Annals of Optimization With Applications

www.anowa.reapress.com

Ann. Optim. Appl. Vol. 1, No. 2 (2025) 93–102.

Paper Type: Original Article

Evaluation of Performance Using Balanced Scorecard (BSC) and Fuzzy Analysis Network Process (FANP) (Case Study: Scientific & Applied Universities of Qazvin Province)

Afra Fatemi*

Department of Industries, Engineering Management, Islamic Azad University, Science and Research Branch, Tehran, Iran; E.

Citation:

Received: 23 July 2024 *Revised: 15 September 2024* *Accepted: 24 November 2024*	Fatemi, A. (2025). Evaluation of performance using balanced scorecard (BSC) and fuzzy analysis network process (FANP) (Case study: Scientific & applied universities of Qazvin province). *Annals of optimization with applications, 1*(2), 93-102.

Abstract

The present study aimed to evaluate performance with the Balanced Scorecard (BSC) and Fuzzy Analysis Network Process (FANP). For this purpose, a researcher-made questionnaire was compiled that comprised four BSC aspects along with their sub-criteria. The experts verified the validity of this questionnaire. Also, the reliability of the current questionnaire was 0.89, which indicates that its reliability is appropriate. The statistical populations of this research are all 91 managers and deputies of scientific and Applied Universities of Qazvin province. Firstly, by experts, a prospect was developed for the universities and was determined suitable strategies for its realization. In the following, each of the criteria to be considered for the implementation of strategy has been identified. The questionnaire was distributed among the target population. Data analysis showed that profitability indicators with a weight of 0.096, customer discovery with a weight of 0.097, use of technology with a weight of 0.094, and innovation with a weight of 0.091 had the most significant impact on the performance of universities. Finally, it was determined that the overall performance of universities is 0.72.8, which indicates their average performance.

Keywords: Performance, Balanced scorecard, Fuzzy analysis network process.

1 | Introduction

Globalization and the development of knowledge-based economies have brought about significant changes in the structure and tasks of education throughout the world. The value of nations depends more on material

Corresponding Author:

resources than on humans, management, and governments. Education improves the scientific infrastructure of nations and, therefore, plays an essential role in their future. The main problem in educational institutions is the lack of a system for accurate performance evaluation and the lack of crucial criteria for identifying the current status of the organization, as many of these institutions focus on unnecessary cases, such as increased welfare facilities. In contrast, issues such as the reputation and volume of academic papers of Professors and students, or increased domestic customer satisfaction, are factors in growing revenues; the lack of standard criteria has created such problems for educational institutions and universities.

Scientific & Applied & University with the aim of increasing the skill level of employees in different sectors of the economy and increasing the professional skills of graduates in the training center who lack executive experience by establishing and organizing the facilities, material resources, and human resources of the executive agencies, in relation to the holding of courses Science-Applied in Associate and Bachelor Degree degrees. Since the Balanced Scorecard (BSC) is an organizational framework for implementing and managing strategy and gaining competitive advantage, and because one of the tasks of strategic management is assessment and control, the BSC is used to measure the performance of development projects with a strategic approach. Using BSC aspects can assess the effectiveness factors and non-performing factors that are not shown in economic efficiency for performance evaluation.

Also, with respect to the fuzzy network analysis, after the creation of a hierarchical structure, fuzzy scales are used to show the relative importance of the factors corresponding to the criteria. Therefore, its implementation in science-applied and technology universities makes it possible for managers and staff to agree on the relative importance of strategic objectives and operations based on it. Hence, it is considered that using the BSC as a credible approach to all functional aspects of the organization, along with a Fuzzy Analysis Network Process (FANP), in order to prioritize the identified aspects to use for evaluating performance efficiently and valid in an educational structure (Scientific and applied universities of Qazvin province).

2|Literature Review

2.1|Definition and Concept of Performance Evaluation

Performance is the meaning of the mode or function quality. Therefore, organizational performance is a general concept that refers to how an organization performs. Neely presents the most famous definition of performance [1]: "The process of explaining the quality of the effectiveness and effectiveness of past actions." According to this definition, performance is divided into two components: 1) a function that describes how the organization uses resources in the production of services or products, that is, the relationship between the actual and desired combination of inputs for the production, and 2) the effectiveness that is a descriptor for the degree of achieving to organizational goals. Performance evaluation refers to a set of actions and information that is used to increase the optimal level of use of resources and facilities to achieve goals and economic methods with effectiveness and efficiency.

