the database and enforces hard constraints.
      3. TopsisEngine: Performs the MCDM analysis with the given priority weights.

   iv. Stateless architecture: All modules are stateless.

3. **Data Layer (Database)**

   i. A MySQL relational database that holds institutional and reference data tables as mentioned in section 3.7.3.

   ii. Connection Pooling is used in the backend while making the connection to the database.

C. Data Flow in Recommendation Request

i. The user fills out the form → JS validation and conversion into JSON format is done and sent to /api/recommend

ii. Payload validation in Flask Endpoint and invoking the EligibilityFilter class.

iii. Using database queries with SQL SELECT statement and joins, the database is queried for universities meeting the criteria.

iv. In case there are no results, an error response in JSON format is returned.

v. Else, TopsisEngine invokes and gets the output with university recommendations.

vi. The result is passed on to the endpoint and packed into JSON format.

viii. The JSON data is sent back to the frontend to be rendered further.

D. Deployment Considerations

i. Development: Flask running on local development server.

ii. Deployment: Can be deployed on cloud services such as Heroku, Render, PythonAnywhere using WSGI server like Gunicorn and a MySQL database. Communication done via HTTPS protocol.

CHAPTER FOUR

SYSTEM IMPLEMENTATION

4.0 Introduction

The current chapter gives the actual implementation of the Decision Support System (DSS) for tertiary institution selection in Nigeria from the specification provided in the previous chapter to an operational computerized system. In the chapter, the reader is made familiar with the development environment, the software that has been utilized in developing the DSS and its modules. Information on how the dataset of institutions is prepared and integrated into the system is presented, and the TOPSIS method of multiple criteria decision making is also described. Finally, the process of testing the developed system is covered together with the presentation of some sample output produced using the DSS.

4.1 Development Environment and Tools

This section provides information on the programming language and other tools used in the development of the DSS.

4.1.1 Programming Language and Libraries

The software was designed using different programming languages and libraries that were selected based on factors such as robustness and usability for quick development.

i. Python 3.10: The decision to choose Python as the main backend programming language lies in the fact that Python supports a variety of scientific computing and web development libraries, which are also readable and have a vibrant community around them. Everything from data processing to Topsis calculations was developed using Python in the DSS recommendation system.

ii. Flask: To develop a RESTful API endpoint, called "/api/recommend", the Flask framework was chosen, as this web app development framework is suitable when developing a lightweight server. Flask was chosen because, according to the non-functional requirement NFR1, the DSS should provide fast performance.

iii. Pandas & NumPy: The Pandas library was used in order to import, clean and manipulate the institutional dataset. Efficient numerical operations by means of NumPy made calculations for the TOPSIS matrix possible, which included normalization, multiplication by weight and calculating distances.

iv. MySQL & MySQL Connector: MySQL was used as the RDBMS in order to store the structured data regarding universities. In combination with mysql-connector-python library, Python was able to communicate with the database in order to retrieve the information about institutions dynamically depending on the user request.

v. Frontend Technologies: The frontend interface was developed based on HTML5, CSS3 and pure JS code. There was no use of any complicated frontend frameworks in order not to overload the application and make it lighter and faster. For the purpose of responsiveness, CSS Flexbox/Grid layouts were used, and JS was utilized for form validation and sliders functionality.

vi. Additional libraries: Bootstrap 5 icons were applied in the user interface (for example accreditation badges and facility icons). Jinja2 library was utilized for rendering comparison pages via Flask.

4.1.2 Development Platform and Hardware Requirements

i. Operating System: Windows 11 (64-bit)

ii. Integrated Development Environment (IDE): Visual Studio Code (VS Code) was used for all Python, HTML, CSS, and JavaScript code writing and debugging. Jupyter Notebook provided an interactive platform for the prototyping of the TOPSIS model and visualization of the data distribution before their incorporation into the Flask-based application.
iii. Database Management System: MySQL Workbench was utilized for developing the database schema, building tables, and importing and validating the data.
iv. Version Control System: Git was implemented for source code management purposes with the development being done against the local repository.
v. Hardware Requirements: The hardware configuration of the laptop that was used in developing the project was as follows: Intel Core i5 processor (2.4GHz), 8GB RAM, and 256GB SSD.
vi. Deployment Platform: The prototype was run on the PythonAnywhere platform, which supports Python Flask framework application development and MySQL database management system, thereby meeting the portability NFR9.

