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The Application of the Analytical Network Process for Select Leaders in Higher Education Institutions

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Abstract

This study aims to examine the application of the Analytic Network Process (ANP) in selecting leaders for public universities in Vietnam. The research seeks to develop a transparent, scientific, and decision-making framework for evaluating leadership candidates based on multiple interrelated criteria in higher education governance. Empirical data were collected from experts, lecturers, and students at a public university in Vietnam, with a total sample size of 257 respondents. The research employed pairwise comparison matrices and ANP procedures, including criteria identification, consistency testing, weight calculation, and candidate ranking. Five criteria were identified for evaluating leadership candidates: professional qualifications and scientific research capacity, ethics and integrity, experience in management and organization, ability to inspire colleagues and students, and ability to mobilize financial resources. The results indicate that ethics and integrity (C2) with weight (0.2550), ability to mobilize financial resources (C5) with weight (0.2350), and experience in management and organization (C3) with weight (0.2309) were the most influential factors in leadership selection. Based on these weighted criteria, three leadership candidates were evaluated and ranked, demonstrating the suitability and effectiveness of the ANP model in supporting decisions for selecting university leaders. The study provides a scientifically based, transparent assessment tool while suggesting policy implications in senior human resource management, in line with the requirements of innovation and sustainable development of Vietnamese higher education.

Keywords: Analytical Network Process, Leader selection, Higher education, Public universities, Vietnam

1. Introduction

In the context of fundamental and comprehensive innovation in education and training in Vietnam, higher education is playing a central role in training high-quality human resources to serve the cause of industrialization and modernization of the country [1], [2]. One of the key factors determining the quality and effectiveness of higher education institutions is the management team [3], [4]. In particular, university leaders are responsible for strategic planning, academic governance, research promotion, international cooperation, and institutional administration in an increasingly competitive and dynamic environment.

In the higher education institutions, leaders such as principals, vice principals, and deans not only perform administrative functions but also shape academic culture, staff development, scientific research, and training quality [5]. Higher education leadership plays an important part in determining the overall direction and development of universities [6], [7]. University leaders are responsible for orienting training activities, promoting scientific research, and fostering academic culture and institutional environments [8], [9]. Effective leadership contributes significantly to institutional reputation, organizational performance, and international integration [10], [11]. Therefore, in the context of higher education autonomy and global integration in Vietnam, university leaders are expected to possess not only professional expertise and managerial competence but also ethical integrity and strategic vision.

Despite the recognized importance of leadership, the selection process for university leaders in many Vietnamese higher education institutions remains largely dependent on administrative procedures and subjective judgments [12]. Existing practices often lack a systematic evaluation framework capable of integrating multiple decision criteria and

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stakeholder perspectives. As a result, leadership appointments may not fully reflect the competencies required for effective university governance and sustainable institutional development. This issue reveals an important research gap: the limited application of scientific multi-criteria decision-making approaches in leadership selection within Vietnamese public universities.

Selecting university leaders is inherently a complex decision-making problem because it requires simultaneous consideration of multiple interrelated criteria, including leadership capacity, management experience, professional qualifications, ethical qualities, adaptability, and organizational compatibility. Conventional evaluation approaches may not adequately capture the interactions and dependencies among these factors. Therefore, there is a growing need for a transparent, objective, and systematic decision-support method that can address these complexities and improve the quality of leadership selection in higher education institutions.

The ANP is a decision method developing on the basis of AHP [13]. Unlike AHP, which assumes linear relationships between factors, ANP allows for consideration of feedback links and interactions between factors and alternatives [14]. The ANP can be applied to consider the interdependencies among all factors with appropriate weighting measures for each factorial criterion [15]. Given that leadership selection in universities involves multiple interconnected attributes, ANP provides an appropriate methodological approach for this context.

This study applies the ANP method to support the selection of leaders in Vietnamese public universities. The research aims to contribute both theoretically and practically by developing a scientific and transparent evaluation framework for leadership selection in higher education institutions. The findings are expected to support universities and policymakers in improving leadership appointment processes in line with the ongoing trend toward autonomy, accountability, and international integration in higher education. Furthermore, the proposed framework may be adapted and applied to other educational institutions in Vietnam.

The remainder of this study is organized as follows: Section 2 presents the literature review. Section 3 describes the ANP methodology. Section 4 discussed the survey and analysis. Finally, conclusions and recommendations are provided in the last section.

2. Literature Review

Studies that utilize multi-criteria decision-making tools to address priority problems are prevalent and span various fields. Previous studies applying AHP mainly focused on prioritization and selection problems in engineering, energy, agriculture, manufacturing, and risk management contexts. For example, Chandra et al. [16], Demir et al. [17], and Veisi et al. [18] demonstrated the suitability of AHP for evaluating alternatives under multiple criteria in infrastructure, renewable energy, and agricultural decision-making. Other studies combined the AHP model with complementary models such as TOPSIS, VIKOR, SWOT, and risk matrices to improve decision accuracy and handle uncertainty in complex environments [19], [20], [21], [22], [23]. These studies collectively confirm that AHP is effective when decision criteria are relatively independent and hierarchically structured.

The ANP model was developed to overcome the limitations of AHP by incorporating interdependencies and relationships among decision criteria. Studies applying the ANP model have mainly addressed complex decision-making problems involving strategic planning, supply chain management, energy policy, and personnel evaluation [24], [25], [26], [27]. Compared with AHP studies, ANP applications place greater emphasis on capturing interactions among factors that influence decision outcomes. For instance, Chen et al. [28] applied ANP to analyze interconnected green supply chain risks, while Kaytez [26] used ANP to prioritize strategies for wind power expansion where multiple criteria influenced one another simultaneously. These studies demonstrate that ANP is particularly appropriate for decision contexts characterized by mutual dependence among evaluation dimensions.

Although several studies have applied ANP to personnel-related decisions, such applications remain limited, especially in educational management. Özdemir & Sagir [29] used the ANP method to prioritize the air traffic controller selected, and Setiawan et al. [30] applied the method to managerial selection in the pharmaceutical industry. However, these studies were conducted in non-educational sectors and focused primarily on operational personnel evaluation. Within higher education research, recent studies have largely concentrated on digital transformation, artificial intelligence, and educational quality improvement rather than leadership selection. For example, Ayeni et al. [31] studied the application of AI in educational settings, focusing on its impact on learning

and teaching. Owan et al. [32] emphasized the possible use of artificial intelligence to measure and evaluate educational quality. Lian et al. [33] examined the most effective tool for fostering competition within the education sector. Ohara [34] discussed the role of social media influences on communication management in educational settings. Fithri et al. [35] conducted a study examining the factors that influence the commercialization of scientific research products at a university. Dempere et al. [36] conducted studies on the impact of ChatGPT on higher education. Akour and Alenezi [37] have made profound observations about the future of higher education in the era of digital transformation. George and Wooden [38] studied the transformation of a higher education strategy based on the development of artificial intelligence. Consequently, there remains a significant gap regarding the application of ANP to leadership selection in higher education institutions.

