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Strategic Assessment of E-Learning Platform Selection: A Multi-Criteria Decision Analysis for Students in India †

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Abstract: The transformative impact of technological advancements has ushered in a new era in education, digitizing traditional learning approaches into accessible E-learning platforms. In the context of India, where students increasingly rely on digital education, the multitude of available platforms has introduced a challenge: selecting the most suitable one. This project addresses this concern by providing information on the optimal E-learning platform. The selection is based on critical criteria such as cost-effectiveness, user experience, technological factors, assessment methods, and the quality of education. To determine the significance of each criterion and rank them, the Fuzzy Analytic Hierarchy Process (Fuzzy-AHP) method is employed. Subsequently, the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy-TOPSIS) is utilized to evaluate and identify the best E-learning platform. The key findings from this research aim to guide students, educators, and institutions in making informed decisions about E-learning platforms, ultimately enhancing the digital learning experience for Indian students.

Keywords: E-learning; Fuzzy-AHP; Fuzzy-TOPSIS; Indian education; teaching evaluation; multi-criteria decision analysis

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1. Introduction

Education, a cornerstone of individual and national success, has undergone a profound transformation propelled by technological advancements, giving rise to the era of E-learning. Traditionally centered around schools and universities, formal education has now embraced a flexible and remote learning approach in the digital age. E-learning, often likened to an expansive ocean of knowledge, grants individuals, including Indian students, the autonomy to learn at their own pace and convenience [1]. Amidst this digital evolution, the pressing challenge for students lies in selecting the optimal E-learning platform from a plethora of choices available. E-learning encompasses diverse forms of online learning and training, utilizing a spectrum of tools such as computers, websites, CDs, and DVDs. This introduction underscores the transformative impact of E-learning in India, shedding light on the challenges faced by students in navigating the digital landscape and making informed decisions about the array of educational platforms vying for their attention. In this dynamic educational landscape, the choice of the right E-learning platform becomes paramount for learners seeking a tailored and effective educational experience [2].

In the highly competitive environment of India, being the second most populous country, individuals across various age groups, including teenagers, adults, and professionals, actively seek education to stay abreast of the latest advancements in today's technologically advanced era. Additionally, students are eager to explore different fields, clarify doubts, and enhance their knowledge, leading to the rise of E-learning. The significant reason behind the rise of E-learning is introduction and usage of the Internet. E-learning is a

state-of-the-art methodology for learning and teaching in the digital form and aims to improve the education system for students of any age.

The COVID-19 pandemic has resulted in a substantial increase in the number of users engaging in electronic learning [3]. Technology plays a pivotal role in providing diverse services and solutions across various levels in the education sector. The education industry is a significant global market, valued at USD 6 trillion, with projections anticipating growth to USD 7.3 trillion by 2025 and further expansion to USD 10 trillion by 2030 [4]. At present, 3.1% of the total educational expenditure globally is spent on digital aspect in education, which is predicted to grow to 5.5% by the year 2025, and it is also estimated that E-learning will become a USD 404 billion market by 2025 from USD 183 billion in 2019 globally [5]. The pace of expansion of E-learning has a major impact on GDP (Gross Domestic Product), as many people gain education in India and this creates more entrepreneurs and professionals to increase the country's growth. The average number of years of education can raise a nation's GDP growth by 0.37%, according to the World Bank. According to this, a country's GDP can expand by 0.3% when the literacy rate rises by 1%. Moreover, an investigation carried out by the National Bureau of Economic Research (NBER) discovered that the region might experience a noteworthy economic benefit of USD 97.8 billion, or an 81% rise in GDP, if the presently enrolled pupils in South Asia, including India, achieve fundamental educational competencies. According to the report, profits of up to USD 259.5 billion, or 2.76%, might be realized if every young person in the region learns the fundamentals. The Indian government has implemented various measures aimed at enhancing the nation's education system. The Right to Education Act (RTE) was implemented in 2010, marking the first significant change in policy. This Act required private schools to set aside 25% of their seats for students from economically disadvantaged groups, making education a fundamental right for all children aged 6 to 14 years. This improved the nation's literacy rates and resulted in a notable increase in the number of children attending school. Higher secondary GER improved significantly from 53.8% in 2020–2021 to 57.6% in 2021–2022, suggesting more access to schooling. Furthermore, the Indian Census revealed that the country's literacy rate rose from 74.04% in 2011 to 77.7% across the country [5]. Furthermore, the alternatives chosen for this study are discussed, which are BYJU'S, UNACADEMY, VEDANTU, TOPPERS, DOUBTNUT, and LEARNVERN.

