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**Web-based Decision Support System for Academic Major Selection for High School Student**

By

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**Web-based Decision Support System**

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# ABSTRACT

When high school students enter university, one of the most important decisions for both them and their parents is choosing a career. This choice has a significant impact on their field of study for the next few years, and it also influences their future career chances, job satisfaction, and future development orientation. However, choosing a career suitable for high school students is difficult due to the lack of reliable information and the lack of accurate guidance tools. Besides, they tend to depend on subjective factors such as family and social pressure, employment trends, etc., without fully understanding those careers. As a result, many students select unsuitable majors, leading to dissatisfaction, changes in academic paths, or even dropping out of university.

In this thesis, I propose developing a Decision System (DSS) for University Major Selection among high school students to solve these problems. The system applies the Simple Additive Weighting (SAW) method, a widely used method in Multi-Attribute Decision Making (MADM), to evaluate and rank university majors based on personal interests, soft skills, abilities, and job requirements  based on rank alternatives by assigning weights to different criteria and summing up their weighted performance scores to give results that are suitable for students. In which DSS is designed with multiple-choice questions divided into two levels: the first analyzes suitable major groups, and the second level narrows the results down to sub-majors. Points for the relevant major will be added after each answer, from which the system will total the highest score belonging to which sub-major and give the final recommendation for the ideal major for students.

The proposed method includes the following steps: Firstly, Requirement Analysis is conducted to determining the target users (students) and their requirements for career counseling. The dataset was constructed from a self-designed survey questionnaire consisting of approximately 60 multiple-choice questions. Survey responses were transformed into weighted decision criteria reflecting students’ personality types, interests, skills, and values. The main and sub-major groups, defined based on the official classification of the Vietnamese Ministry of Education and Training, were used as decision alternatives in the SAW model. Subsequently, a Scoring Model Development phase involves assigning weights to each answer and organizing them into major and minor groups. For System Implementation, a web-based Decision Support System (DSS) platform will be built, utilizing Node.js (JavaScript) for the backend, React for the frontend, PostgreSQL for data storage, and REST API. Finally, the Testing and Evaluation step will be carried out through surveys and case studies with students to validate the system’s accuracy and usability.

This DSS system supports both academic research and practical applications. It provides a decision-making tool for students and guidance resources for university admission.

# CHAPTER 1

# INTRODUCTION

## Background

One of the most important decisions high school students must make is choosing an appropriate university major, since it has a direct impact on their academic trajectory, future employment prospects, and long-term personal growth. However, the lack of trustworthy information, the absence of systematic direction, and the impact of outside variables like peer pressure, family expectations, and labor market trends make this decision-making process frequently difficult and complex. Many students thus find it difficult to make educated decisions, which may result in discontent, repeated big changes, or even leaving school.

This study suggests developing a Decision Support System (DSS) to help high school students choose their university major in order to overcome these problems. By offering organized, tailored recommendations based on students' beliefs, interests, abilities, and career goals, the DSS aims to lower uncertainty and enhance the quality of their choices.

#### Purpose and Objectives:

A high school student’s academic success, career opportunities, and personal development are all directly impacted by their choice of university major, leading to it becoming one of the most important decisions that they will ever make. However, many students struggle to select the best major based on their abilities, interests, and values. Decision Support Systems (DSS) provide a structured, data-driven solution to this problem.

The Decision Support System (DSS) is designed to achieve several strategic objectives in student career guidance. The core goal of the DSS is to assist students in identifying ideal academic majors that align closely with their individual skills, interests, personalities, and career goals. By delivering personalized recommendations, the system helps eliminate uncertainty and reduce confusion during the selection process. Critically, the DSS provides suggestions based on the data submitted by the student, ensuring that decisions are not unduly influenced by external factors. Furthermore, the DSS also serves as a consulting tool for parents and educators, supporting them in guiding academic and career planning. Overall, the system promotes efficient decision-making through the systematic evaluation of multiple complex criteria, ranging from individual competencies to future career prospects.

#### Target Audience

The Decision Support System (DSS) is designed to serve a wide range of stakeholders with diverse roles in the career guidance and education process. The primary user group is High School Students, particularly those preparing to enter university, who require in-depth guidance in selecting suitable academic majors. Parents and Guardians are also crucial stakeholders, utilizing the system as a reference resource to support their children's academic and career decisions. Furthermore, Educators and Counselors will use the system as a professional tool to aid in orientation and career guidance efforts. Additionally, indirect but important stakeholders include Universities, which stand to benefit from recruiting better-prepared students who are a better fit for their programs.

#### Research

An increasing variety of majors, rapidly changing job markets, and growing expectations from students and their parents each contributed to a significant increase in the need for decision support tools in education. Traditional techniques frequently lack personalization and scalability. Through the integration of data analytics and decision models, DSS reduces subjective mismatches in choice between students and their majors. In the long term, this not only benefits students but also contributes to better employees helping students.

## Problem Statement

Choosing a major is one of the most important decisions for high school students, because it directly affects their future learning path, career, and long-term personal development. However, in reality, many students encounter difficulties in this process due to a lack of reliable information sources, a lack of orientation, and being influenced by many external factors. These limitations often lead to choosing the unsuitable major, causing dissatisfaction, frustration, having to change majors during the course of study, or even dropping out of university. Notably, students and parents frequently fail to give this issue any thought; most of them only focus on studying for the exam to get the best scores in the entrance exam instead of investing in finding a career that is truly suitable for them.