The present study builds upon the methodological strengths identified in previous ANP research, particularly the ability of ANP to model complex relationships and interdependencies among evaluation criteria. Leadership selection in higher education involves multiple interconnected dimensions, including managerial competence, academic reputation, strategic vision, innovation, ethics, interpersonal skills, and institutional development capacity. These criteria are not independent; rather, they influence one another in both direct and indirect ways. Therefore, unlike AHP, which assumes hierarchical independence, ANP provides a more suitable analytical framework for capturing these interactions. Based on this rationale, the current study adopts ANP to develop a comprehensive decision-making model for leadership selection in higher education institutions, thereby extending the application of ANP into an underexplored educational management context.

3. Methodology

3.1. Research Process

The research framework presented in figure 1 illustrates the sequential process adopted in this study for selecting higher education institution leaders using the ANP method. The process begins with defining the research objective and conducting a literature review to identify relevant evaluation criteria.

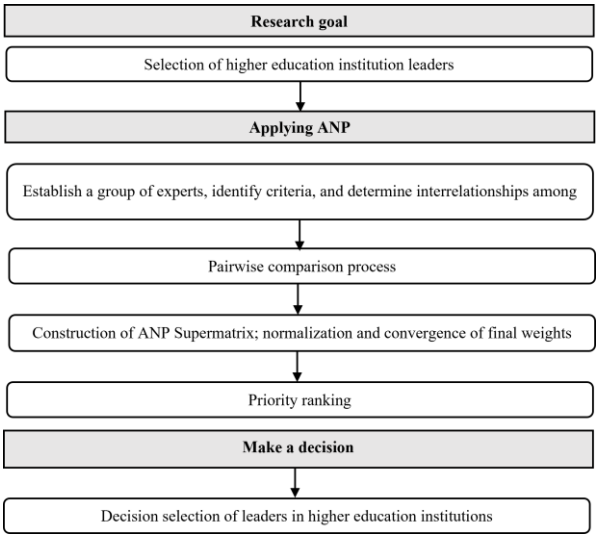

Figure 1. Research framework

Subsequently, an expert panel is established to validate the criteria and determine the interrelationships among them. Based on these relationships, pairwise comparisons are performed to assess both the relative importance and mutual influence of the criteria. The collected judgments are then used to construct the ANP supermatrix. After normalization and iterative convergence, the final weights for the criteria are obtained and used to rank the leadership selections. Finally, the results support the decision-making process for selecting higher education institution leaders.

3.2. Analytical Network Process

The ANP is a multi-criteria decision-making method widely used to analyze and solve complex problems involving many interrelated factors [39]. ANP provides a more comprehensive framework compared to AHP for multi-criteria

decision-making, especially in cases where hierarchical structures fall short. This is particularly important when tackling complex issues or analyzing the intricate interactions both within clusters and between clusters of factors [40]. The ANP method is used to find out the most dominant key factors and determine the priority order of alternative solutions [41]. In this network configuration, ANP considers not only the internal dependencies among elements within the same cluster but also the external dependencies among elements across different clusters. As a result, the method can provide more comprehensive insights, reduce potential evaluation errors, and improve the accuracy of expert judgments [42].

In the ANP framework, the relationships and interactions among criteria are represented through a supermatrix. This supermatrix contains the relative influence weights among elements in the network system. The matrix is then raised to successive powers until it reaches convergence and becomes a limit matrix. The resulting limit matrix contains the final priority weights of the decision elements and alternatives. One limitation of the ANP is that the assumption of convergence for the weighted supermatrix holds true only under specific conditions [43]. Nevertheless, ANP remains an effective and powerful approach for solving complex multi-criteria decision-making problems because it allows the analysis of feedback and mutual influence relationships among factors.

The ANP is a comprehensive theory of relative measurement that enables the creation of composite preferred ratio scales derived from individual ratio scales. These ratio scales represent relative measures of how interacting factors affect one another, based on established control criteria. While AHP is organized in a hierarchical structure, ANP is designed to address issues that involve interactions and mutual influences among factors. Therefore, ANP is structured as a network and more accurately represents the interactions between factors in a multi-criteria decision-making problem [44], [45]. This study applies the ANP method through six fundamental steps, as outlined below:

Step 1: Identify goals and related criteria. The primary objective of this study was to prioritize the selection of leaders for higher education institutions. To establish the evaluation framework, the authors formed a panel of experts consisting of experienced professionals and administrators in the field of higher education. A semi-structured group discussion was conducted to identify, evaluate, and validate the criteria relevant to leadership selection. Prior to the discussion, a preliminary list of criteria derived from the literature review was provided to the experts as a reference framework. Through iterative discussion and consensus building, the experts refined the criteria to ensure comprehensiveness, relevance, and contextual suitability for higher education institutions. The finalized criteria are presented in table 1.

Table 1. Criteria for selecting leaders in higher education institutions

Criteria	Source	Explanation
Professional qualifications, scientific research capacity (C1)	Shen *et al*. [46]	Professional qualifications and scientific research capacity constitute fundamental requirements for leaders in higher education institutions. This criterion reflects the candidate's academic expertise, depth of disciplinary knowledge, and professional competence within a specialized field. In addition, it demonstrates the ability to conduct scientific research, contribute to academic development, and publish research outcomes in both domestic and international scholarly forums. Leaders possessing strong academic and research capabilities are more likely to promote innovation, enhance institutional academic reputation, and support the development of high-quality education and research activities.
Ethics and integrity (C2)	Rostami *et al.* [47]	Ethics and integrity are essential leadership attributes, particularly within higher education environments where leaders are expected to serve as role models for lecturers, staff members, and students. This criterion encompasses honesty, fairness, transparency, responsibility, and the appropriate use of authority for the collective benefit of the institution rather than personal interests. The ethics and integrity of higher education institution leaders play a crucial role in creating a healthy, reputable, and sustainable educational environment.
Experience in management and organization (C3)	Rybnicek *et al*. [48]	Experience in management and organization reflects a leader's capability to effectively administer and develop higher education institutions in a dynamic educational environment. This criterion includes strategic thinking, administrative competence, adaptability, and the ability to coordinate institutional resources efficiently. It also involves competencies related to human resource management, financial administration, curriculum innovation, teaching improvement, international collaboration, and institutional culture development. Leaders with substantial managerial experience are better positioned

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		to improve educational quality, respond to societal and stakeholder expectations, and guide universities toward sustainable development.
Ability to inspire colleagues and students (C4)	Expert Discussion	The ability to inspire colleagues and students represents an important interpersonal and leadership competency in higher education institutions. This criterion reflects the leader's capacity to motivate individuals, encourage professional and academic development, and foster commitment toward common organizational goals. Inspirational leadership is demonstrated through enthusiasm, effective communication, active listening, empathy, and the maintenance of a positive and constructive attitude. Leaders with strong inspirational abilities can create a supportive academic environment that enhances collaboration, innovation, and collective engagement among lecturers, and students.
Ability to mobilize financial resources (C5)	Wanyama [49]	The ability to mobilize financial resources refers to the capability of securing, managing, and optimizing financial support for institutional development and long-term sustainability. This criterion includes identifying new funding opportunities, effectively utilizing existing resources, and establishing partnerships with external stakeholders. Financial resource mobilization plays a crucial role in enabling universities to invest continuously in infrastructure, academic programs, research activities, and technological advancement. Leaders possessing strong financial mobilization capabilities can significantly contribute to the sustainable growth and competitiveness of higher education institutions.