So, performance evaluation in the "organizational dimension" is usually the effectiveness of the activities. The purpose of the plans is to measure the effectiveness of the activities and operations. Regarding the process of performance evaluation, it can also be said that any process involves a set of activities and actions with a specific and rational arrangement of sequences. In the process of performance evaluation, each model and the model that is selected, in the process of observing the order and sequence of the following activities is necessary:

I. Formulating indicators and dimensions and related axes and determining their measurement unit.

II. Determine the weight of the indicators according to their importance and the ceiling of the respective points.

III. Standardization and determining the desired status of each indicator.

IV. Measurement by comparing the actual performance at the end of the assessment period with a predetermined preferred standard.

V. Extract indicators.

Criteria specify the direction of an organization's movement to achieve goals. The first look at the development of indicators will focus on the vision, mission, objectives, long-term, short-term strategies, and operational plans, and focus on the main activities. Source and adaptation sources for developing criteria of performance appraisal of government agencies, laws and decrees of parliament and government, economic, social, and cultural development plans, as well as the 20-year perspective of the country, and the country's industrial development strategy. In the privacy sector, the statutes, operational plans, market share, and any goals that the organization desires are documented. For each criterion, the actual performance is determined using the sum of existing realities and compared with the standard of performance of the desired comparison with the status of the realization of its goals, and, finally, the necessary analysis and, if required, corrective measures to improve performance in it. One point in performance outcomes, usually the approach and view of the ruling in the performance evaluation, is of particular interest.

2.2 | Balanced Scorecard

The most well-known framework for measuring performance is BSC, presented by Kaplan and Norton in 2009 [2]. The strengths of this framework, along with its proper presentation by the authors, as well as organizations need to integrate a comprehensive system that, in addition to taking all aspects of the organization, aligned with their goals and strategies, has made this framework public, As US research firm "Gartre" predicted at the end of 2000, more than 40% of organizations would use BSC to measure their performance. The BSC has four aspects.

2.2.1 | Financial aspect

According to Kaplan and Norton [2], the perceived improvement in the lower levels of the organization is due to implementation strategies based on financial criteria. From the point of view of critics about financial criteria, financial performance is the result of executive activities, and financial success is a logical consequence of the organization's good performance; therefore, the management of organizations with financial criteria must be stopped. However, this claim that financial criteria are unnecessary is rejected for two reasons. Firstly, a well-designed financial control system will be an excellent help for comprehensive quality management plans. Secondly, the boundary between improving performance and financial success is very subtle and, in some cases, is obscure [2].

2.2.2 | Customer aspect

In the Customer aspect, managers first set out the customer and market segments they want to compete with; segments include current and potential customers and markets. This aspect of the scorecard consists of several general criteria and a series of sub-criteria. The main criteria are customer satisfaction, customer retention, new customer attraction, customer profitability, and market share in both market and customer segments. Another set of criteria for this measure is to measure the factors that create value for the customer and thus determine the status of the key indicators [3].

2.2.3 | Learning and growth aspect

The organization's ability to innovate, improve, and learn is directly related to the value of the organization. That is, only having the ability to offer new products, create more value for customers, and improve continuously and efficiently can be introduced into new markets and increase earnings and margins; it is noteworthy that some organizations have to measure products, and Innovative processes set specific goals for their processes [3].

2.2.4 | Internal processes aspect

Customer-related criteria are essential, but those processes, activities, and decisions that lead to an appropriate output for the customer and, consequently, customer satisfaction should be addressed by the managers. The internal criteria of the BSC should be for processes such as time, Product delivery, quality of staff skills, and productivity, emphasizing the most impact on customer satisfaction. Organizations must also strive to identify and measure the main merits and the technologies that guarantee they are most likely to take advantage of in the market. Then, they must decide which of these competencies and processes should be emphasized and identify the criteria for each one [2].

2.3 | Research Background

Regarding the use of two BSC approaches and a fuzzy network analysis process, various studies have been carried out. Heydari et al. [4], in a paper titled "Performance Evaluation of Universities Using a BSC Model," an appropriate financial structure could help the organization's vision and mission. It also improves university operations and provides better educational facilities. Firouzi [5], in a paper titled Performance Evaluation of Bank Branches of the Bank of the Economy, based on the BSC and ANP approach, from the viewpoint of managers and experts of the Mehr Bank of the Economy of Sistan and Baluchestan Province, the financial dimension with the coefficient of 0.52 is the most important criterion for assessing the performance of bank branches. Then, customer dimensions, growth, and learning and process are respectively 0.34, 0.10, and 0.05., in a paper titled ecommerce performance assessment, BSC integration, and fuzzy network analysis, based on prioritization, the internal processes are internal to the top priority. Customer aspects, growth and learning, and finance are in the next order, respectively.