We intend to investigate the following important research questions.

- What are the most important criteria and sub-criteria that affect the selection of the best E-learning platform?
- Which method is suitable to provide the best suitable E-learning platform for the students?

2. Literature Review

A comparative analysis between selected E-learning platforms and existing solutions such as traditional classroom learning, tuition centers, workshops, and seminars aims to assess different aspects of each platform, which are listed below, to determine their relative merits and demerits with respect to the conventional methods.

Cost-Effectiveness (S1): Since cost-effectiveness is closely related to affordability and value for money from the perspective of the client, it is a crucial criterion. Students consider whether the expense of the E-learning program on a certain website is justified by the instructional materials and methodology [6].

User Experience (S2): Usability essentially refers to how individuals can use a product with ease and overall satisfaction. This encompasses various factors such as the ease of navigation for customers or students, ensuring they can quickly find what they need without unnecessary complexity. However, the critical elements in this regard are the platform interface and accessibility. It is crucial to evaluate how easily students of different age groups can access the platform. Moreover, considering how students can engage with the E-learning app over an extended period without boredom or irritation is a key aspect of this criterion [7].

Technological Factor (S3): The technological factor plays an inevitable role because it directly affects infrastructure and innovation, or in other words, design and innovation on the website. In terms of design, when a person first visits the website, it should seem good enough to capture their attention. The innovation factor includes response rate and impression score—this calculates how many hours a student studies. Security is a major worry when it comes to websites. This makes students' lives easier and more secure and allows them to keep an eye on their studies, but it requires a digital certificate to input any sensitive material or use the website [8].

Assessment Method (S4): Evaluation is crucial in the educational journey of students as it mirrors their comprehension of the learning material. This process involves a thorough assessment of their understanding, providing insights that help students gauge their grasp of the subject matter and clarify their studies. The feedback mechanism and adaptability within this process are crucial, particularly in E-learning platforms. The provision of feedback aligned with their progress is vital, as it guides students on areas that require improvement [6].

Education Quality (S5): The quality of education directly impacts the effectiveness of E-learning platforms. It is imperative that these platforms provide accurate and clear content to facilitate quick and easy understanding for students. While there may be a plethora of content available, it is crucial that the material aligns with the course, ensuring accuracy, currency, and completeness. Additionally, the presence of tests, quizzes, and examinations is considered to evaluate the appropriateness of assessment methods within the platform. Instructors also need to be well educated so that they can easily teach students [7]. Table 1 highlights the criteria and sub-criteria considered in this study.

Table 1. Criteria, sub-criteria, and their impact.

Criteria	Sub-Criteria	Code	Impact
Cost-Effectiveness	Affordability	S1	Negative
	Value for Money	S2	Negative
User Experience	Platform Interface	S3	Positive
	Accessibility	S4	Positive
Technological Factor	Infrastructure	S5	Positive
	Innovation	S6	Positive
Assessment Method	Feedback Mechanism	S7	Positive
	Adaptability	S8	Positive
Education Quality	Instructor Quality	S9	Positive
	Certification	S10	Positive

3. Methodology

Figure 1 illustrates the methodology of this research. In this study, the Fuzzy-AHP method is used to identify the weights of the criteria and sub-criteria while the Fuzzy-TOPSIS is utilized to rank the alternatives or E-learning platforms. Due to the space limitations, the details of Fuzzy-AHP and Fuzzy-TOPSIS are not included here. Interested readers are referred to Sheth et al. [9] and Senthilnathan et al. [10] for details.