One of the most significant causes is that students lack access to reliable and comprehensive sources of information about future majors and careers. In most cases, decisions are made based on fragmented sources such as family opinions, advice from acquaintances, or recommendations on social media instead of being built on personalized data from their own abilities and interests, combined with exploring labor market trends and career opportunities. Leading to ambiguity, hesitation, and confusion for students when they cannot find the right direction, especially those who are still developing a clear awareness of their own personal preferences, limitations, and skills.

Additionally, external factors also contribute to increasing the difficulty in picking a major. As students approach their final years of high school, they must deal with pressure from studying and taking exams and also have to deal with peer comparison or competitiveness, parental expectations, and social prejudice about “prestigious” or “high-paying” fields of study. They frequently cannot make informed decisions because of these factors. Students tend to choose majors based on what their friends have chosen, or they follow the expectations and desires of others rather than their own interests and skills. These situations only serve to increase stress, lead to poor academic performance, encourage discouragement, and destroy self-esteem.

Finally, the complexity of the decision-making process itself is also difficult. For high school students, choosing a career requires careful consideration based on many criteria, from personal interests, financial conditions, academic performance, career opportunities, and future goals. Without a structured method to assess these factors, students are likely to make subjective, emotional decisions that are not aligned with their true potential or the needs of the labor market.

All of these problems point to the need to use a structured, data-driven strategy to help students make well-informed, personalized decisions. A Decision Support System (DSS) can fill this gap by integrating data about majors, market trends, and student characteristics. Through the application of recommendation algorithms and decision-making models, the system may offer students organized direction, lower uncertainty, and increase the precision of their selections.

In the end, such a solution helps to improve the relationship between education outcomes and job market goals as well as benefiting students.

## Scope and Objectives

The scope and objectives of a Decision Support System (DSS) for university major selection in order to guarantee that the system can help high school students in determining the best academic path. With the help of a structured, data-driven, and user-friendly platform, the DSS will assist students in overcoming obstacles such as a lack of trustworthy information, a lack of structured support, and outside influences.

**Scope:**

The scope of the Decision Support System (DSS) is clearly defined across multiple aspects. Regarding users, the system primarily serves High School Students preparing for university applications, but it also acts as a supplementary tool for parents, academic advisors, and school counselors. In terms of core functionality, the DSS will recommend general fields of study and specifically suggest both majors and sub-majors based on the student's personal interests, strengths, and career goals. The foundation for these recommendations is a structured assessment questionnaire covering factors such as personality type, soft skills, academic ability, and career objectives. The system utilizes both internal data (student responses) and external data (labor market trends and employment statistics) to ensure the accuracy of its recommendations. To support users, the system will integrate an Information Repository providing detailed information on various academic majors. Finally, the Recommendation Engine employs a matching algorithm to rank the most suitable options. Technically, the system is designed as a user-friendly web-based platform. Although initially built for students in Vietnam, the system possesses the scalability to be applied to a broader regional or international scope through updates to its relevant datasets.

**Objectives:**

The primary objective of this project is to establish an effective Decision Support System (DSS) to enhance the quality of career counseling. The core goal is to provide a Personalized Career Guidance website, meaning the system must offer tailored recommendations for majors and sub-majors based on students' individual goals, interests, and strengths, thereby helping them make more informed decisions. This directly aims to Reduce Misguided Decisions, helping to lower dropout and major-switching rates caused by inappropriate field selection. The system also functions as a Centralized Knowledge Base, providing a platform containing detailed information on training programs, required skills, and career prospects.

To achieve these objectives, the project applies research methods such as Multi-Criteria Decision Making (MCDM), rule-based filtering, and weighted scoring models. The development process includes seven sequential Development Steps: from requirement analysis, database and system design, and decision-making algorithm development, to backend implementation (using Node.js and PostgreSQL) and frontend implementation (using React, HTML, CSS), integration of visualization libraries, and finally, testing and validation with real-world data.

Technologically, the system is built on JavaScript and SQL platforms, utilizing modern Frameworks like Node.js/Express and React.js. PostgreSQL is selected as the primary Database. Standard RESTful APIs are used to ensure efficient system communication, and testing is performed using Postman.

## Assumption and Solution

**Assumption 1:** High school students have access to the Internet, mobile devices, or computers and are willing to take online tests. They are also motivated to learn about themselves to choose the right major.

**Solution:** Build a personalized assessment toolkit (including interest, personality, soft skills, and learning ability tests). The results will be analyzed using a multi-criteria decision model (MCDM) to suggest the most suitable major group.

**Assumption 2:** Information on majors, training programs, and employment trends can be collected from official sources (universities, the Ministry of Education and Training, and market reports). These data can be updated periodically.

**Solution:** Develop a database of majors combined with labor market information. The system will allow students to look up major descriptions, required skills, career opportunities, and expected income levels. DSS will combine this data with personal profiles to make appropriate suggestions.

**Assumption 3**: Students and parents often have difficulty comparing multiple study options due to the lack of visualization and objective evaluation tools.

**Solution**: Provide an intuitive interface to compare study options based on criteria (personal fit, market demand, development trends). Use charts and dashboards to display results, making it easier for students to make decisions.

**Assumption 4:** Users expect a system that is easy to use, accessible from any device, and ensures personal data security. In addition, the technical infrastructure (Node.js, React, PostgreSQL) is capable of deploying a medium-scale DSS and expanding it later.