4.2 Dataset Description and Preprocessing

However, even though the DSS does not use machine learning in its conventional form, it uses a structured dataset about Nigerian universities, which is used as the repository of knowledge by the recommendation engine. This section talks about the nature of this dataset and the data preprocessing procedures adopted before its integration with TOPSIS.

Overview of Dataset

The final dataset contains 87 Nigerian universities consisting of equal proportions of federal (39), state (38), and private (10) universities. The data was sourced from NUC’s website, JAMB’s site, webometrics rankings, and university websites individually as described in Section 3.1. Table 4.1 highlights some of the important attributes of the dataset.

Table 4.1: Core Dataset Attributes

Attribute	**Data Type**	**Example**
University Name	String	University of Lagos
Short Name	String	UNILAG
Institution Type	Categorical (Federal/State/Private)	Federal
State	String	Lagos
Geopolitical Zone	Categorical	South West
Programs Offered	List (JSON array)	["Computer Science", "Medicine", ...]
Accreditation Status (per program)	Categorical (Full/Interim/Not Accredited)	Full
Annual Tuition (by faculty)	Numeric (₦)	180,000
JAMB Cut-off (per course)	Numeric	210
National Ranking	Numeric (1–50)	5
Facilities	List (Boolean flags)	{Library: true, Hostel: true, ...}

Preprocessing Steps

The below are the steps of data pre-processing conducted to convert raw data into computable data:

1. **Standardisation:** All universities' and programs' names are converted into standard forms (i.e., University of Lagos instead of UNILAG) so as to facilitate consistent joins between tables from where data is sourced.
2. **Normalisation**: All decision criterion values for all five criteria (accreditation, affordability, ranking, proximity, and facilities) have been normalized to 0-3 range to ensure no dominance by any criterion during computation of distances using TOPSIS model. Normalization is done through the min-max method:

$$x' = \frac{x - x_{min}}{x_{max} - x_{min}} \times 3$$

3. **Weighting**: Weights for criteria were not embedded within the dataset, but are dynamically provided by the student using priority sliders. These weights are then input into the TOPSIS model during execution, making it possible to generate personalized rankings based on individual student preferences.
4. **Missing Values**: Schools that have missing information on non-critical parameters (such as ranking numbers for recently formed schools) were automatically given a neutral value of 1.5, avoiding any possibility of being disqualified from consideration due to missing data. Programs without accreditation status, on the other hand, were classified as unverified accreditation were marked "Not Listed" and contributed a score of 0 to the accreditation criterion for that institution.

4.3 Algorithm Implementation (TOPSIS Multi-Criteria Ranking)

At the heart of the decision support system lies the use of the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), introduced by Hwang & Yoon (1981). TOPSIS was chosen due to its ability to efficiently rank alternatives with respect to several criteria at once which is exactly the problem facing a prospective university applicant.

The process takes place according to the standard procedure of using the TOPSIS technique and implemented in Python after receiving the student’s profile at /api/recommend. It involves the following steps:

Step 1: Eligibility Filtering

Ranking can only be done after these universities have been filtered for failing to satisfy one or more of the student's requirements; this includes university type preference, program preference, budget limitation, geographical preference, and JAMB cut-off point.

Step 2: Construct the Decision Matrix

A matrix X of size m by n is created, where m is the number of candidate universities while n = 5 indicates the total number of five criteria to consider: Accreditation Score (C1), Cost-effectiveness (C2), Ranking (C3), Location (C4), and Facilities (C5). The element xij refers to the score of university i under criterion j.

Step 3: Normalise the Decision Matrix

Vector normalisation is applied and makes the criteria comparable:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{m} x_{kj}^{2}}}$$

The above step is done using NumPy's linear algebra module.

Step 4: Multiply by Student Weights

The student's priority weights wj (as obtained from FR2, scaled at 1-5) are made to sum up to 1, after which they are multiplied with the above matrix:

$$v_{ij} = w_j \times r_{ij}$$

Step 5: Determine Ideal Best and Ideal Worst

The ideal best vector A^+ and ideal worst vector A^- are determined for each criterion. When dealing with benefit criteria such as accreditation, affordability, ranking, and facilities, the ideal best vector refers to the maximum value, whereas the ideal worst vector is the minimum. For cost criteria, the case is vice versa. The current implementation used all five criteria as benefit criteria as the score indicates better performance (affordability score = -tuition).

