

Application of Decision Support Systems in Education for Strategic Teaching and Learning Optimization

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ABSTRACT

The term "decision support systems" (DSS) describes a type of computer-based system that gives information and resources to decision-makers. A more organised and evidence-based approach to decision-making is necessary to improve the efficacy of instruction in light of the growing complexity of educational administration. The Simple Additive Weighting (SAW) approach, a well-known Multi-Attribute Decision-Making (MADM) tool, is used to analyse the educational applications of Decision Support Systems (DSS). Ten strategic educational interventions are tested in this study using five main performance indicators for institutions. The alternatives were ordered according to their composite weighted scores, which were determined by weighted assessment using normalised criterion weights. According to the results, the most effective innovation-driven and learner-centred changes were a school-wide gamification system (90.20), curriculum alignment with industry trends (89.15), and school-wide gamification implementation. The study's findings corroborate the use of Decision Support Systems as a quantitative, methodical, and transparent framework for educational strategy prioritisation.

Keywords: *Education, Decision Support, Teaching, Learning, Curriculum.*

I. INTRODUCTION

Decision Support Systems in Education embody a revolutionary convergence of information technology, data analytics, and educational strategy designed to enhance the quality, efficiency, and equality of decision-making in education. A Decision Support System (DSS) is a computer-based system that helps people and businesses make smart choices by gathering, processing, analysing, and presenting data in ways that make sense. In the 1960s and 1970s, researchers like Michael S. Scott Morton and Peter G. W. Keen did pioneering work that set the conceptual underpinnings for DSS. They stressed the need to combine human judgement with computerised analytical tools. DSS has changed from basic systems for getting data to complicated, smart, and predictive platforms that may help with strategic, tactical, and operational choices. In the field of education, these systems have become more important since academic administration is becoming more complicated, digital learning environments are rising, and there is a need for policies based on evidence.

Today, the education industry collects a huge amount of data from many different places, including student information systems, learning management systems, standardised tests, digital classrooms, attendance records, and administrative databases. Schools, colleges, and universities all have to make judgements about things like curriculum development, evaluating student achievement, allocating resources, hiring teachers, admissions, retention methods, and institutional accreditation. Without structured analytical methods, these kinds of judgements typically depend on incomplete information or personal opinion. Decision Support Systems give you organised ways to turn raw educational data into useful information. DSS helps administrators and teachers see patterns, guess what will happen next, and look at many situations before making decisions by using data warehousing, data mining, statistical modelling, and visualisation approaches.

Artificial intelligence and machine learning technologies have come a long way in the last several decades, which has greatly increased the range of educational DSS. Now, smart technologies can figure out which students are likely to drop out, suggest personalised learning paths, look at how engaged students are, and make scheduling better. By using predictive analytics, schools can step in before students start doing poorly in school, which helps keep them in school and do better. These changes are in line with the larger trend in education toward making decisions based on data, where facts replace gut feelings as the main basis for policy and practice. As schools and universities become more competitive and responsible, DSS helps by making things clearer, keeping track of performance, and making plans for the future.

At the institutional level, Decision Support Systems help administrators make sure that academic goals are in line with the school's budgetary and infrastructure needs. For instance, colleges employ DSS tools to predict how many students will register, figure out how much money they will need, and see how adding new programs would affect them. Administrators can look at possible consequences before putting money into a policy by simulating alternative policy scenarios. School management systems also use DSS features to keep track of student attendance, academic achievement, and instructor duties. These kinds of technologies help people make smart choices that improve operational efficiency and make sure that limited resources are used in the best way possible. Data-driven insights are very important for curriculum reform, accreditation processes, and quality assurance mechanisms in big educational systems. These systems are run by national bodies like the Central Board of Secondary Education and regulatory agencies like the University Grants Commission.

From a teaching point of view, Decision Support Systems provide teachers the capacity to see how students are learning and how well they are doing in real time. Learning analytics systems included into Learning Management Systems look at things like how often students participate, how long they spend on digital content, and how well they do on quizzes and assignments. Teachers may utilise this information to change how they teach, give specific comments, and plan ways to help students who are struggling. Personalised learning, a primary goal of contemporary education, is attainable when DSS technologies discern individual strengths and shortcomings. These technologies help with personalised teaching and inclusive education by suggesting personalised learning resources and adaptive tests.