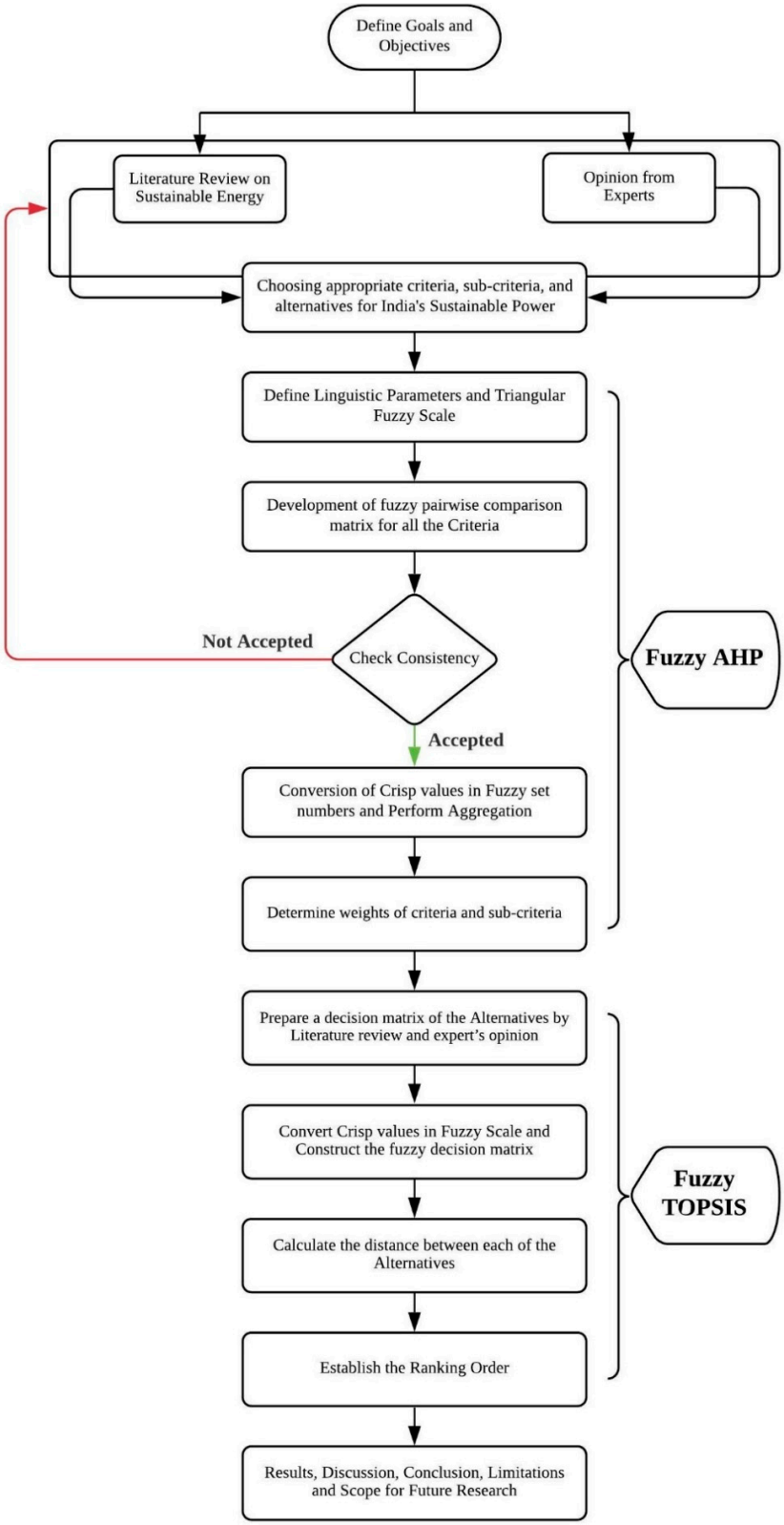


Figure 1. Research framework of this study.