Step 6: Calculate Separation Distances

The Euclidean distance from the best ideal S_i^+ and worst ideal S_i^- for each university is calculated.

$$S_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^+)^2}, S_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2}$$

Step 7: Compute Closeness Coefficient (Match Score)

The relative closeness between each university and the ideal solution is determined according to:

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

Where 0≤C_i≤1. Finally, this value is multiplied by 100 to provide the Match Score.

Step 8: Sort and Return Results

The universities are ranked based on descending order of similarity scores and the top-ranked ones are formatted as a JSON result and passed back to the front end.

The complete process of TOPSIS calculation for a data set of 87 universities takes less than half a second, well within the two-second limit mentioned in NFR1.

4.4 System Implementation and Modules

DSS was developed as a modularized web-based application where there was a distinction made between the front end and back end parts of the application.

4.4.1 System Architecture

Three-Tier Architecture has been employed in the development of the software where;

i. Presentation Layer: Front-end HTML, CSS, and JavaScript presentation layer for handling user input, submitting forms, and presenting results to the user.

ii. Application Layer: Back-end Python Flask server which processes requests, performs eligibility filtering and ranks using TOPSIS algorithm.

iii. Data Layer: Back-end MySQL database which holds the institutional data set.

4.4.2 Core Modules

The system consists of five interrelated modules:

Module 1: Student Profile Module

In this module, the profile form is generated, all details of the student such as JAMB score, O-Level grades, budget, and preferences are captured; these inputs are validated instantly with JavaScript and serialized into a JSON object.

Module 2: Eligibility Filtering Module

After obtaining the profile of the student, this module searches the MySQL database using SQL WHERE conditions to filter out those universities which don't qualify based on the student's preference for their institution type, budget cap, geographical preference, and JAMB score cut-off. This module generates a set of qualifying universities**.**

Module 3: TOPSIS Ranking Engine

This is a Python module that gets the list of universities generated from Module 2 along with the priority weights of the student and generates an ordered list of universities along with their respective match scores**.**

Module 4: Results Presentation Module

The frontend will then process the ranked JSON response and dynamically render result cards. The result cards will have color-coded match scores (green ≥80%, gold 60-79%, red <60%), along with an accreditation badge, tuition fee, rank and action buttons. Filters can be applied to sort and filter the result list without resubmitting.

Module 5: Comparison and Export Module

This module will enable users to compare three universities side by side. A responsive table will be presented with cells color coded (green indicating best value and red for worst). Additionally, a “Download as PDF” option is provided. This triggers printing using the printer-friendly stylesheet.

4.4.3 User Interface Design

The user interface was developed using usability as its central objective, as stated in requirement (Usability). The design includes the following key components:

i. Single-page form containing the user's profile with fields labeled and dropdowns of Nigeria's states, courses offered, and geopolitical zones.
ii. Five horizontal sliders for assigning weights to priorities with clear labels and tooltips.
iii. A results page showing a large button titled "Modify Search," which takes the user back to the filled form.
iv. Responsive design that works smoothly on desktop, tablet, and mobile phones.

4.5 Testing and Evaluation

Tests were carried out to make sure the system fulfilled its functional and non-functional requirements, generated accurate recommendations, and provided an acceptable user experience.

4.5.1 System Testing

System testing checked whether all functional requirements had been met properly. Test scenarios comprising 14 test cases (each for a single requirement) were tested. Some of these test cases are provided in Table 4.2.

Table 4.2: Sample System Test Cases

Test ID	Requirement	Test Description	Expected Result	Status
T01	FR1	Submit a complete, valid student profile	Profile accepted; no error messages	Pass
T02	FR3	Submit form with JAMB score = 450	Error: "JAMB score must be between 0 and 400"	Pass
T03	FR4	Submit profile with budget = ₦100,000	Only universities with tuition ≤ ₦100,000 appear	Pass
T04	FR5	Submit profile with all weights set to 3	Institutions ranked by TOPSIS; match scores between 0–100%	Pass
T05	FR6	Check result cards for accreditation badge	Badge displayed with correct colour	Pass
T06	FR9	Add 3 institutions to compare	Comparison table rendered with colour coding	Pass
T07	FR13	Submit profile that no university matches	"No universities match your current criteria" displayed	Pass

All 14 test cases passed, confirming that the system's core functionalities operate as specified.

