The efficacy of the strategy planning process criteria based on the fuzzy analytical hierarchy process

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The Efficacy of the Strategy Planning Process Criteria based on the Fuzzy Analytical Hierarchy Process

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ABSTRACT

This study investigated the strategic planning procedure used by the University of Jeddah to determine which of its efficacy criteria are the most significant for future development. A university's performance is founded on its ability to capitalize on its specialization and set of skills obtained through meticulous planning and development and involves setting goals using analysis tools to compare options and prioritize constructs. Evaluation approaches to strategic planning lack adaptability and durability. Thus, a high-level deductive instrument that aggregates trade-offs and prioritizes the most essential aspects is needed. This study used the Fuzzy Analytical Hierarchical Procedure (FAHP) to examine whether the University of Jeddah's strategy formulation process improves strategy and planning. This study defined the objectives and criteria, established pairwise comparisons based on the owners of the strategic plan and the faculty and administration questionnaire responses, assigned weights to each criterion, verified their consistency, and ranked them in importance order. This study showed that FAHP can help groups make strategic planning decisions in universities.

Keywords-Fuzzy Analytical Hierarchy Process (FAHP); MCDM; university ranking; decision making; planning

I. INTRODUCTION

Universities want always to maximize the utilization of their specialties and competencies [1]. Multi-Criteria Decision-Making (MCDM) is crucial in achieving a long-term competitive edge in staff selection [2]. The Fuzzy Analytical Hierarchy Process (FAHP) provides a more accurate definition of this type of process than the old AHP [3]. FAHP is widely used in education for evaluation [4-9]. Organizational decision-making and problem-solving can benefit from consensus-based strategic planning. Like any approach, although it presents some challenges and restrictions on the time and effort required to solicit opinions from a wide range of interested parties, it can organize productive dialogue and ultimately establish consensus. Competing ideas and interests at play can slow down the decision-making and execution processes, as they can make it difficult to accommodate and reconcile divergent opinions when members' interests are at odds or when there is an imbalance of power. This can result in judgments that aren't as strong as they could be and that don't adequately address the requirements and goals of all parties. The five strategic objectives of the University of Jeddah are to improve the work and study conditions, provide an integrated learning journey based on excellence in teaching and research, empower distinctive individuals, improve the quality of its services and outputs, and confirm its leadership in many areas [10]. Measuring the effectiveness of the techniques used to help people make decisions is crucial [11], as it could allow the development of a structured model designed to assist decision-makers and selected specialists in dealing with complex problems, achieving consensus, and making the best decisions possible [12]. A hierarchical organization of the components of the problem is needed to analyze them objectively [13-14]. FAHP is a modern analytical approach that employs a fuzzy number triangle to evaluate the values of criteria, making it an excellent method in MCDM that provides clear answers in paired matrices. FAHP has been used in a variety of decision-making contexts due to its ability to classify the relative relevance of criteria that must be evaluated in stages [15-16]. Pairwise comparison scales are based on Triangular Fuzzy Numbers (TFN) [17-18], and FAHP consists of a set of three values, such as a1, a2, and a3, representing the smallest, the most promising, and the greatest values, respectively [16].

This study aimed to evaluate the effectiveness of the strategic planning process of the University of Jeddah by using FAHP to identify key factors that influence its effectiveness and help it to achieve its strategic goals. As a result, this study aimed to investigate the factors influencing the effectiveness of the University of Jeddah's strategic planning process, identify efficient tools for evaluating important criteria, and determine the most effective criteria. The FAHP was used to assign numerical values to the twelve e-learning roadblocks and establish an order of dominance [19]. The main contributions of this study are:

- To set a research goal to evaluate the efficiency of laboratory construction in higher education institutions and use its characteristics and FAHP to create a system and model to do so.
- To describe the key success factors of the criteria of the strategic planning process based on a fuzzy analytical hierarchy, considering the success of previous studies that used similar approaches [20]. Many previous studies also followed this footprint to establish their findings [21-32]. A cause-and-effect diagram was used to identify and organize the causes and sub-causes of poor performance in a hospital and create a hierarchy using information obtained from experts, staff, and patients in [34]. The FAHP method, which employs human cognition and judgment power based on knowledge and experience, was applied and used for decision-making to prioritize the major and sub-causes as potential improvement project topics. Due to limited resources, the priorities corresponding to each major cause and sub-cause can be used to decide on the improvement of projects and their order.