4. Framework Implementation

In this section, the proposed framework is implemented to identify India's best E-learning platform. At the beginning, the decision hierarchy is developed (Figure 2).

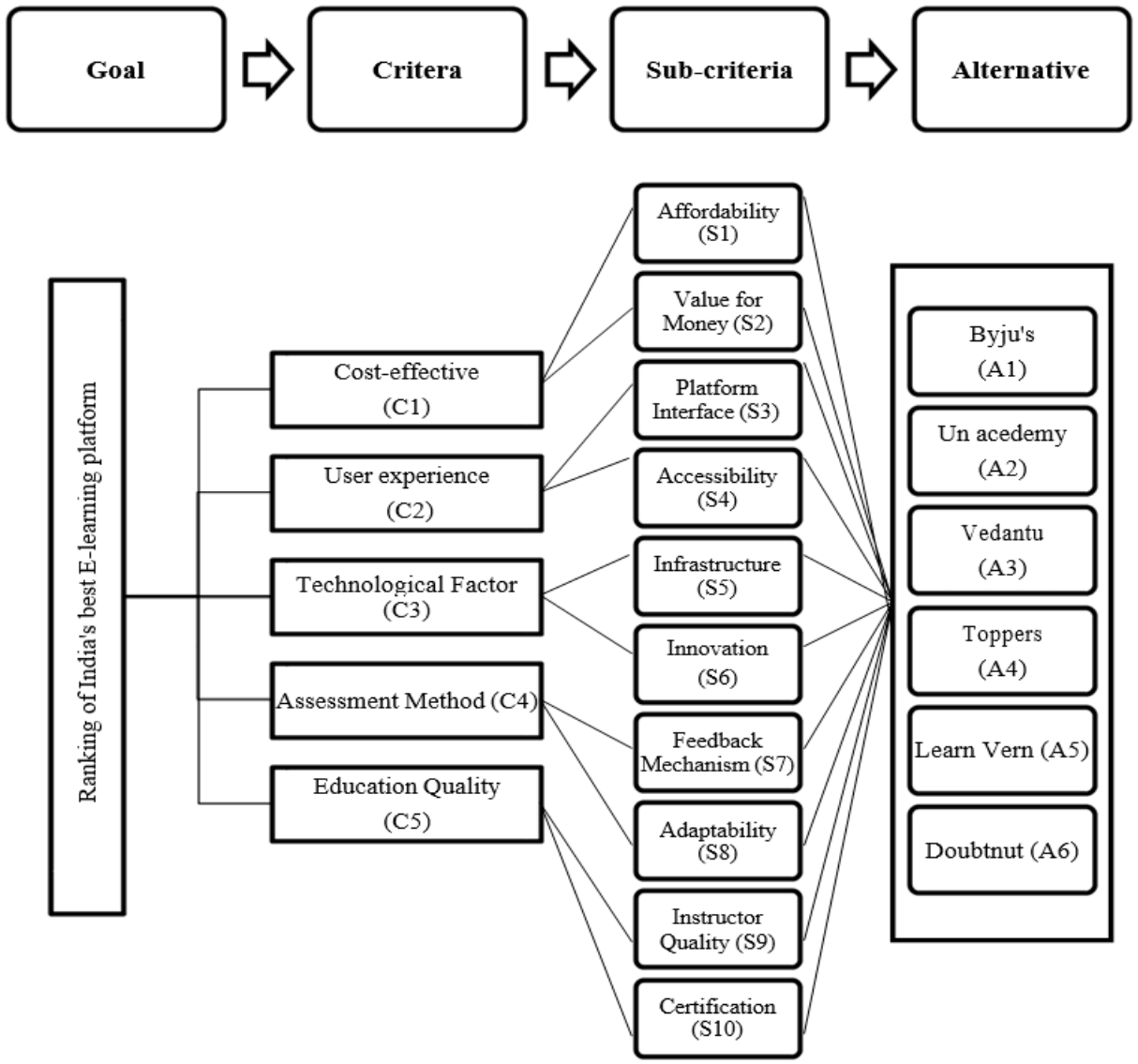


Figure 2. Hierarchical decision-making structure.