4.5.2 User Interface Testing and Walkthrough

A usability walkthrough was performed using five potential users sourced from the researcher’s professional network. Users were tasked with completing five activities: (1) completing the profile form, (2) adjusting priority sliders, (3) viewing institution details, (4) comparing three institutions, and (5) downloading the comparison file in a PDF format. Participant interactions were documented as they engaged in each activity.

All five users were able to perform all the required actions without additional help from other sources. On average, the time needed to go through the entire recommender process (from filling the form to getting the results) was 2 minutes 18 seconds. Most of the feedback was positive, with users mentioning that the priority sliders made the process more personalized and clear. Two users proposed adding a small tip explaining how to interpret the value of the TOPSIS match this feature was included into the final product. On average, users' rating for the app on a 1-5 scale was 4.4.

4.5.3 Performance Evaluation

During load testing with 100 requests at the same time (using Python concurrent.futures package), the average response time to access the /api/recommend API endpoint took 1.1 seconds, with the maximum being 1.8 seconds, which did not exceed the limits set in NFR1, namely, five seconds and two seconds. It should be noted that the database query time took around 40% of the total time, whereas the TOPSIS calculation took less than 10%..

4.6 Results Presentation and Analysis

This section presents sample outputs from the DSS and discusses the system's performance in relation to the project objectives.

4.6.1 Sample Outputs and Interface Screens

In order to show how the system works, a test case was executed using the student data set below:

i. JAMB Score: 230

ii. Preferred Course: Computer Science

iii. Budget: ₦300,000

iv. Preferred Location: South East

v. Institution Category: Federal and State Institutions

vi. Priority weights: Accreditation = 5, Affordability = 4, Ranking = 3, Proximity = 4, Facilities = 2

Six institutions were produced by the system. The top three options are shown in Table 4.3.

Table 4.3: Top Three Recommendations for Sample Student Profile

Rank	University	Type	Match Score	Accreditation	Tuition (₦)	JAMB Cut-off
1	University of Nigeria, Nsukka	Federal	92%	Full	250,000	200
2	Nnamdi Azikiwe University, Awka	Federal	87%	Full	280,000	200
3	Ebonyi State University, Abakaliki	State	81%	Full	300,000	190

University of Nigeria, Nsukka, which was the first recommended institution, received high marks due to its matching student's preferred location, South East; having complete accreditation in Computer Science; affordable tuition; and also having low JAMB cut-off points. Match Score 92% shows that there is a very high match between the recommendations and the student's preferences. The screenshots of the results page showing these recommendations cards, details of the institution page UNN, and side-by-side comparison of the top three recommended institutions have been shown in Appendix 3.

4.6.2 Discussion of Results

The results yielded by the testing scenario clearly show that the DSS successfully resolves the following four issues highlighted in Chapter One:

i. Solving Problem 1 (One-size-fits-all): The DSS generates varied ranking scores based on changes in priority weights for the same student. For example, the proximity weight was
ii. reduced from 4 to 1 in a follow-up test, the top recommendation shifted to a federal university in the South West zone, demonstrating the personalisation capability.
iii. Dealing With Problem 2 (Non-certification Verification): Each result card and the detail page contains information about whether the program is accredited or not. During the test run, two universities providing the course Computer Science, which have Interim

Accreditation status, have been appropriately included in the results but have low accreditation scores..

iv. Solving problem 3 (The inefficiency in the process): The whole process of recommendation, including data input and ranking output, takes less than 2 seconds, whereas a student might take several hours doing this manually through various websites.

v. Solving problem 4 (Under-utilisation of data): All NUC data regarding accreditation, JAMB cut-off points, Webometrics ranking, and specific university data have been effectively combined into one searchable database of recommendations.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

The current chapter provides the ultimate summary of the study performed, conclusions derived from the results obtained, as well as recommendations to be made. It summarizes the critical aspects discussed in each chapter, gives an account of the degree to which the goals outlined in Chapter One were accomplished through the developed Decision Support System, and makes some suggestions for the further improvement of the system in question. Finally, the limitations faced in the study are highlighted, and directions for future research are indicated.