Salehi et al. [6], in a study titled identifying and prioritizing organizational performance evaluation indices with the ANP fuzzy BSC Integrated Approach, it was found that the highest overall weight in terms of internal business processes with a weight of 0.29 and later customer aspect with weight 0.28 and Afterwards, it has financial aspect with weight 0.25 and, lastly, learning and growth aspect with weight 0.18. Anvari et al. [7], in a paper entitled functional evaluation using FANP and BSC, the results indicate that financial criteria are the most important criteria in the company. Minglong's research [8] presented a combination of the network analysis process and the BSC approach, in which twenty-two criteria were considered for the assessment of the University of Science and Technology in Taiwan. The results of the research show that students' learning of the most influential and annual income growth was identified as the most effective criterion.

Sue et al. [9] presented a concept of a BSC-based scorecard used to measure the sustainable performance of semiconductor companies by employing a fuzzy Delphi technique and a network analysis process. The results of the research indicate that the model is useful for increasing organizations' competitiveness in relation to sustainable operations. Yüksel et al. [10] used a combination of the BSC approach and fuzzy network analysis as a case study in manufacturing factories to evaluate their different strategies. By creating a hierarchy of vision, strategies, BSC, and criteria of each aspect, they set the weights at each level, broken down by criteria, BSC aspects, and strategies.

3 | Methodology

The present research is applied in terms of purpose, as it seeks to achieve a practical goal, and in terms of problem-solving method, and data collection is descriptive and survey. The statistical population of the research is all managers and deputies of scientific and practical universities of Qazvin province, which include the Scientific and Applied University, Mahram, Oloum & Fonoun, Jihad-e-Danesh, Pars, Ghazali, Bonyad Shahid, Kaspin Niroo Moharrekeh, Labor House, Qazvin Municipality, Suhrawardi Farhng, and Jonnar & the Red Crescent Education Center. The Qazvin Comprehensive Scientific-Applied University is one of the universities affiliated with the Ministry of Science, Research, and Technology. It aims to promote the skills of the various economic sectors and increase the professional skills of graduates of the training center who lack experience in the implementation and organization of facilities, material resources, and resources of executive

agencies in conducting scientific and applied courses in Associate and Bachelor's Degree programs. The Scientific-Applied University is the sole trustee of the applied academic higher education system under the supervision of the Ministry of Science, Research and Technology. The goal of the comprehensive university is to motivate the participation of governmental and non-governmental organizations to train the specialized human resources of the various economic, social, and cultural sectors in the country, so that training can require Knowledge and skills for the activities that are assigned. The comprehensive university is responsible for planning, organizing, and supporting undergraduate, operational, information, and policymakers, as well as monitoring and evaluating applied centers and institutes. The Scientific-Applied centers and higher education institutions are under the supervision of the University, the executive branch of scientific-applied education, with the aim of improving work knowledge and developing skills appropriate to the field of occupational activities of humans.

3.1| Aims of Applied Academic Education

I. Creating a suitable platform for all-around (Industrial, military, and academic) activities in expanding the use of science and applied science in the country.

II. Promotion of quantitative and qualitative indices of applied education in society.

III. Provide the appropriate infrastructure for the use of theoretical knowledge by graduate students in problem-solving.

IV. Underlining the appropriate infrastructure for the transfer of modern technology.

For sampling, the cluster sampling method is used. According to the research, 119 managers and vice presidents work in all of these universities. To determine the sample size, the Cochran formula was used. The sample size was 91 persons. In this research, a paired comparison questionnaire will be used to collect the required data, whose validity is confirmed by the experts, and its reliability with respect to Cronbach's alpha is 0.89. Further, using the fuzzy data network analysis process, the collected data were analyzed.

3.2|Fuzzy Network Analysis Process

In the real world, many of the decisions contain ambiguous and dual phrases. In order to integrate the experiences, ideas, and decisions of a decision-maker, it is better to translate linguistic estimates into fuzzy numbers. The ANP method uses a matched pair matrix to rank the preferences, in which input data are definite numbers, and in cases where the input data is ambiguous, the matrix can not be used to obtain the desired results.