**Solution:** Build a web DSS system with a friendly interface, multi-device support, and basic security (authentication, data encryption). Design an extensible architecture to integrate advanced functions in the future, such as online consulting, scholarship suggestions, or business connections.

## Structure of thesis

The remaining part of this thesis is divided into the following six chapters. Chapter 1: Overview This chapter gives the thesis's overall background and describes the problem statement, its scope, its objectives, and its assumptions, as well as the suggested solution. It also explains the thesis's general structure. Chapter 2: Review of Literature (Related Work): This chapter examines previous studies, applications, microservices, and economic analysis. The goal of this thesis is to identify research gaps by analyzing the advantages and disadvantages of the existing solutions. Chapter 3: Methodology (Proposed Method): This chapter presents the design of the proposed system. This includes the details of the system architecture, UML diagrams (use case, sequence, class diagrams, and ERD), and descriptions of the evaluation methods applied. Any algorithms or pseudo-code used in the system will also be described. Chapter 4: Implementation and Outcomes: This chapter describes the implementation details, including programming languages, frameworks, and libraries used. This prototype configuration, screenshots of the developed application, and the obtained results based on test datasets of the listed companies are also presented. Chapter 5: Discussion and Evaluation: This chapter discusses the results in detail, comparing the proposed framework with related work presented in Chapter 2. Strengths, weaknesses, and limitations of the system are analyzed. Chapter 6: Conclusion and Future Work: This chapter provides an overview of the thesis's key conclusions and contributions. It also suggests possible directions for future development, including scalingthe system, expanding to additional features, or integrating advanced AI-based prediction models. References: All papers, books, and online sources cited in the thesis are listed in this section, formatted

# CHAPTER 2

# RELATED WORK

## Introduction

Choosing a field of study is considered a necessary decision in a student's educational path, as it significantly impacts academic performance, career opportunities, and long-term job satisfaction and commitment. Unlike simpler choices, choosing a field of study involves many different criteria, including personal interests, learning abilities, personality traits, social orientation, and future career requirements. Therefore, secondary school students often face uncertainty and indecision when making decisions about their field of study without systematic support.

To solve this challenge, many decision support systems (DSS), recommendation models and advisory platforms have been proposed in both academic research and practical applications. These systems aim to support students by analyzing their personal characteristics and matching them with suitable fields of study and careers through structured methodologies.

This chapter provides an overview of existing studies and systems closely related to the proposed online decision support system for selecting a field of study. Rather than providing a broad theoretical foundation, this chapter focuses specifically on relevant works, including previous studies, algorithms, and existing platforms that address similar issues. Each relevant work is analyzed based on its methodology, the algorithms applied, and their advantages and limitations. Through this analysis, research gaps are identified to demonstrate the necessity of the proposed system.

## Decision Support Systems in Education

Decision support systems (DSS) have been applied in the field of education to assist students in making the choices that best suit them. In the educational context, DSS are commonly used for subject selection, study planning, academic performance prediction, and suggesting suitable fields of study.

Traditional academic counselling typically relies on human advisors, but advisors may be limited by subjective judgements and workload. DSS-based methods aim to supplement human advisors by providing consistent, data-driven recommendations with greater accuracy. These systems typically integrate student data, predefined rules, and computational models to support the decision-making process.

Early educational DSS systems primarily focused on rule-based logic, where student inputs were compared against predefined criteria. Although these systems were easy to implement, they lacked flexibility and personalization.

## 2.3 SAW-Based Decision Support Systems for Major Selection

The simple additive weighting (SAW) method is one of the oldest and most widely used decision-making methods. [1] that has been widely applied in decision support systems due to its simplicity, transparency, and effectiveness in ranking alternatives. In the field of educational decision support, SAW is particularly suitable for issues involving the selection of fields of study, where it is necessary to simultaneously evaluate multiple quantitative and qualitative criteria.

### 2.3.1. Study1: Decision Support System for High School entrance selection

A web-based decision support system (DSS) was proposed by Zubaedah and Prasetyo (2022) to support the selection of new students for secondary school. In many areas, student admission decisions are primarily based on geographic zoning, which often disadvantages high-achieving students residing outside designated zones. At the same time, schools desire to maintain student quality, creating a conflict between educational goals and government regulations. [2]

To address this problem, Zubaedah and Prasetyo developed a Decision Support System (DSS) using the Simple Additive Weighted (SAW) method as the core decision model of the system. In the proposed system, each student applicant is treated as an alternative, while the admission requirements are represented as a set of evaluation criteria. These criteria include academic performance and other supporting factors beyond zoning considerations, allowing the decision-making process to better reflect overall student suitability. [2]

In this study, SAW is applied using the standard weighted sum model. First, a decision matrix is created, with each column denoting an evaluation criterion and each row representing a student applicant. A normalization procedure is used to convert the criteria's raw values into a comparable range since they may come from various measurement scales. This step makes sure that no criterion has a disproportionate impact on the outcome because of scale disparities.

After normalization, each criterion is multiplied by a preset weight to show its relative importance in the admissions decision. These weights are established by institutional policies and expert judgment. Each student's final preference score is calculated by adding the weighted normalized values for each criterion. A student's overall suitability for admission is indicated by this total score.