5.2 Summary of the Study

The need for such research arises due to the recurring difficulties that Nigerian potential students encounter while choosing tertiary institutions. As mentioned by Adeoye *et al*. (2022) and Manishimwe *et al*. (2025), students tend to make their decisions based on incomplete and biased sources instead of using reliable and objective data from the universities themselves. Additionally, Okeke (2022) found that not confirming the accreditation of educational institutions prior to admission often results in inadequate performance and non-recognized degrees. This problem justified the creation of a Decision Support System.

The problems, objective, and purpose were stated in Chapter One. Four problems were recognized: the prevalence of one-size-fits-all approach that does not consider any personal traits; the absence of the accreditation process or any quality assurance programs in institutions; the difficulty and complexity associated with comparing different institutions manually; and the under-exploitation of data, which is scattered on several different platforms. The purpose of this research was to create an advanced DSS that will take care of all the mentioned issues using filters, ranking system, and presenting data.

Literature reviews on the subject matter are provided in Chapter Two. These include five literature review areas such as the conceptual basis for Decision Support System, applications of DSS using AI in a Nigerian university environment, the applicability of Multi-Criteria Decision Making Methods in higher education, technology acceptance and DSS adoption behaviors by students, and the existing factors affecting students' decision-making in the Nigerian tertiary sector. Important studies conducted by Ismail, Soliman, and Mohamed (2025) outlined the architecture of an effective DSS, while Mohammed-Shittu (2025) showed evidence of DSS viability in Nigeria. Muharlisiani *et al*. (2023) proved the relevance of applying MCDM methods including BWM in higher education. Gao (2024) proved that usability and confidence of users were essential for effective DSS usage, whereas Adeoye *et al*. (2022) along with Manishimwe *et al*. (2025) offered empirical proof of current information gap problems faced by students.

The third chapter described the systems analysis and design approach used. The Waterfall approach was chosen because of its step-by-step process, which fits the static nature of the requirements and limitations imposed by an academic project. All functional and non-functional requirements, which include user authentication, data input into a profile, user eligibility screening, TOPSIS evaluation, results presentation, comparison and exporting functions, were defined. The models used included a Use Case diagram, an Activity diagram, a Class diagram, and a Sequence diagram using Unified Modeling Language.

Chapter Four described system implementation. The development of the DSS utilized Python 3.10 with the use of Flask for backend development, MySQL for data management, and HTML5, CSS3, and JavaScript for the frontend. The institution database containing the information on 87 universities in Nigeria was gathered using accreditation reports of the NUC, JAMB cut-offs, Webometrics ranking, and individual university websites. The TOPSIS multi-criteria ranking method was used as the core engine in generating recommendations. All 14 test scenarios were found to be successful, having achieved the average API response time of 1.1 seconds which satisfied the non-functional requirement on performance. In terms of user acceptance testing, a rating of 4.4 out of 5.

5.3 Conclusion

The study was able to create an innovative Student-Centered Decision Support System for choosing a tertiary institution in Nigeria, which directly tackles all the issues discussed in Chapter One and bridges the gaps highlighted in Chapter Two.

Objective One involved the designing of a system which considers individual differences, such as qualification, economic capacity, choice of subject, location, and career path. The objective was accomplished by creating a comprehensive profile of the student which includes his/her JAMB score, O-Level score, choice of subject, tuition budget, and location preference. The eligibility filtering component guarantees that the universities that meet the students' criteria are selected and recommended. From the sample case illustrated in Section 4.6.1, we can tell that a student who has ₦300,000 to spend and who favors the South East Zone will get his or her list, but another student who has different preferences will be recommended a different list. It is clear that the system has transcended the one-size-fits-all approach that Adeoye *et al*. (2022) criticized.

Objective number two entailed the consolidation of relevant information concerning education in terms of program accreditation, quality, tuition costs, facilities, and ranking on a common platform for decision making. The objective was fulfilled by collation of relevant information through various sources like the accreditation reports by NUC, JAMB cut-offs, Webometrics ranking, and specific sites of universities onto a common MySQL database. According to Section 4.2, the database comprises of accreditation status of the programs, tuition structures, JAMB cut-offs, and facility availability among the 87 universities. This information is presented in an integrated form through result cards, institution profile pages, and comparative tables. According to Okeke (2022), not verifying the status of accreditation prior to enrolling results in poor consequences; hence, the system has been designed to avoid that pitfall by highlighting the accreditation badges and program status.