The selection of the five criteria in this study was based on both an extensive literature review and expert discussions involving experienced professionals in higher education management. The purpose of this process was not to include all possible leadership characteristics, but rather to identify the most representative and practically measurable criteria that directly influence leadership effectiveness in higher education institutions. These criteria were chosen because they reflect the core dimensions of university leadership in the context of higher education governance, including academic competence, moral responsibility, managerial capability, inspirational leadership, and institutional development capacity.

Although other potential leadership factors were identified during the preliminary review and expert consultation process, such as communication skills, international collaboration experience, political awareness, innovation capability, and digital transformation, these factors were not included as independent criteria for several reasons. First, some of these aspects overlapped conceptually with the selected criteria. For example, communication and motivational abilities were considered part of the ability to inspire colleagues and students (C4), while innovation capability was reflected through professional qualifications and management experience (C1 and C3). Second, several criteria were considered difficult to measure objectively and consistently through pairwise comparison and stakeholder evaluation within the ANP framework. Third, to maintain the practicality and consistency of the ANP model, the number of criteria needed to remain manageable because an excessive number of interrelated criteria could increase model complexity and reduce the consistency of expert judgments. Therefore, the five selected criteria were considered sufficient to represent the essential competencies of higher education leaders while ensuring the feasibility, consistency, and interpretability of the ANP analysis model.

Step 2: Establishing the network structure. The authors developed a network that illustrates the interactive relationships among the identified criteria. They qualified these relationships prior to performing pairwise comparisons of the criteria. This step is essential because leadership selection in higher education involves multiple interconnected dimensions, including academic competence, managerial capability, ethics, and interpersonal influence.

Step 3: Pairwise comparison and consistency analysis. After establishing the network structure, experts continue to perform the quantitative assessment step by comparing pairs of importance levels and interactions between criteria. The comparison was performed using Saaty's 1-9 scale, as shown in table 2, to ensure standardization and uniformity in the assessment.

Table 2. Importance comparison scale [42]

Definition	Level of importance	Description
Equal importance	1	Criteria i and j are equally important.
Moderate importance	3	Criteria i is less important than Criteria j.
Important	5	Criteria i is more important than Criteria j.

Very important	7	Criteria i is very important than Criteria j
Extremely important	9	Criteria i is definitely more important than Criteria j
Intermediate value	2;4;6;8	

The results obtained assist in establishing the matrix of relative weights among the associated factors. The pairwise comparison matrix is shown in equation (1).

$$A = [a_{ij}]_{n\times n} = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \ldots & a_{2n} \\ \vdots & \vdots & \ddots & \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \ldots & 1 \end{bmatrix} \quad (1)$$

a_{ij} represents the relative importance of criteron i compared with criterion j, satisfying the reciprocal property: $a_{ji} = \frac{1}{a_{ij}}$.

The priority vector w is obtained from the principal eigenvector of matrix A, shown in equation (2).

$$Aw = \lambda_{max} w \quad (2)$$

λ_{max} denotes the maximum eigenvalue of the comparison matrix; and w represents the normalized eigenvector corresponding to the relative weights of the criteria.

To verify the reliability and logical consistency of expert judgment, the consistency index (CI) and consistency ratio (CR) were calculated. The consistency index is determined by equation (3). and the consistency ratio is calculated as shown in equation (4).

$$CI = \frac{\lambda \max - n}{n-1} \quad (3)$$

The consistency ratio is calculated as shown in equation (4).

$$CR = \frac{CI}{RI} \quad (4)$$

where random inconsistency (RI) is presented in table 3, and CR < 0.1 indicates an acceptable level of consistency.

Table 3. RI index [50]

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Step 4: Construction of the supermatrix. Following the pairwise comparison process, the local priority vectors were synthesized to construct the ANP supermatrix. The supermatrix represents the entire network structure and incorporates all interdependent relationships among criteria and alternatives. The unweighted supermatrix is represented as shown in equation (5).

$$A = \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1n} \\ W_{21} & W_{22} & \ldots & W_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ W_{n1} & W_{n2} & \ldots & W_{nn} \end{bmatrix} \quad (5)$$

each supermatrix W_{ij} describes the influence of one cluster on another cluster within the network system.

The weighted supermatrix satisfies the stochastic property in which the sum of each column equals one. Such a supermatrix is called a weighted supermatrix.

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Step 5: Limit supermatrix and convergence. To derive the global priority weights, the weighted supermatrix was raised to sufficiently large powers until convergence was achieved. The limit supermatrix is expressed as shown in equation (6).

$$W\infty = \lim_{k\to\infty}(W)^k \quad (6)$$

Convergence is achieved when the values in the matrix no longer change significantly between successive iterations. The resulting limit supermatrix provides the final global priority weights for the criteria and alternatives in the decision network.

Step 6: Make a decision. After determining the global priority weights, the authors proceeded to evaluate the candidates according to the established criteria. Specifically, criteria related to professional qualifications and scientific research capacity (C1), ethics and integrity (C2), experience in management and organization (C3), and ability to mobilize financial resources (C5) were evaluated by seven members of the School Council. The criterion concerning the ability to inspire colleagues and students (C4) was assessed by 50 lecturers and 200 students selected through random sampling.

The evaluation employed the Vietnamese 10-point grading scale, where scores ranging from 9.0 to 10.0 are categorized as "excellent," scores from 8.0 to 8.9 are considered "good," scores between 7.0 and 7.9 are labeled as "fairly good," scores from 6.0 to 6.9 are deemed "average good," scores between 5.0 and 5.9 are classified as "average," scores from 4.0 to 4.9 are regarded as "weak," scores below 4.0 are identified as "poor," and a score of 0 is marked as "unranked."

The final candidate ranking was determined by aggregating the normalized evaluation scores with the ANP-derived global priority weights. The candidate obtaining the highest overall score was considered the most suitable individual for leadership selection within the higher education institution. Figure 2 presents the network diagram illustrating the ANP model developed for selecting leaders in higher education institutions.