II. METHODOLOGY

A. Defining Criteria and Objectives

The primary focus of this study was the application of a methodology that takes into account more than one criteria. This would make it much simpler to determine which of the significant effectiveness criteria have the greatest influence on achieving the University of Jeddah's process of making important decisions according to its strategic planning. The criteria used were the main criteria and the subcriteria determined by the Department of Strategic Planning and Realization of the Kingdom's Vision 2030 which are accessible through the website of the University of Jeddah.

B. Selection of Experts and their Opinions

This study conducted a survey using a questionnaire to obtain the feedback of faculty members, administrators, and officials of the University of Jeddah's strategic plan to carry out pairwise comparisons, finding out which aspects of the criteria and subcriteria are more important and how they differ from one another. The survey questionnaire was constructed using straight weights, such as Agree, Strongly Agree, Neutral, Disagree, and Strongly Disagree, and there were a total of 61 responses.

C. Triangular Fuzzy Numbers

The opinions are presented as TFN to represent uncertainty or ambiguity [6], as it is more effective to describe. TFN comes in the format $A\sim=(l, m, u)$ and is defined as low, medium, and high, as shown in (1) [32]. Table I shows the linguistic scale and the corresponding crisp value (1-9) for the fuzzy triangular scale.

$$U_\tau(x) = \begin{cases} \frac{x-1}{m-1}, & 1 \le x \le m \\ \frac{u-x}{u-m}, & m \le x \le u \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

TABLE I. LINGUISTIC TERMS AND THE CORRESPONDING TRIANGULAR FUZZY NUMBERS

Scale	Definition	TFN
1	Equally important (Eq. Imp.)	(1,1,1)
3	Weakly important (W. Imp.)	(2,3,4)
5	Fairly important (F. Imp.)	(4,5,6)
7	Strongly important (S. Imp.)	(6,7,8)
9	Absolutely important (A. Imp.)	(9,9,9)
2	The intermittent values between two adjacent scales	(1,2,3)
4		(3,4,5)
6		(5,6,7)
8		(7,8,9)

D. Pairwise Comparison Matrix with Triangular Fuzzy Elements

Equation (2) shows the fuzzy pairwise comparison matrix, related to the data obtained using the FAHP linguistic variable scale given in Table II.

$$\tilde{A} = \left(\tilde{a}_{ij}\right)_{n\times n} = \begin{bmatrix} (1,1,1) & (l_{12},m_{12},u_{12})\cdots & (l_{1n},m_{1n},u_{1n}) \\ (l_{21},m_{21},u_{21}) & (1,1,1) \quad \cdots & (l_{2n},m_{2n},u_{2n}) \\ \vdots & \vdots & \vdots \\ (l_{n1},m_{n1},u_{n1}) & (l_{n2},m_{n2},u_{n2}) & (1,1,1) \end{bmatrix} \quad (2)$$

where:

$$\left(\tilde{a}_{ij}\right) = \left(l_{ij},m_{ij},u_{ij}\right) = \left(\tilde{a}_{ij}\right)^{-1} = \left(\frac{1}{u_{ji}},\frac{1}{m_{ji}},\frac{1}{l_{ji}}\right), i,j = 1,\cdots n; \neq j$$

TABLE II. PAIRWISE COMPARISON MATRIX FOR DECISION-MAKING CRITERIA

Criteria	C.1	C.2	C.3	C.4	C.5	C.6	C.7
C.1	1,1,1	1,1,1	1,2,3	1,1,1	1,2,3	1,1,1	1,2,3
C.2	1,1,1	1,1,1	1/3,1/2,1/1	1,1,1	1,1,1	1,1,1	1,1,1
C.3	1/3,1/2,1/1	1,2,3	1,1,1	1,1,1	1,2,3	1,1,1	1,2,3
C.4	1,1,1	1,1,1	1,1,1	1,1,1	1,1,1	1,1,1	1,1,1
C.5	1/3,1/2,1/1	1,1,1	1/3,1/2,1/1	1,1,1	1,1,1	1,1,1	1,1,1
C.6	1,1,1	1,1,1	1,1,1	1,1,1	1,1,1	1,1,1	1,1,1
C.7	1/3,1/2,1/1	1,1,1	1/3,1/2,1/1	1,1,1	1,1,1	1,1,1	1,1,1

E. Defuzzification of the Obtained Matrices

The defuzzification of all matrix elements was performed to facilitate the determination of the consistency ratio for each pairwise comparison using [33]:

$$P_{crisp} = \frac{(4m+l+u)}{6} \quad (3)$$

Table III shows the de-fuzzification of the matrix's elements.