The third objective was the development of a tool that makes comparing different tertiary institutions by various criteria easier and faster. It was accomplished by using the TOPSIS multi-criteria ranking technique that computes match scores on the basis of the student's priorities. The compare function enables side-by-side analysis of three institutions at once, where cells in color code indicate the best value for each category. The complete cycle of recommendation generation starting from form filling to generating sorted recommendations is completed in less than two seconds, which takes many hours for a student to compile information and compare it using multiple sites separately (Manishimwe *et al*., 2025). In a study involving five potential users, the usability rating of the platform was 4.4 out of 5.

Objective four involved improving decision making based on data. This was done by ensuring that all recommendations were made based on facts derived from objective data as opposed to subjective social influences. According to Gao (2024), implementation of the DSS model yields beneficial impacts in learning outcomes when there is confidence in the system. This is because the DSS helps by showing clear match scores that have been generated using priority weights generated by the student themselves. Showing which criteria made up these scores enables students not to enroll in unrecognized courses without their knowledge since the program flags programs that lack full accreditation by NUC, as warned by Okeke (2022).

Objective 5 aimed at testing the efficiency of the system via user testing with potential students before implementing it. This objective was successfully met through rigorous testing and acceptance testing of the system as presented in section 4.5. The 14 functional test cases were successful, thus indicating that the system satisfies its design requirements. Testing carried out on five potential students showed that all users performed their duties successfully without any hindrance, having an average recommendation time of two minutes and 18 seconds. The user satisfaction rate of 4.4 out of 5 is an indication of user acceptance.

Conclusion

In summary, the Decision Support System designed in this research is a solution to one of the most important educational problems that affect Nigerian students currently. This is achieved through integration of disjointed educational information, utilization of multi-criteria decision making procedures, and presentation of results using an easy-to-understand graphical user interface that ensures students make decisions based on their qualifications and economic and personal preferences.

5.4 Recommendations

In view of the results of this study and problems experienced while developing the system, the following recommendations are made for potential students, education stakeholders, and future researchers. The recommendations will be categorized into short term system improvements, medium term system expansion and future strategies.

5.4.1 Immediate System Enhancements

These recommendations can easily be incorporated into the current system architecture using minimal development resources and would make substantial improvements to the recommendation algorithm.

Recommendation 1: Incorporation of Course-Specific JAMB Cut-off Scores

The current algorithm incorporates institutional minimum JAMB scores since there is an insufficiency of course-specific data. However, since universities release more detailed admission requirements on the JAMB portal and institution-specific sites, future versions of the system should include course-specific cut-off scores. This will help increase the precision of recommendations as the system will screen institutions where the student's JAMB score exceeds the institution's minimum score but falls below the course-specific score. In other words, even if a student attains a JAMB score of 210 and satisfies an institution's general score requirement of 200, they may not qualify for a specific program in the institution that requires 250.

Recommendation 2: Automated OCR-Based WAEC Result Processing

The file upload functionality will currently process uploaded WAEC result documents for verification. The next improvement in this context will be the implementation of OCR technology through Tesseract or other similar OCR APIs in order to identify subjects and corresponding grades from scanned images or digital PDF WAEC result forms. This will lower the workload of students in terms of data entry and avoid any typing error, and also benefit the students who already have scanned copies of their results. According to Gao (2024), any reduction in efforts made by users increases technology adoption.

Recommendation 3: Annual Data Refresh and Administrative Management

Seeing that tuition charges, JAMB cut-off marks, course options, and accreditation vary each year, the system needs to have a data refresh and administrative process including the following elements :

i. **Scheduled Updates of Database**: In cases where data can be sourced from the respective databases automatically, the system needs to be set up to refresh its own data based on preset schedules.

ii. **Dashboard for System Admin**: A special dashboard needs to be created that will allow system administrators to update institution-related data in the database, add new institutions, adjust decision rules, and analyze results from the database without having to interact with it directly.

iii. **Audit Logs**: Modifications to database records should be tracked through audit logs, allowing for easier rollback in case of erroneous entries and facilitating historical trend analysis.

iv. **Notification of Updates**: Registered users need to be notified about any major changes in tuition fees, accreditation statuses, programs offered by institutions, etc., which allows them to re-run their decision process using the new data.

As Ismail, Soliman, and Mohamed (2025) observed, data freshness is one of the most important attributes of an effective decision support system.

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