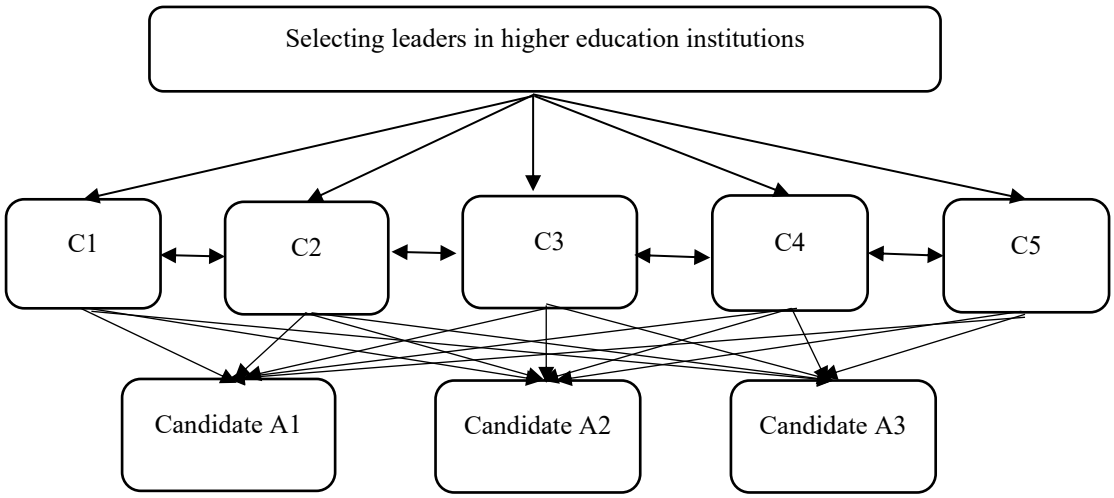

Figure 2. Network diagram for selecting leaders in higher education institutions

4. Results and discussion

4.1. Expert Characteristics

In qualitative research, sample sizes are typically small, ranging from 5 to 50 participants, as this research method focuses on gathering insights about an event or phenomenon rather than applying rigid numbers. The expert method also applies here, as it involves selecting experts based on their knowledge and practical experience [51]. In this study, purposive sampling was employed to select experts with substantial experience and direct involvement in higher education management. A total of seven experts participated in the ANP evaluation process. The selection of this number was not based merely on general qualitative research conventions but was aligned with the methodological requirements of the ANP approach. Previous studies applying AHP/ANP methods have commonly utilized relatively

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small panels of domain experts because the pairwise comparison process requires participants to possess deep contextual understanding and decision-making experience. Therefore, the use of seven experts in this study is considered appropriate to ensure both the reliability and consistency of the pairwise comparison matrices. Their direct involvement in management, training, and evaluation activities provided them with comprehensive knowledge of the candidates and the institutional context. This expertise enabled them to provide informed and reliable judgments during the ANP comparison process. In addition, to ensure objectivity and comprehensiveness in the evaluation, the candidate scoring also involved 50 lecturers and 200 randomly selected students who had worked directly with the candidates. Table 4 presents the detailed characteristics of the study sample. Table 4 presents the detailed characteristics of the study sample.

Table 4. Expert characteristics

Job/position	Experience in higher education management			Gender and age		
	5-10 years	11-15 years	16-20 years	Male	Female	Age
School Board Member	2 experts	3 experts	2 experts	5	2	40-60
Lecturer				24	26	30-50
Student				112	88	19-21

4.2. The Matrix Results in a Pairwise Comparison of the Relative Importance and Relationship Between the Criteria

The pairwise comparison matrix of relative importance between criteria is shown in table 5. The results indicate clear differences in the perceived importance of the five criteria. Among them, criterion C2 achieved the highest priority weight (0.465), demonstrating that experts considered this criterion to play the most dominant role in the leadership competency framework. The substantial gap between C2 and the remaining criteria suggests a consensus regarding its strategic importance. In contrast, C4 obtained the lowest priority weight (0.055), implying that although it contributes to the framework, its influence is comparatively limited when evaluated against the other criteria.

In addition, C1 ranked second with a priority weight of 0.247, indicating that this criterion was also considered highly influential by the experts. Meanwhile, C5 (0.144) and C3 (0.089) were assessed as having moderate and relatively lower importance, respectively. These findings reveal that the experts tended to prioritize criteria associated with strategic and managerial capabilities over those perceived as supportive factors.

Furthermore, the consistency ratio (CR = 0.0151 < 0.1) confirms that the judgments provided by the experts were highly consistent and reliable. Therefore, the comparison matrix satisfies the consistency requirement of the ANP methodology, ensuring the robustness of the subsequent weighting and network analysis.

Table 5. Pairwise comparison matrix of criteria

	C1	C2	C3	C4	C5	Priority vector
C1	1	1/2	3	4	2	0.247
C2	2	1	5	7	4	0.465
C3	1/3	1/5	1	2	1/2	0.089
C4	1/4	1/7	1/2	1	1/3	0.055
C5	1/2	1/4	2	3	1	0.144
RI=1.12; λ max= 5.0675 ; CI= 0.0169; CR= 0.0151<0.1						

The pairwise comparison matrices illustrating the interrelationships among the criteria are presented in tables 6–10. The results demonstrate that the criteria are not independent but exhibit varying levels of mutual influence within the ANP network.

As shown in table 6, criterion C2 exerted the strongest interrelationship effect under the influence of criterion C1, with a priority weight of 0.400, whereas C3, C4, and C5 had equal influence levels (0.200). This suggests that C2 is strongly connected to C1 and may serve as a central driving factor in the network structure.

Table 6. Pairwise comparison matrix of the interrelationships between criteria (C1)

C1	C1	C2	C3	C4	C5	Priority vector
C1	-	-	-	-	-	0
C2	-	1	2	2	2	0.400
C3	-	1/2	1	1	1	0.200
C4	-	1/2	1	1	1	0.200
C5	-	1/2	1	1	1	0.200
RI=0.9; λ max= 4.0000 ; CI= 0; CR= 0< 0.1						

Similarly, the results in table 7 indicate that under criterion C2, criterion C5 had the greatest influence (0.469), followed by C3 (0.280). This finding shows that improvements in C2 closely associate with the development of C5 and C3, highlighting the interconnected nature of leadership competencies.

Table 7. Pairwise comparison matrix of the interrelationships between criteria (C2)

C2	C1	C2	C3	C4	C5	Priority vector
C1	1	-	1/3	1	1/4	0.115
C2	-	-	-	-	-	0
C3	3	-	1	2	1/2	0.280
C4	1	-	1/2	1	1/3	0.136
C5	4	-	2	3	1	0.469
RI=0.9; λ max= 4.0395; CI= 0.0132; CR= 0.0146 <0.1						

The results in table 8 reveal that criteria C4 and C5 had equal and dominant influences (0.333) under criterion C3, while C1 and C2 had weaker effects (0.167). This pattern indicates that C3 is more strongly associated with operational and implementation-related dimensions represented by C4 and C5.

Table 8. Pairwise comparison matrix of the interrelationships between criteria (C3)

C3	C1	C2	C3	C4	C5	Priority vector
C1	1	1	-	1/2	1/2	0.167
C2	1	1	-	1/2	1/2	0.167
C3	-	-	-	-	-	0
C4	2	2	-	1	1	0.333
C5	2	2	-	1	1	0.333
RI=0.9; λ max= 4.0000 ; CI= 0; CR= 0 <0.1						

In table 9, criterion C3 emerged as the most influential factor (0.482) under criterion C4, suggesting that C3 plays a critical supporting role in strengthening the effectiveness of C4. Meanwhile, the relatively low weight of C5 (0.088) indicates a weaker interaction between these two criteria.