Leung and Cao [11] argued that one of the reasons for the low accuracy of this type of opinion is that they are asked to allocate a fair comparison to their paired comparison based on their perceptions of phenomena. In contrast, the individual's perception of the phenomenon in a definitive numerical form can not be expressed. Still, a series of numbers can be better than a definite number reflecting the perceived importance of a phenomenon in relation to another phenomenon. Therefore, fuzzy ANP can better simulate the process of decision-making in the human mind than the traditional ANP.

Hence, in the gathering of expert opinion, the tangible expressions used in the fuzzy ANP couple comparison questionnaire have been used instead of the definitive proportions in the traditional ANP. The scale used in this study is a 2-phase fuzzy scale proposed by Tassafamariam and Sdiqi [12] Scale. Using the 2-dimensions scale gives more work to the experts when doing a pair comparison. After collecting answers from experts on a scale of 2 and in some language units, the responses must be taken on a scale with the ability to analyze reactions, because it is impossible to perform mathematical operations on qualitative expression variables. The combination of the ANP model with the BSC approach is based on fuzzy logic and the principle of uncertainty. Indicators are derived from the related literature, and the experts applied their corrective comments on the indicators in the proposed ANP model based on the following steps:

Step 1. Determine the perspective of experts.

Step 2. Determine the strategies to achieve the designed perspective.

Step 3. Determine the scales for the BSC and performance criteria.

4 | Findings

In the first step, according to the experts' opinions and in the steps outlined in Section 3-1, the methodology for the prospect for these universities was developed, and in order to achieve these three strategies, three strategies were selected. According to the views of the BSC, for each, the three sub-criteria are defined as follows.

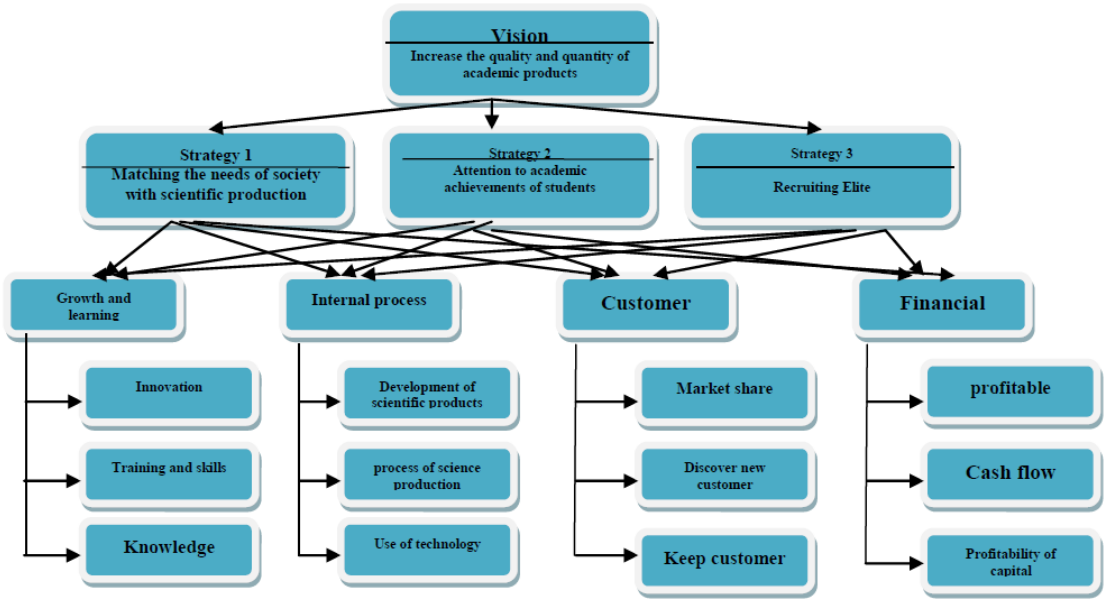

Fig. 1. The hierarchy model consists of a perspective, strategies, perspectives, and performance indicators.

After determining the basics of strategies, the scales of the BSC are determined based on the strategy.

Table 1. Independent weights and matrix paired comparisons of strategies.

Strategies	Strategy 1	Strategy 2	Strategy 3	Weights
Strategy 1	(1,1,1)	(7,8,9)	(4,5,6)	0.51
Strategy 2	(1.8, 1.7, 1.5)	(1,1,1)	(1.6, 1.5, 1.4)	0.79
Strategy 3	(4,5,6)	(1.4, 2.3, 1.2)	(1,1,1)	0.64

Given the weights obtained, it can be stated that the second strategy has a greater impact on the achievement of goals, and then the third and the first strategies are in the next rank. In the following, we will examine the effect of each of these strategies on the objectives; the results in *Table 2* will be presented.