This study involved the selection of five decision makers, including students and university and school professors with extensive experience in India's E-learning platforms, as well as a stakeholder who holds stocks in the E-learning platform. Initially, these experts constructed a pairwise comparison matrix for the criteria and sub-criteria illustrated in Figure 2, employing the scale specified in Table 2. The aggregation of their opinions was achieved using the geometric mean method, as presented in Table 2. Subsequently, a consistency check was conducted, and all experts met the acceptance criteria.

Table 2. Aggregated result of all the experts' opinions.

	C1	C2	C3	C4	C5
C1	(1.00, 1.00, 1.00)	(2.76, 3.90, 4.97)	(3.37, 4.42, 5.45)	(0.98, 1.50, 2.35)	(0.70, 1.15, 1.78)
C2	(0.20, 0.26, 0.36)	(1.00, 1.00, 1.00)	(0.85, 1.35, 2.17)	(0.22, 0.28, 0.40)	(0.25, 0.34, 0.46)
C3	(0.18, 0.23, 0.30)	(0.46, 0.74, 1.18)	(1.00, 1.00, 1.00)	(0.24, 0.32, 0.50)	(0.20, 0.26, 0.37)
C4	(0.43, 0.67, 1.02)	(2.17, 3.25, 4.28)	(2.00, 3.13, 4.19)	(1.00, 1.00, 1.00)	(0.40, 0.57, 0.96)
C5	(0.56, 0.87, 1.43)	(2.19, 2.93, 3.97)	(2.70, 3.84, 4.92)	(1.05, 1.74, 2.48)	(1.00, 1.00, 1.00)

The subsequent phase involves establishing the weights for criteria. Following that, we ascertain the weights for each sub-criterion and arrange them based on the weighting derived for the criteria. Finally, the global weights for each respective sub-criterion were calculated. Table 3 provides a summary of the global weights and relative rankings for each sub-criterion.

Table 3. Criteria weight and sub-criteria global weight.

Criteria	Sub-Criteria	Code	Local Weight	Local Weight	Global Weight	Rank
Cost-Effectiveness	Affordability	S1	0.327	0.75	0.2450	1
	Value for Money	S2		0.25	0.0817	4
User Experience	Platform Interface	S3	0.086	0.80	0.0688	6
	Accessibility	S4		0.20	0.0172	9
Technological Factor	Infrastructure	S5	0.073	0.83	0.0607	7
	Innovation	S6		0.17	0.0121	10
Assessment Method	Feedback Mechanism	S7	0.221	0.33	0.0736	5
	Adaptability	S8		0.67	0.1472	3
Education Quality	Instructor Quality	S9	0.294	0.80	0.2351	2
	Certification	S10		0.20	0.0588	8

The best alternative is determined using the TOPSIS method, following the instructions outlined in the flow diagram. Initially, the literature review is utilized to create the decision matrix, which is then transformed into a fuzzy scale based on its value. Subsequently, a crisp value is assigned to establish the primary matrix. Finally, a fuzzy normalized matrix is generated, entirely dependent on the cost and benefit criteria. The weighted normalized fuzzy matrix is produced by multiplying the normalized matrix by the sub-criteria weight once it has been calculated. Fuzzy Positive Ideal Solution (FPIS), Fuzzy Negative Ideal Solution (FNIS), closeness coefficient, and the rank of the E-learning platform are presented in Table 4.