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Table 9. Pairwise comparison matrix of the interrelationships between criteria (C4)

C4	C1	C2	C3	C4	C5	Priority vector
C1	1	1/2	1/3	-	2	0.158
C2	2	1	1/2	-	3	0.272
C3	3	2	1	-	5	0.482
C4	-	-	-	-	-	0
C5	1/2	1/3	1/5	-	1	0.088
RI=0.9; λ max= 4.0177 ; CI= 0.0059 ; CR= 0.0066 <0.1						

Finally, table 10 demonstrates that criterion C2 again had the strongest impact (0.530) under criterion C5, reinforcing its dominant position of C2 within the overall network of relationships. The repeated prominence of C2 across several matrices suggests that this criterion functions as a key influencing factor in the leadership competency model.

Table 10. Pairwise comparison matrix of the interrelationships between criteria (C5)

C5	C1	C2	C3	C4	C5	Priority vector
C1	1	1/4	1/2	2	-	0.137
C2	4	1	2	7	-	0.530
C3	2	1/2	1	3	-	0.256
C4	1/2	1/7	1/3	1	-	0.077
C5	-	-	-	-	-	0
RI=0.9; λ max= 4.0092 ; CI= 0.003 ; CR= 0.0034 <0.1						

In addition, all interrelationship matrices satisfied the consistency requirement with $CR < 0.1$, confirming that the expert judgments were coherent and statistically acceptable. Therefore, the obtained results provide a reliable analytical basis for constructing the supermatrix and determining the final priority weights in the ANP model.

4.3. Results of Supermatrix, Convergence Matrix, and General Weight of Criteria

The decision was made after comparing the relative priority of the criteria. Also compare each pair of their mutual relationships. The supermatrix W has been established as table 11. This matrix accurately represents the dependency structure and feedback relationships among the criteria, which are essential for calculating the overall weight of each criterion.

Table 11. Supermatrix W

	Goal	C1	C2	C3	C4	C5
Goal	0	0	0	0	0	0
C1	0.247	0	0.115	0.167	0.158	0.137
C2	0.465	0.400	0	0.167	0.272	0.530
C3	0.089	0.200	0.280	0	0.482	0.256
C4	0.055	0.200	0.136	0.333	0	0.077
C5	0.144	0.200	0.469	0.333	0.088	0

In the supermatrix, the authors repeatedly raised the matrix to successive powers in order to achieve convergence. The convergence process was monitored by examining the stabilization of values across the matrix columns after each iteration. In this study, convergence was attained at the 15th, where the priority weights became stable and identical across columns, indicating that the influence structure among criteria had reached a steady-state condition. Consequently, W^{15} was adopted as the limit supermatrix. This procedure is consistent with the standard ANP

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methodology proposed by Saaty [45], in which the supermatrix is iteratively multiplied until long-term stable priorities are obtained. The resulting limit matrix reflects the final relative importance of the criteria and serves as the basis for determining the overall weights presented in table 12.

Table 12. Limit matrix

	0	**0**	**0**	**0**	**0**	**0**
C1	0.1245	0.1245	0.1245	0.1245	0.1245	0.1245
C2	0.2550	0.2550	0.2550	0.2550	0.2550	0.2550
C3	0.2309	0.2309	0.2309	0.2309	0.2309	0.2309
C4	0.1546	0.1546	0.1546	0.1546	0.1546	0.1546
C5	0.2350	0.2350	0.2350	0.2350	0.2350	0.2350

From the limit matrix, the author obtained the weights of the criteria in selecting leaders of higher education institutions, shown in table 13.

Table 13. General weighting of criteria in selecting leaders in higher education institutions

Category	**Criteria**	**General weight**
Professional qualifications, scientific research capacity	C1	0.1245
Ethics and integrity	C2	0.2550
Experience in management and organization	C3	0.2309
Ability to inspire colleagues and students	C4	0.1546
Ability to mobilize financial resources	C5	0.2350

The overall weight analysis results from the ANP model, presented in table 13, indicate that the criteria for selecting leaders in higher education institutions vary in importance, reflecting the expectations and practical requirements for this role within the context of Vietnamese higher education. Among the five evaluated criteria, “ethics and integrity” (C2) achieved the highest priority weight of 0.2550, indicating that moral qualities, transparency, and ethical responsibility are perceived as the most critical attributes of higher education leaders. This result suggests that, within the context of university governance, leadership effectiveness is strongly associated with the ability to maintain institutional trust, ensure fairness in decision-making, and establish a positive organizational culture. The prominence of this criterion reflects the increasing expectation that university leaders should demonstrate not only managerial competence but also exemplary ethical conduct in both academic and administrative activities.

The criterion of “ability to mobilize financial resources” (C5) ranked second with a weight of 0.2350. This finding highlights the growing importance of financial management and external resource acquisition in the context of higher education autonomy and institutional competition. University leaders increasingly need to establish partnerships, attract investment, and secure diversified funding sources to support sustainable institutional development. The relatively high weight assigned to this criterion indicates that strategic financial capability has become a central component of leadership effectiveness in modern higher education institutions.

“Experience in management and organization” (C3) was ranked third with a weight of 0.2309, demonstrating that administrative and organizational competencies remain essential requirements in leadership selection. The close weighting between C3 and C5 suggests that respondents perceived managerial experience and financial capability as complementary dimensions of effective leadership. This criterion reflects the practical demands placed on university leaders to coordinate institutional operations, manage human resources, implement strategic planning, and respond effectively to organizational challenges in increasingly complex educational environments.

The criterion of “ability to inspire colleagues and students” (C4) obtained a weight of 0.1546, indicating a moderate level of importance compared with the other criteria. Although ranked lower, this criterion still contributes substantially to leadership effectiveness, particularly in fostering motivation, academic collaboration, and institutional cohesion.

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Inspirational leadership may strengthen employee commitment and student engagement, thereby supporting the achievement of institutional goals and the development of a positive academic environment.

Finally, "professional qualifications and scientific research capacity" (C1) received the lowest weight of 0.1245. Although academic competence remains an important component in evaluating higher education leaders, the findings suggest that respondents placed greater emphasis on ethical, managerial, and strategic leadership capabilities than on individual scholarly achievements. This result may indicate a transition in leadership expectations within higher education institutions, where the role of university leaders is increasingly oriented toward governance, organizational management, and institutional sustainability rather than solely academic excellence.

Overall, the weighting structure in table 13 demonstrates that leadership selection in higher education institutions is influenced more strongly by ethical values, strategic resource management, and organizational capability than by purely academic qualifications. The findings reflect the evolving governance context of higher education, in which university leaders are expected to balance academic responsibilities with managerial efficiency, financial sustainability, and institutional development.

4.4. Results and Priority Ranking

The authors collected evaluation scores from 7 experts for 4 criteria: (C1) professional qualifications and scientific research capacity, (C2) ethics and integrity, (C3) experience in management and organization, and (C5) ability to mobilize financial resources. They also gathered evaluation opinions from 50 lecturers and 200 students regarding criterion (C4), ability to inspire colleagues and students, before calculating the average score for each candidate based on these criteria. The average score, when expressed as a decimal, is rounded to four decimal places to accurately reflect the differences in scores among candidates. The comprehensive results detailing the scores and rankings for each candidate can be found in table 14.