TABLE III. DE-FUZZIFIED MATRIX DECISION-MAKING CRITERIA

Criteria	C.1	C.2	C.3	C.4	C.5	C.6	C.7
C.1	1	1	2	1	2	1	2
C.2	1	1	0.5	1	1	1	1
C.3	0.5	2	1	1	2	1	2
C.4	1	1	1	1	1	1	1
C.5	0.5	1	0.5	1	1	1	1
C.6	1	1	1	1	1	1	1
C.7	0.5	1	0.5	1	1	1	1

F. Checking the Consistency Ratio (CR)

After estimating the importance of the criteria, the Consistency Ratio (*CR*) of the obtained matrix was checked using:

$$CI = \frac{(\lambda_{max}-n)}{(n-1)} \quad (4)$$

$$CR = \frac{CI}{RI} \quad (5)$$

where λ_{max} is the maximum eigenvalue, *N* is the number of criteria, and *RI* is the average random index. A *CR* of 0.1 (10%) was set to judge the stability of the opinions in the matrix. The lower the *CR* is than 0.1 shows more stability and noncontradiction, but when it crosses 0.1, the opinions should be rejected and returned to the questionnaire stage.

TABLE IV. RATIO INDEX

N	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1-12	1.24	1.32	1.41	1.45

III. RESULTS AND DISCUSSION

This study presented a significant criterion that was taken into account during the strategic planning process at the University of Jeddah. The seven primary criteria that should be included in the strategic plan for the University of Jeddah were determined, as well as their dimensions (sub-criteria), and the FAHP was used to determine the order in which the criteria should be ranked. Table V provides a summary of the weights of the criteria derived from pairwise comparisons and the rankings for the subcriteria that were considered. To calculate the general weight, for example, C1=0.167×0.185, where 0.185 represents the weight of the main criteria and 0.167 is the local weight of the sub-criterion, the general weights of all listed criteria were determined and the results showed that C 1.1 was classified as the most important factor that affects the performance of the university's strategic planning process. Table VI shows a list of the criteria in priority order.

This study established the objectives and criteria necessary to carry out the FAHP study, which is an effective method in MCDM because it gives clear results in pairwise matrices. FAHP uses TFN to evaluate the criteria values and make pairwise comparisons based on the questionnaire responses from the strategic plan's owners and the University of Jeddah faculty and administration. It is vital to define and assign weights to each criterion before determining whether or not they are consistent and placing them in the order of significance. Based on these findings, FAHP may prove to be an advantageous tool for the strategic planning needs of student organizations.

TABLE V. DETERMINED GLOBAL RANKS OF THE CRITERIA.

Main criteria	Weight	Ranking	Subcriteria	Local weight of subcriteria	Local rank	Global weight of criteria	Global rank
C 1	0.185	1	C 1.1	0.167	1	0.0308	1
			C 1.2	0.104	7	0.0192	26
			C 1.3	0.138	5	0.0256	8
			C 1.4	0.167	2	0.0308	2
			C 1.5	0.141	4	0.0260	6
			C 1.6	0.132	6	0.0244	13
			C 1.7	0.151	3	0.0279	3
C 2	0.128	5	C 2.1	0.142	3	0.0181	29
			C 2.2	0.142	4	0.0181	30
			C 2.3	0.156	1	0.0199	18
			C 2.4	0.142	5	0.0181	31
			C 2.5	0.144	2	0.0184	28
			C 2.6	0.131	7	0.0167	41
			C 2.7	0.142	6	0.0181	32
C 3	0.174	2	C 3.1	0.142	3	0.0247	9
			C 3.2	0.142	4	0.0247	10
			C 3.3	0.155	1	0.0269	4
			C 3.4	0.142	5	0.0247	11
			C 3.5	0.121	7	0.0210	15
			C 3.6	0.155	2	0.0269	5
			C 3.7	0.142	6	0.0247	12
C 4	0.138	3	C 4.1	0.142	3	0.0195	19
			C 4.2	0.155	1	0.0213	16
			C 4.3	0.142	4	0.0195	20
			C 4.4	0.121	7	0.0166	45
			C 4.5	0.155	2	0.0213	17
			C 4.6	0.142	5	0.0195	21
			C 4.7	0.142	6	0.0195	22
C 5	0.119	6	C 5.1	0.13	5	0.0154	47
			C 5.2	0.141	2	0.0167	42
			C 5.3	0.141	3	0.0167	43
			C 5.4	0.187	1	0.0222	14
			C 5.5	0.13	6	0.0154	48
			C 5.6	0.13	7	0.0154	49
			C 5.7	0.141	4	0.0167	44
C 6	0.138	4	C 6.1	0.187	1	0.0258	7
			C 6.2	0.13	5	0.0179	33
			C 6.3	0.141	2	0.0194	23
			C 6.4	0.13	6	0.0179	34
			C 6.5	0.13	7	0.0179	35
			C 6.6	0.141	3	0.0194	24
			C 6.7	0.141	4	0.0194	25
C 7	0.119	7	C 7.1	0.131	3	0.0155	46
			C 7.2	0.143	2	0.0170	36
			C 7.3	0.143	2	0.0170	37
			C 7.4	0.143	2	0.0170	38
			C 7.5	0.143	2	0.0170	39
			C 7.6	0.143	2	0.0170	40
			C 7.7	0.156	1	0.0185	27