Based on the calculated SAW scores, the system generates a ranked list of students that schools can use as a reference tool. The rankings allow decision-makers to objectively compare profiles and admit students based on their preferences not only by region, but also by other characteristics such as academic ability. The Decision Support System (DSS) is implemented using web technology, enabling administrators to efficiently input data, perform SAW score calculations, and display ranking results.

The system was developed as a web application using PHP, MySQL, and HTML, following the Waterfall software development model. Through this declarative development, the Decision Support System (DSS) provides transparent ranking results that school administrators can easily understand. Empirical evaluation showed a significant improvement in decision accuracy, with accuracy reported to increase from 56% to 100% after applying the SAW-based methodology. [2]

**Strengths:**

The main strength of this study lies in the practical application of the SAW methodology in the context of real-world education policy. The use of a web-based architecture enhances usability and ease of use, while the SAW methodology ensures transparency and simplicity in ranking results. Furthermore, the system successfully demonstrates that integrating multiple criteria can improve decision accuracy compared to using only the classical partitioning method.

**Limitations:**

Although effective, this system relies on static criterion weights, which may not fully reflect the diversity of stakeholder preferences. The SAW model is limited because the criteria in the model only fit interest-based criteria. The evaluation focuses primarily on improving accuracy without extensive validation across diverse datasets or different student groups. Furthermore, the system is designed for administrative decision-making for school admissions rather than student-centered guidance, thus limiting its applicability in contexts of recommending majors to students.

**Implications for this study:**

Although the study by Zubaedah and Prasetyo (2022) focused on student enrollment based on zoning regulations, it demonstrated the relevance of the SAW methodology to web-based educational decision support systems. Inspired by this approach, the study proposes applying SAW to support academic choice, expanding on previous research by focusing on student-centered, user-friendly decision-making processes and transparency.

### 2.3.1. Study 2: Decision Support System for selecting academic majors

Taufiq and Mustofa proposed a decision support system for major selection using the Simple Additive Weighting (SAW) method to assist high school students in choosing appropriate academic streams [9]. This study addresses a common problem faced by prospective university students: difficulty in choosing a major that aligns with both their individual abilities and future academic requirements. In many cases, students rely on advice from friends or relatives or choose randomly, which can lead to an unsuitable major and increase the risk of academic failure or dropping out later.

To address this issue, the authors used the Simple Additive Weighting (SAW) method as the decision-making mechanism for the system to suggest suitable majors for students. SAW was chosen for its ability to handle multi-criteria evaluations in a structured and understandable way. In the proposed model, each university major is considered an alternative, while the selection criteria include various academic indicators and factors related to the student's interests and personality.

The decision-making criteria in this study included students' scores in relevant subjects at high school, such as mathematics, science, and foreign languages, as well as their self-assessed level of interest in specific academic areas. Each criterion was assigned a weight reflecting its importance in determining a student's suitability for a particular major. These assigned weights were determined based on recommendations from educational experts and school standards, ensuring that the decision-making process would be less prone to error.

The SAW calculation process begins with constructing a decision matrix, where rows represent disciplines and columns represent evaluation criteria. Because the criteria values ​​are derived from different scales, such as scores and interest scores, the system applies a normalization process to convert all values ​​into a comparable format. This normalization step is crucial to prevent score bias caused by differences in the scales used for each criterion.

After normalization, the system calculates a priority score for each major by multiplying the normalized values ​​by their corresponding weights and summing the results. The final result is a ranked list of suggested majors, with higher scores indicating a stronger fit between the student's information and the requirements of the major. This ranking serves as a guide for students in their major selection process.

In this study, experimental results indicate that SAW is effective in generating transparent and easily interpretable recommendations. However, the approach relies on static weighting, which may limit adaptability to individual student profiles. Accordingly, the SAW model has the advantage of being easy to calculate and apply if the criteria in the model only include benefit criteria. Therefore, in the standardization step, attention should be paid to benefit and non-benefit criteria. Methods for improving the standardization and application of the SAW model have overcome this problem if the data is non-negative.

**Strengths:**

One of the key strengths of the SAW-based approach is its computational efficiency and interpretability. The calculation process is straightforward and easy to explain, which is particularly important in educational decision-making where transparency is required. The use of a web-based prototype also improves accessibility and usability, enabling counselors or students to interact with the system using standard web browsers. Furthermore, SAW produces a clear ranking of alternatives, aligning well with the goal of recommending suitable academic majors.

**Limitations**

Despite its advantages, the proposed system exhibits several limitations. First, the weighting scheme is static and expert-defined, which may not adequately reflect individual student preferences or changing educational requirements. Second, SAW assumes linear compensation among criteria, allowing low performance in one criterion to be offset by high performance in another, which may not always be appropriate in academic decision-making contexts. Additionally, the system does not incorporate learning or adaptive mechanisms to refine recommendations based on historical user data or feedback.

## 2.4 Comparative analysis and discussion

Both studies reviewed confirm that SAW is an effective method for educational decision support systems due to its simplicity, transparency and computational efficiency. These characteristics are particularly important in a web environment, where ease of use and interpretability are essential factors.

However, a common limitation in SAW-based systems is their reliance on subjective and static criterion weights. As discussed by Velasquez and Hester [3], the use of static weights can reduce the flexibility of the system when user preferences change. Despite this limitation, SAW remains suitable for applications where the transparency of the decision is prioritized over the complexity of the algorithm.