Table 14. Scores and rankings of candidates

	C1	C2	C3	C4	C5	Total score	Rank
wj	**0.1245**	**0.2550**	**0.2309**	**0.1546**	**0.2350**		
A1	8	7	9	8.7000	6.2857	7.6812	2
A2	7.4286	9	7	7.1000	7.8571	7.7802	1
A3	7.4286	7.7143	7.8571	7.5000	7.1429	7.5443	3

Based on the criteria weighting established through the ANP model and the assessment scores provided by experts, lecturers, and students, the research team calculated the total score for each candidate. The results indicate that candidate A2 received the highest total score of 7.7802, ranking first, followed by A1 with a score of 7.6812 and A3 with a score of 7.5443.

The difference between candidates is relatively small; however, it can be observed that A2 has an advantage in the highly weighted criteria, especially ethics, integrity, and ability to mobilize financial resources. The advantage A2 holds in these two criteria is clear, although this candidate does not excel in the other criteria. Conversely, A1 has outstanding management and technical capabilities but faces limitations in financial mobilization, which could impact its overall ranking. Candidate A3 has consistent scores across all criteria; however, they do not particularly excel in any specific area. The results indicate that the criteria with the highest weight, specifically ethics and integrity (C2), ability to mobilize financial resources (C5), and experience in management and organization (C3), play a vital role in distinguishing candidate rankings. Candidates who perform well on these criteria will have a high probability of being selected as leaders in the current context of university autonomy and high requirements for public ethics.

In addition, the results also indicated that combining assessments from multiple sources (experts, lecturers, and students) and applying the ANP method allowed for a comprehensive and objective analysis, reflecting the multidimensional nature of the leadership selection process.

5. Conclusions

5.1. Conclusions and Policy Implications

This study used the ANP method to establish a systematic and quantitative evaluation process for selecting leadership in public higher education institutions in Vietnam. The identification of five key criteria includes professional qualifications and research capacity, ethics, integrity, management experience, the ability to inspire colleagues and students, and the ability to mobilize financial resources. The results indicated that ethics and integrity were the highest weighted criteria, reflecting the fundamental role of personal qualities in the context of academic leadership. In addition, the ability to mobilize financial resources and experience in management and organization is also highly valued, showing a shift from purely academic management to a strategic and effective operational management model. Calculating the total score and ranking candidates' shows that individual differences come not only from technical competence but also depend significantly on the ability to adapt to modern management requirements and social expectations.

The study contributes both theoretically and practically by providing a transparent and scientifically grounded decision-support framework for leadership selection in higher education institutions. Furthermore, the findings support the broader applicability of multi-criteria decision-making approaches, particularly the ANP model, in personnel evaluation, recruitment, and leadership development processes within the education sector. However, we should acknowledge several methodological limitations when interpreting the findings. Although the ANP model provides a structured mechanism for synthesizing evaluations from multiple stakeholder groups, the assessment process still relies considerably on subjective judgments from experts, lecturers, and students. Individual perceptions, institutional relationships, prior experiences, and personal expectations may have influenced the scoring process, particularly for qualitative criteria such as ethics and integrity or the ability to inspire colleagues and students. In addition, the relatively small differences in total scores among candidates suggest that minor variations in evaluators' perceptions could potentially affect the final ranking outcomes.

The research findings highlight significant policy implications for public higher education institutions in Vietnam. First, universities should develop a systematic and multidimensional framework of leadership evaluation criteria, emphasizing public ethics, resource mobilization capacity, and management experience. These criteria should be standardized and quantified to improve transparency, fairness, and comparability among candidates. Second, multi-criteria decision-making approaches such as ANP should be more widely integrated into senior personnel evaluation processes because they allow interdependent relationships among criteria to be considered more comprehensively than traditional assessment methods. Third, selection boards need to diversify the composition of evaluation participants, including not only leaders and experts but also representatives of lecturers and students, who are directly related to leadership effectiveness in school operations. Combining various assessment sources will provide a more comprehensive reflection of the candidate's abilities and impact within a specific work environment. Fourth, as universities gradually transition to a comprehensive autonomy mechanism, the head's ability to mobilize and manage finances should be prioritized as a key criterion. This is especially important for public schools facing budget limitations and the necessity for sustainable development. Finally, from the perspective of state management agencies, the Ministry of Education and Training may consider developing reference frameworks or official guidelines for university leadership assessment based on scientific evidence and decision-making models such as ANP to improve governance quality across the higher education system.

5.2. Limitations

Although the study has made a significant contribution to the development of a process for evaluating university leadership candidates using the ANP method, there are still some limitations that need to be objectively recognized. The study was conducted as a case study at a public university, which limits the generalizability of the results. Each educational institution may have its characteristics in terms of size, mission, organizational structure, and operating context, leading to differences in the priority of assessment criteria. The assessment involves a relatively modest number of experts, lecturers, and students, primarily from within the school.

The limitations discussed above indicate several potential avenues for future research. One promising direction is to broaden the study to encompass a range of public universities in various geographical regions. This expansion would facilitate a comparative analysis and enable the adjustment of criteria weights, ensuring they better reflect the diverse practices found within the Vietnamese higher education system. Increase the size and diversity of the survey sample, such as with alumni, to increase objectivity and comprehensiveness in candidate assessments. Combine ANP with other decision-making analysis models such as TOPSIS, AHP, or fuzzy logic.

6. Declarations

6.1. Author Contributions

Conceptualization: P.H.H., A.T.N., and V.V.T.; Methodology: A.T.N.; Software: V.V.T.; Validation: P.H.H., A.T.N., and V.V.T.; Formal Analysis: A.T.N., and V.V.T.; Investigation: A.T.N., and V.V.T.; Resources: P.H.H.; Data Curation and Statistical: A.T.N., and V.V.T.; Writing Original Draft Preparation: P.H.H., A.T.N., and V.V.T.; Writing Review and Editing: P.H.H., A.T.N., and V.V.T.; Visualization: P.H.H.; All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The authors sincerely thank all the experts, lecturers, and students who participated in this research. The data presented in this study are available on request from the corresponding author.

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6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] N. M. Tri, P. D. Hoang, and N. T. Dung, “Impact of the industrial revolution 4.0 on higher education in Vietnam: Challenges and opportunities,” *Linguist. Cult. Rev*., vol. 5, no. S3, pp. 1–15, 2021, doi: 10.21744/lingcure.v5nS3.1350.

[2] T. M. Uoc and N. T. K. Nguyen, “Developing high quality human resources in the process of industrialization and modernization in Vietnam today,” J. Positive School Psychol., vol. 6, no. 2, pp. 772–783, 2022.

[3] S. Polishchuk and O. Horbatiuk, “The problem of quality and efficiency of educational institution management,” *J. Vasyl Stefanyk Precarpathian Nat. Univ*., vol. 10, no. 1, pp. 197–204, 2023, doi: 10.15330/jpnu.10.1.197-204.