Decision Support Systems also play a big role in making decisions about education policy and governance. Governments and officials use combined educational data to plan changes, decide how to spend money, and see how well programs are working. DSS frameworks are used to look at national education surveys, performance indicators, and demographic data to find out why there are differences in access, gender gaps, regional imbalances, and socio-economic factors that affect educational results. Evidence-based policymaking increases accountability and makes ensuring that initiatives are aimed at the places that need them the most. In developing nations, where educational obstacles are frequently complex and financial limitations are acute, DSS serves as a strategic instrument for maximising investments and tracking advancement towards sustainable development objectives.

In education, a Decision Support System usually has three main parts: a database management subsystem, a model management subsystem, and a user interface subsystem. The database part keeps both organised and unstructured data that comes from different instructional procedures. Statistical models, optimisation algorithms, and forecasting approaches are all part of the model management component. These tools use the data to make sense of it. The user interface makes it easier for decision-makers to talk to the system, usually through dashboards, graphical reports, and interactive visualisations. More and more, modern DSS systems include cloud computing, big data analytics, and real-time processing. This makes them more scalable and accessible to institutions that are spread out across the country.

Types of DSS

There are five main types of Decision Support Systems:

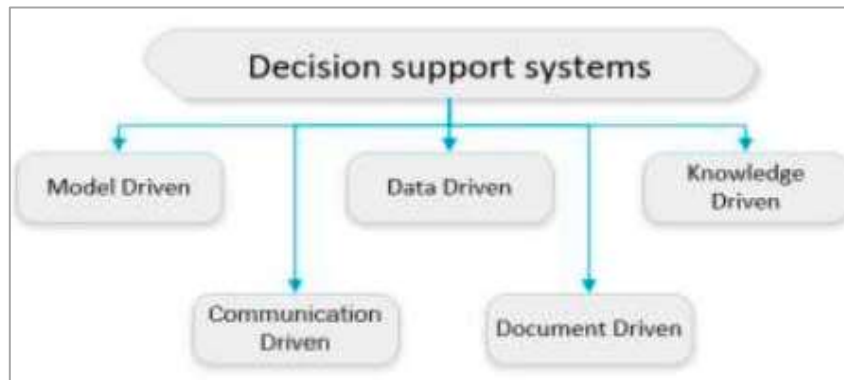


Figure 1: DSS Classification Model

Communication Driven DSS

Some examples of communication-driven DSS are chats, instant messaging, online collaboration, and net-meeting systems. It is meant for internal teams to have meetings or for users to talk to one other.

Data Driven DSS

This is a computer-based data system that has a query system for asking questions. The database may be accessed by the web, a mainframe, or a client/server link. It is mostly used to add data to existing databases or to add value to existing data. These kinds of DSS are mostly made for managers, employees, and those who sell products and services.

Document – Driven DSS

The web is a place for online firms to build, deploy, and run applications. And this is what people call the document-driven DSS. It is used as a showground to make community-based sites where people can work together and the application software runs over the web instead of being installed on each machine.

Knowledge – Driven DSS

When information is used, it becomes knowledge. Knowledge-driven DSS is a method that lets a system produce, store, move, and use information. The knowledge-driven DSS helps the organization learn more from its surroundings and use what it learns in its operations.

Model – Driven DSS

These can be utilised by computers that don't need to be connected to the internet. They help you make decisions by letting you look at or choose from the info that is accessible. Managers, employees, and those who work with organisations all utilise them.

II. REVIEW OF LITERATURE

Funda, Vusumzi. (2024) The rapid advancement and inherent usefulness of technology have made it an essential component of modern life. Knowing what drives people to embrace new technologies is crucial, given how important they are. Intelligent systems that assist with university decision-making are the subject of this research, which mostly targets institutions in developing nations. The goal of this literature review is to identify relevant and beneficial publications and to assess their usefulness and relevance. For this full-text systematic review, we used PRISMA-P to identify high-quality articles published between 2010 and 2022. According to studies, IDSS is an effective tool for assisting humans in making decisions

in the face of uncertainty by combining human-computer interaction with data, models, and structured procedures. Conversely, academics have paid less attention to choice problems involving fundamental additive weighing.