Other MCDM methods, such as AHP and TOPSIS, have been applied in similar contexts. Although these methods provide more rigorous evaluation and ranking mechanisms, they often result in higher computational complexity and reduced interpretability [4] [5]. For web-based decision support systems (DSS) aimed at students, this complexity may negatively impact user acceptance.

## 2.5 Implications for the Proposed System

SAW is found to be a suitable approach for creating a web-based DSS for academic major selection based on the reviewed studies. Previous research offers insightful information about system architecture, algorithm choice, and usability issues. However, there are still issues with contextual adaptation, dataset structure, and personalization.

Inspired by these findings, the suggested system in this pre-thesis uses the SAW approach with an emphasis on enhanced web-based accessibility, structured datasets that are in line with Vietnamese educational standards and supporting student-centered decision-making based on information on majors available in Vietnam according to the Ministry of Education and Training [6]. This study expands on existing work by introducing a tiered SAW-based recommendation model, a questionnaire-based scoring framework, and a two-tier decision-making process specifically designed for major and minor selection. These contributions enable more personalized, detailed, and scalable recommendations for high school students, thereby addressing shortcomings identified in previous studies.

# CHAPTER 3

# METHODOLOGY

## Overview

This chapter presents the methodology employed to classify users into suitable majors and sub-majors based on their responses to a questionnaire. The system applies a rule-based, explainable, and domain-driven decision model known as the Simple Additive Weighted Method. This method allows each answer option to contribute to multiple labels (brands) through a structured scoring vector, enabling flexible and transparent classification without the need for machine learning training data. This chapter covers the system architecture, design models (UML), database schema, algorithms, and implementation steps, ensuring that the proposed solution is both systematic and scalable.

## User requirement analysis

The goal of this section is to identify and analyze the functional and non-functional requirements of the system based on the expectations of two main user groups: students and administrators. Understanding user requirements helps ensure that the proposed system satisfies the actual needs of its intended users, supports decision-making effectively, and provides a smooth user experience.

### User Roles

In the system, the student is the key user who participates in the quiz, responds to the questions, and receives a personalized recommendation for the most suitable major based on the scoring and analysis method. Meanwhile, the admin is responsible for controlling all quiz-related content, including generating, updating, and maintaining the questions and answer possibilities, to ensure the accuracy, consistency, as well as general quality of the main recommendation system.

### 3.2.2. Functional Requirements

The functional requirements for the specialized recommendation system differ between the roles of Student and Administrator. For Students, the system allows users to register and log in securely, enabling them to create accounts and authenticate. The core functionality is controlled by the Survey Module, which is divided into two levels. Level 1 is designed to broadly determine the appropriate subject group (e.g. Engineering, Business, Information Technology, Design), while Level 2 uses more detailed questions to recommend specific sub-subjects (e.g. Software Engineering, Marketing, Graphic Design). A key element of the system is the Scoring process, in which each choice for a question has a specific weighting, and the system aggregates the scores for each group to determine the highest suitability. This leads to an automatic Scoring feature and ultimately presents students with the most suitable field of study recommendation. Additionally, the system must maintain the integrity of user data by allowing students to view the History of results from previous questionnaire responses and previous recommendations to help students gain a more comprehensive overview.

### 3.2.3. Non-Functional Requirements

The non-functional requirements define the quality attributes necessary for the stable function and user satisfaction of the system, covering five critical dimensions. Firstly, Security is essential: all user passwords must be protected using safe cryptographic hashing algorithms (e.g., bcrypt), and the system's integrity is essential by limit administrative tasks only to authorized personnel. Secondly, Usability states that the interface must be easy to use, ensuring that users can complete key tasks, such as tests, without prior training. Thirdly, Scalability demands a modular backend architecture able to dealing with future modifications and additions of components without requiring complete redesign, thus supporting system growth. Fourthly, Performance specifies that all system responses must be delivered within seconds to ensure a responsive user experience. Finally, Maintainability is ensured by the use of the same modular structure, which already simplifies easy updates, debugging, and overall system management over its lifecycle.

### Use Case Diagram

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Figure 1: Use Case Diagram

### Sequence Diagram

A diagram of a project

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Figure 2: Sequence Diagram

### Architecture Diagram

A diagram of a system architecture

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Figure 3: Architecture Diagram

## Database Design

### ERD Diagram

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Figure 4: ERD Diagram

The Entity–Relationship Diagram (ERD) represents the conceptual data structure supporting the SAW-based decision-making process. A User interacts with the system by completing a multi-level Questionnaire, which is organized into Level 1 (Major selection) and Level 2 (SubMajor selection).

Each questionnaire consists of 30 Questions, and each question provides 4 Options. Each option contributes weighted scores to one or more Majors (Level 1) or SubMajors (Level 2), forming the basis for quantitative evaluation.

The system aggregates option-level scores at the major and sub-major levels and evaluates them using predefined SAW criteria. Based on the computed scores, the system generates a Recommendation, which stores the selected major or sub-major along with the corresponding suitability score.

**Relationships:**

* Major 1—N SubMajor: A major may contain multiple sub-majors, while each sub-major is associated with exactly one major.
* Level 1—N Question: Each level groups multiple questions, and each question belongs to a single level.
* Question 1—N Option: each Question has multiple Options, Options cannot exist independently without their parent question.
* User 1—N Submission: A user may complete multiple assessment attempts, but each submission belongs to exactly one user.
* Submission1—1Result: Each submission produces a single result, and each result corresponds to one submission.
* Question N—M Criteria: each question to evaluate multiple criteria with different weights.