The implications of this study depend on the analysis of the criteria. The "Local weight of Sub-Criteria" and the "Global weight of Criteria" both investigate the actual circumstances. The weights indicate that the most important decision criterion is "Providing qualitative programs to keep ahead of local, regional, and worldwide developments", indicating the improvement of people's lives through the provision of college programs that have been verified for their quality level and meet the requirements of the labor market. It is also essential to establish a unique learning and research environment to maintain and improve the number of academics and scientists, although local gatherings, beneficial friendships, and common objectives and views are also components of essential concerns. Despite this, high-tech decision-support tools related to the rules of good governance are essential for a productive academic culture, in addition to encouraging the growth of new firms, young people, and creative endeavors.

The predictions of strategic planning using FAHP are subjected to several biases, assumptions, limits, and problems. One of the most crucial is that the power of the study could be compromised due to insufficient sample size or lack of representation. A not representative sampling of the population being studied may introduce bias and lack of generalizability, as the criteria and options considered may potentially be subject to bias. FAHP is founded on the availability and quality

of data. Erroneous judgments and forecasts may be made based on incomplete, out-of-date, or unreliable data. Acquiring accurate and thorough data is a time-consuming and arduous process, and it can be difficult or controversial to put FAHP estimates and strategic objectives into action. Adoption of strategies could be hampered by the reluctance to change. Strategic planning may need to be adjusted as a result of stakeholders' openness to change, resource constraints, administrative hurdles, or unanticipated events. Strategic planning that incorporates a comprehensive FAHP analysis requires a substantial investment of resources and expertise, and the depth of the analysis can be constrained by available resources. It is essential to communicate limitations, as researchers can more realistically evaluate results and suggestions if they are aware of and take into account any biases, assumptions, and constraints. This study also pinpoints areas for further study and improvement within the strategic framework of the University of Jeddah and other higher education institutions.