Table 2. Independent weights and matrix of paired comparisons of BSC views.

	Financial	Customer	Internal Process	Growth and Learning	Weights
Strategy 1					
Financial	(1,1,1)	(1,3,5)	(3,2,1)	(5,6,7)	0.45
Customer	(6.1, 1.7, 1.5)	(1,1,1)	(1,2,3)	(7,8,9)	0.28
Internal process	(5,4,3)	(1,1,3)	(1,1,1)	(1.2, 1.3, 1.4)	0.49
Growth and learning	(2,3,4)	(1.6, 1.8, 1.7)	(2,3,4)	(1,1,1)	0.51
Strategy 2					
Financial	(1,1,1)	(4,5,6)	(2,3,4)	(5,6,7)	0.43
Customer	(1.3, 1.4, 1.5)	(1,1,1)	(1,1,2)	(1,2,3)	0.20
Internal process	(1,3,5)	(3,4,5)	(1,1,1)	(9,8,7)	0.56
Growth and learning	(2,3,4)	(4,5,6)	(1,2,3)	(1,1,1)	0.50
Strategy 3					
Financial	(1,1,1)	(5,6,7)	(6,7,8)	(2,3,4)	0.41
Customer	(1.5, 1.6, 1.7)	(1,1,1)	(1.2, 1.3, 1.4)	(1,1,3)	0.38

Table 2. Continued.

	Financial	Customer	Internal Process	Growth and Learning	Weights
Internal process	(7,8,9)	(3,4,5)	(1,1,1)	(3,4,5)	0.45
Growth and learning	(1.7, 1.8, 1.9)	(1,2,3)	(3,4,5)	(1,1,1)	0.55

According to *Table 2*, the most important aspect of Strategy 1 is the learning growth with weight (of 0.51). In Strategy 2, the most crucial element of the domestic business process is weighted (0.56), and in Strategy 3, the most critical element is the growth and learning with a weight of 0.55. In the following, the independent weights of performance indicators are calculated using the pairwise matrix, the results of which are as follows.

Table 3. Independent weights for the financial criteria.

Financial	Profitable	Cash Flow	Profitability of Capital	Weights
Profitable	(1,1,1)	(4,5,6)	(1,2,3)	0.46
Cash flow	(1.5, 1.6, 1.7)	(1,1,1)	(3,4,5)	0.38
Profitability of capital	(3,4,5)	(1.4, 1.5, 1.6)	(1,1,1)	0.42

Table 4. Independent weights for the customer criteria.

Customer	Market Share	Discover New Customer	Keep Customer	Weights
Market share	(1,1,1)	(3,4,5)	(1,2,3)	0.32
Discover new customer	(3,4,5)	(1,1,1)	(3,4,5)	0.45
Keep customer	(1.5, 1.6, 1.7)	(6,7,8)	(1,1,1)	0.35

Table 5. Independent weights for the internal processes criteria.

Internal Processes	Development of Scientific Products	The Production Process of Science	Use of Technology	Weights
Development of scientific products	(1,1,1)	(2,3,4)	(5,6,7)	0 36
Process of science production	(6,7,8)	(1,1,1)	(1.6, 1.7, 1.8)	0.40
Use of technology	(4,5,6)	(1,1,2)	(1,1,1)	0.39

Table 6. Independent weights for the growth and learning criteria.

Grow and Learn	Innovation	Training and Skills	Knowledge	Weights
Innovation	(1,1,1)	(3,4,5)	(1,2,3)	0.38
Training and skills	(1,1,3)	(1,1,1)	(1.2, 1.3, 1.4)	0.32
Knowledge	(4,5,6)	(6,7,8)	(1,1,1)	0.28

In the following, we will examine the relationship between the scorecard aspects, the independent volumes of the BSC, and the relationship between the scenes. The use of this study explains the effect of each perspective on other perspectives based on paired comparisons between paradigms. It is determined that the matrix of paired comparisons is composed of the perspectives. It is presented in the results in *Tables 7-10*.

Table 7. Independent financial matrix.

Financial	Customer	Internal Processes	Grow and Learn	Weights
Customer	(1,1,1)	(1,1,2)	(3,4,5)	0.23
Internal processes	(1.5, 1.6, 1.7)	(1,1,1)	(1.3, 1.4, 1.5)	0.22
Grow and learn	(2,3,4)	(4,5,6)	(1,1,1)	0.18

Table 8. Independent customer matrix.