**Data Flow:**

* Authoring (Admin):
* Admin creates Majors, Questions, and Options.
* For Level 1, scoring keys are Major codes; for Level 2, scoring keys are SubMajor codes.
* Quiz (User):
* Frontend loads questions by level.
* On submit: Level 1 aggregates points by Major codes. Level 2 aggregates by SubMajor codes to identify the specialization.
* If logged in, a Submission is persisted with the recommendation and score breakdown.
* Results: Users fetch the latest Submission to view recommended Major/SubMajor and score details.

### 3.4.2 Class Diagram

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Figure 5:Class Diagram

The class diagram illustrates the static structure of the proposed Decision Support System (DSS) for academic major recommendation. It defines the core entities involved in user assessment, scoring, and recommendation generation, together with their attributes, operations, and relationships.

The User class represents system users, including students and administrators. It stores essential authentication and authorization information such as email, password hash, and role.

The Submission class records a complete assessment attempt made by a user. It stores the selected major and sub-major codes, final score, and detailed scoring data in JSON format. Each submission is time-stamped, allowing the system to track user history and multiple attempts.

The Result class stores the result of a submission, including the selected option identifier and a scoring snapshot in JSON format.

The Major class contains basic descriptive information and acts as the parent entity for sub-majors based on the official classification of the Vietnamese Ministry of Education and Training.

The SubMajor class represents specialized fields under a major. Each sub-major is linked to exactly one major and provides more suitable recommendation results.

The Level class groups questions into different evaluation stages. This structure allows the DSS to assess users progressively, from general interests to more specific competencies.

The Question class stores survey questions used in the assessment based on personality, skills, interests, and abilities.

The Option class represents possible answers to a question. Each option stores a scoring scheme as a JSON object that maps major or sub-major codes to weighted scores, enabling flexible and configurable scoring logic.

The Criteria class defines evaluation dimensions such as skills, interests, or abilities. These criteria form the basis for mapping questions to scoring logic (SAW).

The QuestionCriteriaMap class resolves the many-to-many relationship between Question and Criteria. It assigns a specific weight to each criterion for a given question, allowing fine-grained control over the evaluation model.

## 3.5. Algorithm

### 3.5.1 Concept

This project develops a system for suggesting majors/sub-majors based on a model using the Simple Additive Weighting (SAW) method, one of the most popular decision-making methods in MADM.

The system is designed to transform qualitative questionnaire responses into quantitative decision inputs. Each answer option in the multiple-choice questionnaire contributes predefined numerical scores to one or more academic domain codes (majors or sub-majors). These scores represent the degree of relevance between a student’s response and a particular academic domain.

All evaluation criteria in this system are treated as benefit criteria, meaning that higher accumulated scores indicate higher suitability. This assumption is valid because all questionnaire contributions represent positive alignment (e.g., interests, skills, and preferences) rather than cost or penalty factors. The SAW method is particularly appropriate in this context due to its simplicity, transparency, ease of calculation, controllability, and flexibility, allowing adjustments based on educational domain knowledge.

The overall methodology consists of four main stages: Data collection through a structured questionnaire, Criteria formulation and criteria weighting, SAW-based computation and ranking, and Recommendation generation.

The questionnaire is designed with a two tier structure: Major orientation (Level 1) and specialization within a selected Major (Level 2).

### 3.5.2 Algorithm

The proposed algorithm applies the Simple Additive Weighting (SAW) method, which is mathematically equivalent to a weighted sum model, to infer recommendations from multi-label questionnaire data.

Each selected questionnaire option contributes a predefined weight to one or more academic codes through a score-mapping mechanism.

The raw score for an academic code i is calculated as:

=

* *UserSelected* = set of options that the user selects
* = is the score contributed by the o-th selected option to code i

**Hierarchical design:**

Level 1 (Major) the system evaluates all Major codes. For each Major code M, the score is update:

* = the cumulative score for Major M
* = the weight contributed by a selected option to Major M

After processing all selected options, the accumulated scores are grouped into predefined evaluation criteria to construct a decision matrix. The matrix is then normalized using the SAW normalization formula for benefit criteria:

* = the score of Major I under criterion j.

The final SAW score for each Major is computed as:

The majors are ranked in descending order of SAW scores*.* Then apply a rule using the threshold between the two highest scores, if ∆ ≥ 0.03 then automatic progression to Level 2 (SubMajor); otherwise, the full raking will be presented for the user to consider and choose by themselves.

Level 2 (SubMajor) further analysis within the chosen Major to find a suitable SubMajor by building a system of questions related to the Major. For each SubMajor code S, update:

* = the cumulative score for SubMajor S
* = the weight contributed by the current option to S

A SAW-based ranking process, identical to Level 1, is applied to the Sub-Major decision matrix. Sub-Majors are normalized, weighted, and ranked based on their final SAW scores.

Finally, the system provides a list of ranked Sub-Major within the selected Major, and a recommended Sub-Major with a corresponding suitability score.

This hierarchical design ensures that recommendations are both broadly appropriate at the Major level and precisely tailored at the Sub-Major level, while maintaining consistency and interpretability through the SAW method.