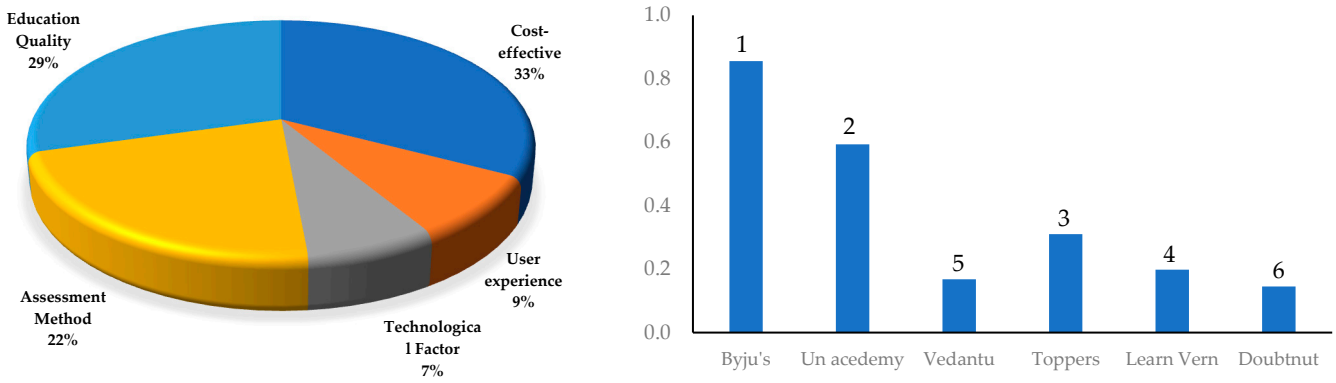
Table 4. Final rankings from closeness coefficient.

Alternatives	FPIS	FNIS	Closeness Coefficient	Rank
Byju's	0.176	1.067	0.858	1
Unacademy	0.508	0.799	0.611	2
Vedantu	0.906	0.345	0.276	4
Toppers	0.984	0.262	0.211	5
LearnVern	0.877	0.373	0.298	3
Doubtnut	1.106	0.140	0.112	6

5. Results and Discussions

Figure 3a depicts the weights assigned to various criteria determined through the utilization of the Fuzzy-AHP method. Notably, Cost-Effectiveness emerges as a primary criterion exerting a substantial influence on the selection of E-learning platforms, as elucidated in the chart. Additionally, Education Quality and Assessment Method emerge as two pivotal factors that carry the second-highest impact on the digital E-learning platform selection process. The significance of these criteria, particularly in tandem with Cost-Effectiveness, underscores their crucial role in shaping the selection dynamics of E-learning platforms.

According to Figure 3b, the best E-learning platforms for students are Byju's and Unacademy; however, the other E-Learning platforms, like Toppers and LearnVern, are also good options to learn from, while Vedantu and Doubtnut are the digital platforms ranked lowest in the study as per their service level.



(**a**) Criteria Weight (**b**) Alternative Rankings

Figure 3. Criteria weights and ranks of the alternatives.

6. Conclusions

The population is continuing to rise, which is driving up demand for education. Maintaining a high degree of literacy is crucial for India because it acknowledges education as a crucial factor for both individual achievement and national growth. Choosing the best learning platform becomes essential given the abundance of options accessible. This study uses the Fuzzy-AHP and Fuzzy-TOPSIS approaches in defining which E-learning platform is best. In order to analyse the weighting of elements and sub-criteria, the first step is to introduce Fuzzy-AHP. After that, Fuzzy-TOPSIS is used to provide rankings for the options. This method guarantees a thorough assessment, making it easier to choose the finest E-Learning platform among the many available choices. A notable limitation stems from the subjective determination of the weights assigned to factors and sub-criteria, relying on individual perspectives. This subjectivity introduces variability, as the weight of criteria may differ even within the same study. The impact of any given criterion or sub-criterion holds substantial influence, potentially leading to significant alterations in the results. This outcome benefits students, educators, and stakeholders in several ways. For students, it provides the flexibility to learn anytime and anywhere, catering to their individual learning preferences. Educators can earn income and share their expertise without the need for physical coaching centers or venues, enabling them to reach a broader audience. Additionally, stakeholders can capitalize on the growth of this approach to generate revenue. In the world of new technology advancements, the plethora of options for the continuous rise of start-ups in the E-learning sector suggests that future studies may need to consider additional criteria and alternatives as well as using different methods. Moreover, conducting sensitivity analysis will be essential to confirm the direction of this study and ensure its alignment with the intended objectives, as well as identifying areas that may require improvement.

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