[4] Z. A. Mohamud, M. A. Farah, L. A. Osman, M. A. Mohamed, and I. H. Mohamud, “Mapping the evolution of leadership in higher education: A bibliometric analysis,” *Cogent Educ*., vol. 12, no. 1, pp. 1–20, 2025, doi: 10.1080/2331186X.2025.2554957.

[5] B. C. Fusarelli, L. D. Fusarelli, and F. Riddick, “Planning for the future: Leadership development and succession planning in education,” *J. Res. Leadersh. Educ.*, vol. 13, no. 3, pp. 286–313, 2018, doi: 10.1177/1942775118771671.

[6] M. Nadeem, “Leadership's role in effective quality assurance implementation in higher education institutions,” *Educ. Q. Rev.*, vol. 6, no. 3, pp. 237–248, 2023, doi: 10.31014/aior.1993.06.03.778.

[7] L. L. D. Mallillin, J. M. Rapsing, L. B. Bondoc, and M. C. R. Adriano, “Influences of a leader in higher education institutions (HEIs) in leading school in times of crisis: Basis for an input to educational policy,” Int. J. Adv. Multidiscip. Res. Stud., vol. 5, no. 2, pp. 1746–1754, 2025.

[8] H. J. Kipasika, "Expression of leadership mission, vision, values, and strategic objectives in academic institution development practices," *J. Res. Innov. Implic. Educ*., vol. 8, no. 1, pp. 393–402, 2024, doi: 10.59765/nywp5295.

[9] D. Ariyani and M. Zuhaery, "Principal's innovation and entrepreneurial leadership to establish a positive learning environment," *Eur. J. Educ. Res*., vol. 10, no. 1, pp. 63–74, 2021, doi: 10.12973/eu-jer.10.1.63.

[10] J. Van Den Broek, F. Eckardt, and P. Benneworth, "The transformative role of universities in regional innovation systems: Lessons from university engagement in cross-border regions," *Handb. Univ. Reg. Dev*., vol. 2019, no. Jan., pp. 54–72, 2019, doi: 10.4337/9781784715717.00011.

[11] A. U. Brigue and V. N. Orlu, "Ethical considerations of leaders and integrity in public universities," Int. J. Inst. Leadersh. Policy Manag., vol. 5, no. 2, pp. 245–261, 2023.

[12] B. Ruben, G. Mahon, and K. Shapiro, "Academic leader selection, development, evaluation, and recognition: Four critical higher education challenges," *Int. Perspect. Leadersh. High. Educ*., vol. 15, no. Jan., pp. 115–138, 2022, doi: 10.1108/S1479-362820220000015007.

[13] T. L. Saaty, "Decision making with the analytic network process (ANP) and its super decisions software: The national missile defense (NMD) example," *ISAHP Proc*., vol. 2001, no. Jul., pp. 365–381, 2001, doi: 10.13033/isahp.y2001.028.

[14] S. M. Ordoobadi, "Application of ANP methodology in evaluation of advanced technologies," *J. Manuf. Technol. Manag*., vol. 23, no. 2, pp. 229–252, 2012, doi: 10.1108/17410381211202214.

[15] A. Nedjati and G. Izbirak, "Evaluating the intellectual capital by ANP method in a dairy company," *Procedia Soc. Behav. Sci*., vol. 107, no. Dec., pp. 136–144, 2013, doi: 10.1016/j.sbspro.2013.12.840.

[16] S. Chandra, P. K. Gautam, A. P. Singh, and M. A. A. Niazi, "Site selection for suitability of dam construction using analytic hierarchy process (AHP): A review study on Rihand Dam, Uttar Pradesh, India," *Arab. J. Geosci*., vol. 17, no. 11, pp. 1–18, 2024, doi: 10.1007/s12517-024-12097-x.

[17] A. Demir, A. E. Dinçer, and K. Yılmaz, "A novel procedure for the AHP method for the site selection of solar PV farms," *Int. J. Energy Res*., vol. 2024, no. 1, pp. 1–18, 2024, doi: 10.1155/2024/5535398.

[18] H. Veisi, R. Deihimfard, A. Shahmohammadi, and Y. Hydarzadeh, "Application of the analytic hierarchy process (AHP) in a multi-criteria selection of agricultural irrigation systems," *Agric. Water Manag*., vol. 267, no. 1, pp. 1–12, 2022, doi: 10.1016/j.agwat.2022.107619.

[19] K. T. Van, A. T. Nguyen, and V. V. Tuyen, "Prioritizing risks in production activities: A study of salt processing enterprises in the central region of Vietnam," *Int. J. Saf. Secur. Eng*., vol. 15, no. 2, pp. 275–285, 2025, doi: 10.18280/ijsse.150208.

[20] A. T. Nguyen, V. K. Tran, and V. V. Tuyen, "Applying the analytic hierarchy process to prioritize risks of the food supply chain in Vietnam," *Int. J. Anal. Hierarchy Process*, vol. 17, no. 1, pp. 1–15, 2025, doi: 10.13033/ijahp.v17i1.1199.

[21] G. Boonsothonsatit, S. Vongbunyong, N. Chonsawat, and W. Chanpuypetch, "Development of a hybrid AHP-TOPSIS decision-making framework for technology selection in hospital medication dispensing processes," *IEEE Access*, vol. 12, no. Jan., pp. 2500–2516, 2024, doi: 10.1109/ACCESS.2023.3348754.

[22] D. Abdul, J. Wenqi, A. Tanveer, and M. Sameeroddin, "Comprehensive analysis of renewable energy technologies adoption in remote areas using the integrated Delphi-fuzzy AHP-VIKOR approach," *Arab. J. Sci. Eng*., vol. 49, no. 5, pp. 7585–7610, 2024, doi: 10.1007/s13369-023-08334-2.

[23] A. T. Nguyen and V. V. Tuyen, "Combination of the SWOT analysis technique and the AHP method to prioritize the selection of business strategy at packaging manufacturing companies," *Int. J. Sustain. Dev. Plan*., vol. 20, no. 2, pp. 555–563, 2025, doi: 10.18280/ijsdp.200208.

[24] A. F. Misbahuddin, Y. S. Akil, and S. Manjang, "Prioritizing the planning for sustainable renewable energy in South Sulawesi using ANP approach," *EECCIS*, vol. 2022, no. Sep., pp. 94–99, 2022, doi: 10.1109/EECCIS54468.2022.9902956.

[25] M. Bakhshi, A. Yaghoobnezhad, and H. Nikoo Maram, "Developing a hybrid approach to credit priority based on accounting variables (using analytical network process (ANP) and multi-criteria decision-making)," *Int. J. Nonlinear Anal. Appl*., vol. 12, no. Special Issue, pp. 15–28, 2021, doi: 10.22075/ijnaa.2021.4759.

[26] F. Kaytez, "Evaluation of priority strategies for the expansion of installed wind power capacity in Turkey using a fuzzy analytic network process analysis," *Renew. Energy*, vol. 196, no. Sep., pp. 1281–1293, 2022, doi: 10.1016/j.renene.2022.07.043.

[27] A. Ergin and G. Alkan, "The selection of ocean container carrier: An analytic network process (ANP) approach," *J. ETA Marit. Sci.*, vol. 11, no. 3, pp. 159–167, 2023, doi: 10.4274/jems.2023.96977.