### 3.5.3 Pseudocode

INPUT:

Q = set of questionnaire questions

O = set of answer options selected by the student

Majors = {M1, M2, ..., Mk} // k = 23 major groups

Criteria = {C1, C2, C3, C4, C5}

Weights = {w1, w2, w3, w4, w5} // sum(wj) = 1

Threshold = 0.03 // decision confidence threshold

DATA STRUCTURES:

RawScoreMajor[M] // accumulated raw score for each Major

DecisionMatrix[M][C] // score of Major M under Criterion C

Normalized[M][C] // normalized decision matrix

SAWScore[M] // final SAW score for each Major

--------------------------------------------------

LEVEL 1: MAJOR RECOMMENDATION

--------------------------------------------------

1. Initialize RawScoreMajor[M] = 0 for all M in Majors

2. FOR each selected option o in O DO

FOR each Major M affected by option o DO

RawScoreMajor[M] += weight(o, M)

END FOR

END FOR

3. Initialize DecisionMatrix[M][C] = 0 for all M, C

4. FOR each selected option o in O DO

Identify Criterion C associated with option o

FOR each Major M affected by option o DO

DecisionMatrix[M][C] += weight(o, M)

END FOR

END FOR

5. FOR each Criterion C in Criteria DO

maxValue = max(DecisionMatrix[\*][C])

FOR each Major M in Majors DO

IF maxValue > 0 THEN

Normalized[M][C] = DecisionMatrix[M][C] / maxValue

ELSE

Normalized[M][C] = 0

END IF

END FOR

END FOR

6. FOR each Major M in Majors DO

SAWScore[M] = 0

FOR each Criterion Cj in Criteria DO

SAWScore[M] += Weights[Cj] \* Normalized[M][Cj]

END FOR

END FOR

7. Sort Majors in descending order of SAWScore

8. Let M1 = Major with highest SAWScore

Let M2 = Major with second highest SAWScore

9. IF (SAWScore[M1] - SAWScore[M2]) >= Threshold THEN

SelectedMajor = M1

ProceedToLevel2 = TRUE

ELSE

SelectedMajor = NULL

ProceedToLevel2 = FALSE

Output ranked list of Majors

END IF

--------------------------------------------------

LEVEL 2: SUB-MAJOR RECOMMENDATION

--------------------------------------------------

11. FOR each selected option o in SubMajor questionnaire DO

FOR each SubMajor S affected by option o DO

RawScoreSub[S] += weight(o, S)

END FOR

END FOR

12. Apply SAW steps (Decision Matrix → Normalization → Weighted Sum)

to all SubMajors of SelectedMajor

13. Rank SubMajors by final SAW scores

14. Output:

- SelectedMajor

- Ranked list of SubMajors

- Top recommended SubMajor with suitability score

END

# CHAPTER 4

# IMPLEMENTATION AND RESULTS

## Implement

This chapter describes the technical implementation of a Decision Support System (DSS), including the installation environment, software configuration, programming techniques, and the results obtained from the project. The goal is to explain how the DSS was built and validated through real outputs.

### Core Technologies Used

The web-based includes a backend built by Node.js (ES modules) and Express server that connects to PostgreSQL directly, exposing REST endpoints for quiz retrieval and submission, combines JWT for authentication and dotenv for loading environment variables. Frontend uses React, Vite, axios and Tailwind CSS.

#### Key components

The server layer built with Node.js and Express, exposing RESTful endpoints aligned with functional domains: authentication (JWT issuance and role verification), survey (Level 1 aggregated by Major, Level 2 differentiated by SubMajor, submission recording), results (user result retrieval and administrative views).

At the presentation layer, the frontend is implemented as a Single Page Application (SPA) using React and Vite, organized with component-based structure and client-side routing (React Router).

The data layer uses PostgreSQL with a conceptual model comprising the core entities: User, Major, SubMajor, Level, Question, Option, Submission, and Result. The hierarchical relationship between Major and SubMajor

## Results and Screenshots

Describe the results and screenshots recorded from the project and explain and demonstrate how the DSS project works.

### Home Page

A screenshot of a computer

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Figure 6: Home Page

According to the Support Career, users first access the Home page, then users can click the "Take the free test", “Start the assessment” or "Career Test" buttons to take the test without logging in to an account. In case users want to save the results, they can click the "Login" button to log in/register.

### User Authentication

When clicking the "Login" button, users are redirected to the Login screen. This interface allows users to authenticate either by entering their email and password.

The system integrates a user feedback mechanism, displaying a success message when an account is successfully created. Conversely, the interface will display an error dialog box when invalid input data is detected during authentication or registration, prompting the user to correct the error.

After successful login or registration, the user will be redirected back to the Home page. The main difference between the non-logged in user mode and the Authenticated mode is the "My Results" button that appears on the toolbar.

### Take the statement

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Figure 7: Start the statement

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Figure 8: Chose an option

(Figure 7) (Figure 8) show the Level 1 questionnaire interface where students select answers reflecting their interests, academic strengths, skills, and preferred working environments. Each selected option contributes predefined scores to one or more Major codes.

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Figure 9: Click "Next" or "Previous" to change the answer

When you start taking the test, the website will display multiple choice questions and 4 different answers for the user to choose from, as well as the test progress on the top right. The user can click the "Next" button to move to the next question, or "Previous" to return to the previous question. Each time you answer a question, the progress will also increase by %.