TABLE VI. LIST OF CRITERIA IN PRIORITY ORDER

Code	Criteria	Rank
C 1.1	Providing qualitative programs to keep abreast of local, regional, and global updates	1
C 1.4	Supporting job opportunities for university graduates by making fruitful partnerships with relevant authorities	2
C 1.7	Activating field training and experiential learning activities in the work environment	3
C 3.3	Enabling the students to train on practice community activities related to national issues	4
C 3.6	Establishing training centers to provide advanced programs and courses for all segments of society	5
C 1.5	Adopting and nurturing talented and outstanding people through specialized quality programs and services	6
C 6.1	Develop programs to attract talented people and create the appropriate environment to develop their skills	7
C 1.3	Continuous evaluation to measure the level of development of university program outputs	8
C 3.1	Building diverse cooperation and partnership relationships with community institutions and business organizations	9
C 3.2	Providing society with its needs with the qualified human resources commensurate with the future development of the professions	10
C 3.4	Linking the university with productive institutions in a reciprocal social and developmental relationship	11
C 3.7	Exchanging the dissemination of the fruitful participatory culture between the university and the community	12
C 1.6	Designing specialized programs to qualify students with special needs	13
C 5.4	Achieving credibility, transparency, and commitment to defined policies and stated promises	14
C 3.5	Employing the university's possibilities for community development and parallel activities	15
C 4.2	Upgrade the level of information security in the university's electronic work system	16
C 4.5	Use of data and information effectively to predict crises and solve problems	17
C 2.3	Directing scientific research and graduate programs toward areas that serve national issues	18
C 4.1	Develop data and information management systems to serve workflow in all fields	19
C 4.3	Establishing Information centers that contribute to decision-making and performing tasks effectively	20
C 4.6	Provide programs and modern technologies that help in the provision and development of academic programs	21
C 4.7	Integrating electronic services for all sectors of the university in all fields	22
C 6.3	Sponsoring business incubators for small projects to motivate individuals and community development	23
C 6.6	Building strategic partnerships that support innovation and creativity and provide pioneering programs for entrepreneurship	24
C 6.7	Developing talents and creating creativity by creating an environment that incubates ideas and innovations	25
C 1.2	Develop faculty members, curricula, and educational methods according to international standards	26
C 7.7	Increasing financial returns and university revenues by providing opportunities to enroll in its paid academic programs	27
C 2.5	Attracting researchers and scientists to produce and invest in advanced knowledge	28
C 2.1	Supporting and motivating distinguished scientific research and regional and international publication	29
C 2.2	Encouraging the formation of scientific teams and specialized research groups	30
C 2.4	Establishing scientific and medical research centers that contribute to sustainable local development	31
C 2.7	Employing the results of applied research in the flourishing of the Knowledge Economy	32
C 6.2	Developing the capabilities of faculty members to discover the talents and abilities of students and ways to enhance them	33
C 6.4	Supporting the creative abilities and skills of university employees according to international standards	34
C 6.5	Providing an environment that enhances creativity and innovation in the technical industries and entrepreneurship	35
C 7.2	Supporting projects and initiatives that contribute to the development of the university's resources	36
C 7.3	legalization of public spending and reducing wastage to achieve fiscal balance	37
C 7.4	Sustainability of university services by conducting periodic maintenance on its properties and facilities	38
C 7.5	Involving the private sector in investing in the various sectors of the university	39
C 7.6	Diversifying sources of self-financing by establishing scientific and medical endowments	40
C 2.6	Increasing investment in the field of scientific research by establishing effective partnerships with the government and private sectors	41
C 5.2	Determining academic, administrative, and financial priorities and references according to regulations that ensure no conflict of interest	42
C 5.3	Improving the degree of satisfaction of the beneficiaries of the university services; Finding solutions to obstacles and procedural problems	43
C 5.7	Establishing effective oversight mechanisms for the university sectors to promote a culture of accountability and accounting	44
C 4.4	Improving data and information analysis systems to invest in opportunities and interact with challenges	45
C 7.1	Initialization appropriate opportunities for investment in the university's facilities and services	46
C 5.1	Restructuring of administrative systems and processes to raise the productivity of academic, administrative, and financial performance	47
C 5.5	Evaluate the performance of various practices according to global performance indicators updated periodically	48
C 5.6	Distributing the university's available resources to different sectors and activities according to specific criteria	49

Strategic planning by FAHP has its flaws, assumptions, restrictions, and problems. An essential problem is the small size and lack of representation of the sample. The capacity to generalize and avoid bias toward particular concepts or groups may be compromised by the lack of suitable size or representational sampling, as there is a potential for bias in the evaluation of criteria and options. FAHP relies on access to high-quality data. Conclusions and predictions based on inaccurate, out-of-date, or otherwise unreliable information should be treated with caution. It takes a lot of time and effort to collect reliable information that is useful for strategic planning. Furthermore, putting FAHP projections and long-term plans into action could prove difficult or divisive. Adoption of a new strategy may be slowed by resistance to change. The adaptability of stakeholders, the scarcity of available resources, bureaucratic roadblocks, and unanticipated events are all factors that could affect strategic planning. A lack of resources could prevent an in-depth investigation. Limits should be communicated. Researchers can realistically assess the results and proposals of the study after being aware of these limitations, biases, and assumptions. Opportunities for further study and improvement are also highlighted, all within the context of the institution's strategic plan.

In conclusion, it is essential to diversify programs, endowments, and educational offerings to ensure the continued viability of the program over the long run. It is also very crucial to have a high-quality updating program that promotes scientific research and publication both regionally and globally, to develop a variety of community and business connections, in addition to adding value to the workflow.

IV. CONCLUSION

This study used the FAHP method as a multicriteria tool for decision-making, given its ability to enable a systematic examination of trade-offs. As a result, it was able to identify the effective critical criteria that influence the performance of the university's strategic planning process, which is essential to its success. The study was applied to the University of Jeddah by establishing a pairwise comparison matrix based on the opinions of the faculty and administration members responsible for the strategic plan, to define goals and criteria, determine the weights of the criteria, check the consistency ratio, and arrange the criteria according to their priority. The University of Jeddah believes that FAHP is beneficial in facilitating the difficult choices that are necessary for the formulation of strategic initiatives.

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