Bai, Haining. (2024). The use of big data, advanced analytics, and machine learning in decision-support systems (DSS) might be useful for educational institutions. By collecting and analysing large volumes of data from many sources, such as student performance, administrative records, and institutional resources, the Data Science Suite (DSS) provides administrators and teachers with valuable insights and prediction models. These kinds of discoveries have the potential to improve organisational effectiveness and student results via enhanced curriculum creation, student interventions, and strategic planning. The DSS equips school administrators with the resources necessary to address challenges and capitalise on opportunities in today's educational landscape with its real-time data processing capabilities, which enable data-driven decision-making. Integrating the Recommender Ranking Decision Support System (RRDS) with big data analytics provides a novel approach to enhanced educational administration. The origins of the RRDS are the focus of this investigation into the use of big data analytics to the educational setting. Using a variety of data sources, the RRDS enhances student performance, maximises the use of available resources, and paves the way for individualised education.

Muharlisiani, Lusy et al., (2023). An academic decision-support system (DSS) is presented in this work to aid in university-level customised instruction. This study analysed several learning strategies by drawing on the Best Worst Method (BWM), a popular MCDM approach, and criteria drawn from the preferences and priorities of University X professors. The most technology-enabled strategies were found to be online self-paced courses and adaptive learning tools, with one-on-one coaching coming in second. These findings shed information on the relative merits of different learning strategies, which contributes to the development of a DSS that can recommend the optimal approaches for personalised learning. Better academic outcomes may result from implementing this strategy into educational environments' decision-making processes. In order to confirm these findings in other educational settings and to investigate possible methods of integrating empirical data into decision-making, more research is required.

Fakieh, Khalid. (2015) Institutions of higher learning recognise Decision Support Systems (DSS) for many purposes, such as integrating information and facts, executing the best and most likely explanations, and refining judgements while hesitating. This article has outlined many issues with decision support systems (DSS), reviewed the best research in the field, and provided their own original study on how to implement a DSS in a university setting. Previous work on DSS module representation using an institution's existing systems and databases is detailed in this research article, along with results and actions involving the institution's faculty, students, and decision-makers in a variety of explicit settings pertaining to the procedures.

Mansmann, Svetlana & Scholl, Marc. (2007). The decision-making process in academic planning revolves around sorting through vast amounts of data from many sources. With the proliferation of new technical fields derived from computer science, electrical engineering, and computer engineering, deans and department chairs should ensure that new programs and specialisations receive adequate funding. Allocating teaching resources correctly is the emphasis of academic workload management, which aims to support the university's educational framework (faculty, degrees, courses, admission procedures, teaching workload, etc.). An technique to determining educational capacity, its distribution and usage, and its implementation as a decision-support system capable of simulating and evaluating various situations are all presented in this paper.

III. RESEARCH METHODOLOGY

A popular Multi-Attribute Decision-Making (MADM) approach, the Simple Additive Weighting (SAW) method is used in this study's quantitative decision-making framework. The study used a descriptive and analytical approach to score different educational systems according to various performance metrics.

The following five criteria were derived from a conceptual examination of educational performance indicators and implementation priorities:

- C1: Improve Student Performance
- C2: Enhance Teacher Effectiveness
- C3: Increase Curriculum Relevance
- C4: Optimize Resource Allocation
- C5: Improve Student Engagement

These criteria represent core dimensions of institutional effectiveness in teaching and learning environments.

Ten strategic alternatives were selected as potential interventions:

- A1: Implement personalized learning programs
- A2: Introduce more interactive teaching methods
- A3: Provide regular professional development workshops
- A4: Implement a peer-mentoring system
- A5: Integrate more real-world examples into the curriculum
- A6: Update curriculum aligned with industry trends
- A7: Adopt a more efficient scheduling system
- A8: Implement a digital resource management system
- A9: Introduce more project-based learning
- A10: Implement a school-wide gamification system

Each criterion was given a weight according to how important it was thought to be in improving the institution. After being normalised, the weights were added together to get 1.

$C1 = 0.25$, $C2 = 0.20$, $C3 = 0.15$, $C4 = 0.25$ and $C5 = 0.15$

The most important factors, representing the aims of the school, were student achievement and resource optimisation, which were each given the highest weight of 0.25.

A performance scale from 0 to 100 was used to assess each alternative in relation to the five criteria. You may think of the scores as an estimate of how well each option meets the specified requirement.

The SAW method uses the following formula to determine the total score for each option:

$$\text{Weighted Sum (Ai)} = \sum (W_j \times R_{ij})$$

Where:

W_j = weight of criterion j

R_{ij} = score of alternative i on criterion j

To get the final score for each option, we multiplied the weighted scores for each criterion by their weights and added them together. The next step was to sort the options by reducing the weighted sums.