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Figure 10: Complete 30 question of level 1

A screenshot of a computer screen

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Figure 11: Top 3 Majors have highest scores

After completing 30 questions for Level 1, users will see the top 3 most suitable majors based on their RAW scores. If satisfied, they can choose one of the Major groups to create a Sub-Major question set for Level 2. If dissatisfied, they can retake the test. A special feature of the test is that if the scores of the top-ranked major and the second-ranked major are not significantly different (0.03), the system will automatically switch to the Major group with the highest score.

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Figure 12: Ranking scores and Majors

A screenshot of a chat

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Figure 13: Raking of Majors and jump to group of top Major in level 2 with highest score

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Figure 14: Continue to complete questions of SubMajor

At level 2, users continue to complete 30 questions from the recommended Major group, those 30 questions will help users to re-classify their majors better. After selecting 30 questions at level 2, users click the "Complete level 2" button at the bottom of the table to complete the test (Figure 14).

### View the result

A screenshot of a test results

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Figure 15: Result page

After the user completes the test, the system will redirect the user to the results page and display suggested majors based on the total score of the choices. On this page, the user can also view their previous tests for comparison.

### View the detail Career

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Figure 16: All of information about Careers

In addition, users can view information about Major/SubMajor by clicking on the "Careers" button. Here, all 23 popular majors in Vietnam are displayed. Users can click on the majors to see details.

### Admin

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Figure 17: Admin role – Create new questions

A screenshot of a chat

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Figure 18: Admin role - Edit/Detele quetions

Admin role allow insert/ delete/edit all questions, options, each of score options. Admin can manages all of the information about the test (Figure 23-24)

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Figure 19: Admin Dashboard

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Figure 20: Admin Dashboard

As an administrator, you can view user test results, including Raw Score, Decision Matrix, Normalized Matrix, and the final Ranking for any given user's test (Figure 16) (Figure 17). This allows you to manage and collect user data to improve the website.

## 4.2.7 Example how it work

**Step 1- Definition of Alternative (Majors):** the alternatives represent groups of Majors. Although the full system evaluates 23 Majors, but a set 5 of representative Majors is used in this example to illustrate the process.

Table 1: Define Alternatives as Majors

|  |  |
| --- | --- |
| Symbol | Alternative |
| A1 | CIT |
| A2 | ART |
| A3 | EDU |
| A4 | BUS |
| A5 | HEA |

**Step 2- Criteria and Aggregated Scores:**

After the user completes the questionnaire, the answers are converted into composite scores for each criterion and major. These values ​​form the decision matrix

Table 2: Decision matrix

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Major | C1 | C2 | C3 | C4 | C5 |
| CIT | 2 | 0 | 6 | 4 | 0 |
| ART | 0 | 2 | 0 | 0 | 0 |
| EDU | 0 | 0 | 0 | 0 | 0 |
| BUS | 0 | 0 | 0 | 2 | 0 |
| HEA | 0 | 0 | 0 | 0 | 0 |

All criteria are treated as benefit criteria, meaning higher values indicate better suitability.

**Step 3- Normalization:**

To ensure comparability across criteria, the decision matrix is normalized using the SAW normalization formula:

The maximum values for each criterion are:

The resulting normalized matrix is shown below.

Table 3: Normalized matrix

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Major | C1 | C2 | C3 | C4 | C5 |
| CIT | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| ART | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 |
| EDU | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| BUS | 0.00 | 0.00 | 0.00 | 0.50 | 1.00 |
| HEA | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Step 4- Weight Assignment:**

Each criterion is assigned to a weight based on its relative importance. The weights satisfy

Table 4: SAW Weight

|  |  |  |
| --- | --- | --- |
| Symbol | Criteria | Weight |
| C1 | Academic Strength | 0.3 |
| C5 | Interest | 025 |
| C3 | Skill | 0.2 |
| C4 | Work Environment | 0.15 |
| C5 | Social Value | 0.1 |

**Step 5 – Calculate SAW score:**

For CIT: = (0.25 1.00)+(0.30 0.00)+(0.20 1.00)+(0.15 1.00)+(0.10 0.00) = 0.6

For ART: =(0.25 0.00)+(0.30 1.00)+(0.20 0.00)+(0.15 0.00)+(0.10 0.00) = 0.3

For BUS: =(0.25 0.00)+(0.30 0.00)+(0.20 0.00)+(0.15 0.50)+(0.10 0.00) = 0.075

**Step 6 – Ranking and Recommendation:**

The final SAW scores are ranked in descending order. The system selects the major with the highest SAW score as the recommended major

Table 5: Ranking about final score and recommendation Major

|  |  |  |
| --- | --- | --- |
| Rank | Major | SAW score |
| 1 | CIT | 0.6 |
| 2 | ART | 0.3 |
| 3 | BUS | 0.075 |
| 4 | EDU | 0 |
| 5 | HEA | 0 |

**Step 7 – Decision Rule for Level Transition**

To determine whether the system automatically moves to Level 2 (subMajor), the score difference between the two highest-ranked majors will be evaluated:

then the system automatically proceeds to Level 2, which is the CIT Major questionnaire. (Conversely, a ranking list will be displayed for users to make their own selection).

# CHAPTER 5

# DISCUSSION AND EVALUATION

## Discussion

Abc…

## Comparison

Abc…

## Evaluation

Abc…

# CHAPTER 6

# CONCLUSION AND FUTURE WORK

## Conclusion

Abc...

## Future work

Abc…

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# APPENDIX