Customer	Financial	Internal Processes	Grow and Learn	Weights
Financial	(1,1,1)	(2,3,4)	(5,6,7)	0.23
Internal processes	(2,3,4)	(1,1,1)	(4,5,6)	0.18
Grow and learn	(1.6, 1.7, 1.8)	(1,1,2)	(1,1,1)	0.25

Table 9. Independent internal processes matrix.

Internal Processes	Customer	Financial	Grow and Learn	Weights
Customer	(1,1,1)	(2,2,3)	(4,5,6)	0.32
Financial	(2, 1.2, 1)	(1,1,1)	(1.4, 1.4, 1.5)	0.22
Grow and learn	(2,3,4)	(1,1,2)	(1,1,1)	0.19

Table 10. Independent grow and learn matrix.

Grow and Learn	Customer	Financial	Internal Processes	Weights
Customer	(1,1,1)	(2,3,4)	(1,2,3)	0.25
Financial	(1,2,3)	(1,1,1)	(3,4,5)	0.26
Internal processes	(3,4,5)	(4,5,6)	(1,1,1)	0.21

In this step, the independent weights are related to the landscapes and weights of the performance indicators, comprehensive weights, which are calculated by multiplying the non-independent weights by the independent weights of each of the indexes of comprehensive weights.

Table 11. Comprehensive weights for performance criteria.

Scorecard Aspects	Dependent Weights	Performance Criteria	Independent Weights	Comprehensive Weights
Financial	0.201	Profitable	0.46	0.096
		Cash flow	0.38	0.079
		Profitability of capital	0.42	0.088
Customer	0.220	Market share	0.32	0.070
		Discover new customers	0.45	0.099
		Keep customer	0.35	0.077
Internal processes	0.243	Development of scientific products	0.36	0.087
		Process of science production	0.40	0.097
		Use of technology	0.39	0.094
Grow and learn	0.240	Innovation	0.38	0.091
		Training and skills	0.32	0.076
		Knowledge	0.28	0.067

We will continue to evaluate the performance of the universities in question. Considering the overall weight and evaluation of linguistic variables and the scale value of each, the coefficient of performance will be obtained by multiplying the overall weight by the scale value.

Table 12. Performance of academic and applied academic centers under study.

Performance Criteria	Overall Weight	Linguistic Evaluation	Scale Value	Performance
Profitable	0.096	Very much	1	0.096
Cash flow	0.079	Average	0.5	0.039
Profitability of capital	0.088	Much	0.75	0.066
Market share	0.070	Average	0.5	0.035
Discover new customers	0.099	Very much	1	0.099
Keep customer	0.077	Average	0.5	0.038
Development of scientific products	0.087	Much	0.75	0.065
Process of science production	0.097	Very much	1	0.097
Use of technology	0.094	Very much	1	0.094
Innovation	0.091	Very much	1	0.091
Training and skills	0.076	Average	0.5	0.038
Knowledge	0.067	Average	0.5	0.033
Overall performance of universities				0.728

According to the results, it can be said that the overall performance of the universities is 0/72.8, which means most criteria had a significant impact on the performance of the universities. The tremendous impact is on the profitability, discovery of new customers, the process of scientific production, the use of technology, and innovation on the university's performance.

5 | Conclusion

According to the studies, we found that among the criteria studied, profitability, new customer discovery, process of science production, use of technology, and innovation had the most significant impact on the performance of the universities. The overall performance of universities was 0/72, which is the average performance of universities. Considering that customer discovery has been the most effective criterion for the performance of these university centers, this recognition of customers through the recruitment of new students and the development and production of science, it is suggested that the under-study centers with the creation of scientific and research space attract students and elites and support their scientific products to the developed perspective.

With regard to this, it has been determined that the performance of the centers of the universities under study is high in terms of internal processes, which means that dachshunds should appear in the process of production and development of successful knowledge. It is suggested that the study centers with a gradual overhaul of this subject should pay close attention because the purpose of the academic centers is nothing but the production and development of science. Other issues related to this research include the following:

I. Conduct this study with other approaches, such as FAHP and TOPSIS, to compare the results.

II. To carry out the subject of this research at other academic centers.

III. Diagnose performance problems in the universities under study.

Conflict of Interest Disclosure

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter discussed in this manuscript.

Data Availability Statement

The datasets used and/or analyzed during the current study are not publicly available due to [reason if applicable] but can be made available by the corresponding author when scientifically justified.

Funding Statement

The authors confirm no financial support was provided for the research, authorship, or publication of this article.

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