IV. RESULTS AND DISCUSSION

Table 1: Performance Scores of Alternatives

Criteria / Alternative	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
C1 (0.25)	88	82	72	76	83	90	92	74	84	91
C2 (0.20)	84	88	91	82	78	85	87	92	79	86
C3 (0.15)	78	84	88	92	77	89	86	72	81	88
C4 (0.25)	91	87	82	78	93	88	84	76	92	90
C5 (0.15)	87	93	77	82	88	94	78	83	89	95

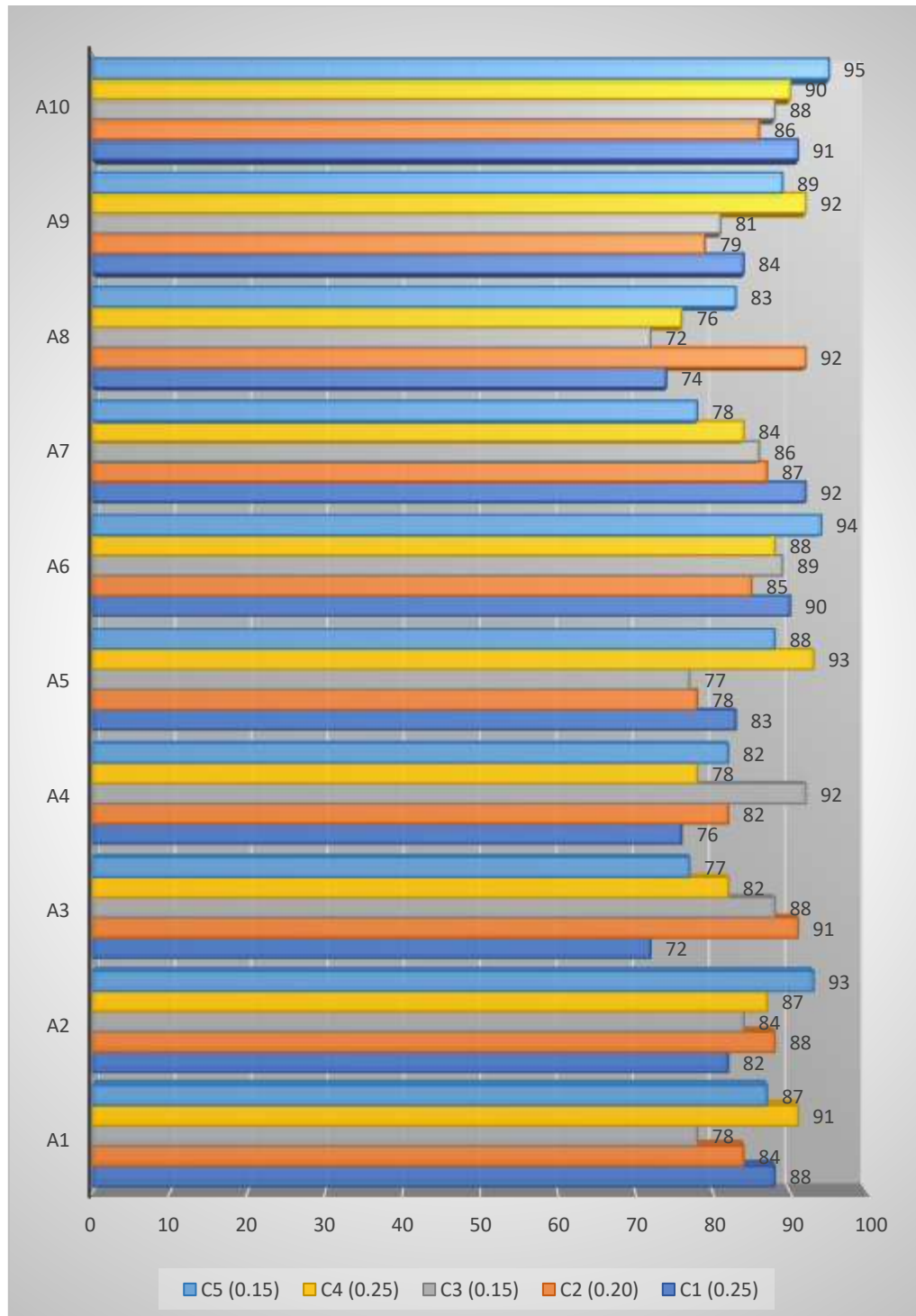


Figure 2: Performance Scores of Alternatives

Table 1 shows the performance scores for each option based on the five weighted criteria. These values show how each option is better than the others. When it comes to C1 (Improve Student Performance), options A7 (92), A10 (91), and A6 (90) have the best chance of improving academic results. For C2 (Improve Teacher Effectiveness), A8 (92) and A3 (91) had the highest scores.