[28] I. F. Chen, P. Y. Kuo, R. C. Tsaur, S. Sarkar, and S. C. Huang, "Risk analysis of green supply chain using a hybrid multi-criteria decision model: Evidence from laptop manufacturer industry," *Axioms*, vol. 11, no. 12, pp. 1–25, 2022, doi: 10.3390/axioms11120668.

[29] M. Özdemir and M. Sagir, "Application of the ANP in the interview phase of air traffic controller candidate selection process," *Aircr. Eng. Aerosp. Technol.*, vol. 93, no. 10, pp. 1616–1623, 2021, doi: 10.1108/AEAT-08-2020-0166.

[30] A. Setiawan, A. Handojo, and O. Gozali, "Development of officer selection system using the method of analytic network process (ANP) at pharmacy company," *Int. J. Eng. Manuf.*, vol. 6, no. 2, pp. 1–9, 2016, doi: 10.5815/ijem.2016.02.01.

[31] O. O. Ayeni, N. M. Al Hamad, O. N. Chisom, B. Osawaru, and O. E. Adewusi, "AI in education: A review of personalized learning and educational technology," *GSC Adv. Res. Rev.*, vol. 18, no. 2, pp. 261–271, 2024, doi: 10.30574/gscarr.2024.18.2.0062.

[32] V. I. Owan, K. B. Abang, D. O. Idika, E. O. Etta, and B. A. Bassey, "Exploring the potential of artificial intelligence tools in educational measurement and assessment," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 19, no. 8, pp. 1–16, 2023, doi: 10.29333/ejmste/13428.

[33] J. Lian, T. Zhu, L. Ma, X. Wu, A. A. Heidari, Y. Chen, and G. Hui, "The educational competition optimizer," *Int. J. Syst. Sci.*, vol. 55, no. 15, pp. 3185–3222, 2024, doi: 10.1080/00207721.2024.2367079.

[34] M. R. Ohara, "The role of social media in educational communication management," *J. Contemp. Adm. Manag.*, vol. 1, no. 2, pp. 70–76, 2023, doi: 10.61100/adman.v1i2.25.

[35] P. Fithri, A. Hasan, Syafrizal, and D. Games, "Obstacle factors of research product commercialization in Andalas University," *Educ. Sci. Manag.*, vol. 2, no. 2, pp. 79–91, 2024, doi: 10.56578/esm020202.

[36] J. Dempere, K. Modugu, A. Hesham, and L. K. Ramasamy, "The impact of ChatGPT on higher education," *Front. Educ.*, vol. 8, no. Jul., pp. 1–15, 2023, doi: 10.3389/feduc.2023.1206936.

[37] M. Akour and M. Alenezi, "Higher education future in the era of digital transformation," *Educ. Sci.*, vol. 12, no. 11, pp. 1–18, 2022, doi: 10.3390/educsci12110784.

[38] B. George and O. Wooden, "Managing the strategic transformation of higher education through artificial intelligence," *Adm. Sci.*, vol. 13, no. 9, pp. 1–20, 2023, doi: 10.3390/admsci13090196.

[39] M. Nilashi, R. Zakaria, O. Ibrahim, M. Z. A. Majid, R. M. Zin, and M. Farahmand, "MCPCM: A DEMATEL-ANP-based multi-criteria decision-making approach to evaluate the critical success factors in construction projects," *Arab. J. Sci. Eng.*, vol. 40, no. 2, pp. 343–361, 2015, doi: 10.1007/s13369-014-1529-1.

[40] M. H. Fahamsyah, Y. Soejarminto, H. A. Yaqin, and A. S. Rakhmat, "Analytic network process (ANP) method: Factor analysis of the non-implementation of municipal Islamic bonds in Sukuk potential areas in Indonesia," *East Asian J. Multidiscip. Res.*, vol. 2, no. 8, pp. 3305–3322, 2023, doi: 10.55927/eajmr.v2i8.5409.

[41] E. S. Hastuti and B. Santoso, "Metode analytic network process (ANP) untuk menganalisis faktor belum diterapkannya municipal Islamic bonds pada daerah berpotensi sukuk di Indonesia," *J. Ekon. dan Bisnis,* vol. 19, no. 1, pp. 1–15, 2018, doi: 10.30659/ekobis.19.1.1-15.

[42] T. L. Saaty, "Relative measurement and its generalization in decision making: Why pairwise comparisons are central in mathematics for the measurement of intangible factors—the analytic hierarchy/network process," *RACSAM Rev. R. Acad. Cienc. Exactas Fís. Nat.*, vol. 102, no. 2, pp. 251–318, 2008, doi: 10.1007/BF03191825.

[43] J. Xu, L. Li, and M. Ren, "A hybrid ANP method for evaluation of government data sustainability," *Sustainability*, vol. 14, no. 2, pp. 1–18, 2022, doi: 10.3390/su14020884.

[44] H. Taherdoost and M. Madanchian, "Analytic network process (ANP) method: A comprehensive review of applications, advantages, and limitations," *J. Data Sci. Intell. Syst.*, vol. 1, no. 1, pp. 12–18, 2023, doi: 10.47852/bonviewJDSIS3202885.

[45] T. L. Saaty, "Fundamentals of the analytic network process—Dependence and feedback in decision-making with a single network," *J. Syst. Sci. Syst. Eng.*, vol. 13, no. 2, pp. 129–157, 2004, doi: 10.1007/s11518-006-0158-y.

[46] W. Shen, Y. Huang, and W. Fan, "Morality and ability: Institutional leaders' perceptions of ideal leadership in Chinese research universities," *Stud. High. Educ*., vol. 45, no. 10, pp. 2092–2100, 2020, doi: 10.1080/03075079.2020.1823645.

[47] R. M. Taheri, D. A. H. Mohammad, and E. Kavousi, "Designing a suitable leadership model to achieve new missions of higher education," *Iran. J. Educ. Sociol.*, vol. 4, no. 1, pp. 186–195, 2021, doi: 10.52547/ijes.4.1.186.

[48] R. Rybnicek, K. H. Leitner, L. Baumgartner, and J. Plakolm, "Industry and leadership experiences of the heads of departments and their impact on the performance of public universities," *Manage. Decis.*, vol. 57, no. 12, pp. 3321–3345, 2019, doi: 10.1108/MD-10-2018-1173.

[49] E. W. Wanyama, "Strategic leadership for effective resource mobilization: A case of public universities in Kenya," Glob. Dyn. Afr., vol. 2021, no. Jan., pp. 313–322, 2021.

[50] T. L. Saaty, "Decision making with the analytic hierarchy process," *Int. J. Serv. Sci*., vol. 1, no. 1, pp. 83–98, 2008, doi: 10.1504/IJSSCI.2008.017590.

[51] S. L. Dworkin, "Sample size policy for qualitative studies using in-depth interviews," *Arch. Sex. Beha*v., vol. 41, no. 6, pp. 1319–1320, 2012, doi: 10.1007/s10508-012-0016-6.