A4 (92) and A6 (89) do very well on C3 (Increase Curriculum Relevance). When it comes to C4 (Optimise Resource Allocation), A5 (93) and A9 (92) show that they are more efficient. Finally, A10 (95), A6 (94), and A2 (93) get the best marks under C5 (Improve Student Engagement).

Table 2: Weighted Sum Calculation and Ranking

Alternative	Weighted Sum	Rank
A1	87.10	4
A2	86.65	5
A3	82.40	8
A4	80.70	9
A5	86.90	3
A6	89.15	2
A7	86.55	6
A8	79.80	10
A9	86.75	4
A10	90.20	1

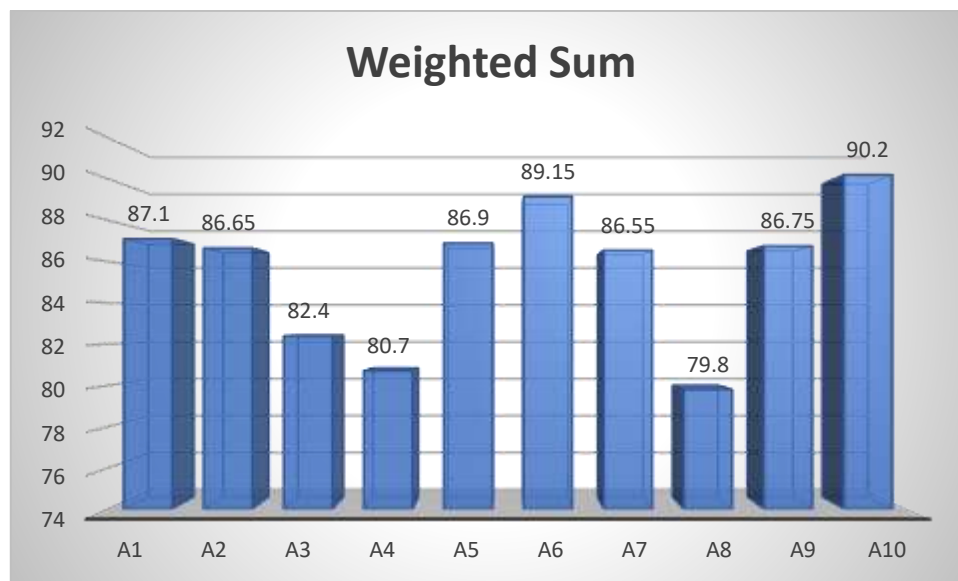


Figure 3: Weighted Sum

The weighted total results suggest that A10 is the best overall strategy since it has the highest score of 90.20. A6 comes next with a score of 89.15, which shows that it did well on all of the criteria. A1 (87.10) and A9 (86.75) are both quite effective, and A5 (86.90) and A2 (86.65) also do well in comparison. A7 gets an 86.55, which means it has a modest effect. A3 (82.40) and A4 (80.70) are lower-ranked options, and A8 (79.80) has the lowest score.

V. CONCLUSION

This study shows that decision support systems are particularly helpful for helping schools plan strategically and improve students' academic performance. The research utilised the Simple Additive Weighting technique to thoroughly evaluate various learning and teaching approaches for essential

performance metrics. Some of these things were how involved the students were, how effectively the program worked, how well the instructor did their job, and how well the resources were used. The study demonstrates that two examples of innovative and student-centered solutions that clearly deliver the highest institutional benefits are adopting a school-wide gamification system and aligning the curriculum with market trends. The strongest overall benefit came from modifications that made students more active and made their education more meaningful. These adjustments fared well on the most significant criteria. The study argues that Decision Support Systems could help people make decisions regarding school. These systems are built on data and are well-organised and easy to understand. DSS brings together many different ways to look at things into one analytical framework. This makes strategic decisions at institutions more objective and of higher quality.

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