

Construction and Application of a Comprehensive Management Effectiveness Evaluation System for University Teaching and Research Laboratories

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Abstract: University laboratories serve the dual functions of talent cultivation and research innovation. However, existing laboratory management evaluations predominantly focus on single dimensions such as safety, resource utilization, or intelligent management, lacking a comprehensive assessment that accounts for the synergistic effects of teaching, research, management, safety, and economic benefits, and thus failing to fully reflect the true management effectiveness of laboratories. Taking a university in Wenzhou as an example, this paper constructs a comprehensive management effectiveness evaluation indicator system for university laboratories comprising 12 indicators across four dimensions—teaching support, research output, resource utilization, and safety management—based on the principles of scientific rigor, systematicity, and operability. The analytic hierarchy process (AHP) is employed to determine indicator weights, with 15 experts in laboratory management invited to score the judgment matrices; expert opinions exhibited moderate coordination, the consistency test at the criterion level was passed, and the rationality of weights was ensured through consistency checks, while reliability and validity tests were conducted to verify the scientific soundness of the system. Using the laboratories of six secondary colleges at the university as evaluation units, 198 valid questionnaires were collected from enrolled students, experimental teaching staff, and laboratory managers for case application. The results show that the safety management dimension received the highest weight (0.2615), with relatively balanced weights across dimensions; the comprehensive effectiveness scores of the six colleges ranged from 3.60 to 4.03, and the evaluation results effectively distinguished the management effectiveness levels of laboratories across colleges, corroborating the results of IPA (importance–performance) analysis. The system provides a quantitative tool and reference basis for university laboratory management decision-making and performance improvement.

Keywords: University laboratories; Management effectiveness; Evaluation indicator system; Analytic hierarchy process; Reliability and validity

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1. Introduction

University laboratories serve as important bases for conducting experimental teaching, scientific research, talent cultivation, and social service, and their construction and management levels are directly related to the teaching quality and research innovation capacity of universities. In recent years, with the continuous growth of higher education investment and the deepening advancement of the “Double First-Class” initiative, university laboratory construction has achieved remarkable progress. However, the persistent problems of “emphasizing construction, neglecting management” and “emphasizing hardware, neglecting performance” remain prominent, and the comprehensive benefits of laboratory resources have not yet been fully realized^[1–3]. Many universities still rely primarily on experience-based management and administrative assessment in laboratory management, lacking scientific, systematic, and quantifiable evaluation methods, making it difficult to objectively measure and effectively improve the comprehensive management effectiveness of laboratories^[4,5].

From the existing literature, scholars both domestically and internationally have conducted extensive research on university laboratory construction and management, mainly focusing on the current status of laboratory construction and management, the development of intelligent management systems, safety management, and individual performance evaluation^[6,7]. For instance, some scholars have constructed an evaluation indicator system for the management of university nursing open laboratories^[7], proposed evaluation indicator systems and methods for university laboratory open management^[8], studied comprehensive evaluation systems for open teaching laboratories^[9], conducted comprehensive evaluations of university laboratories based on the analytic hierarchy process^[6], and assessed the construction benefits of university teaching laboratories^[10]. In the field of safety management, scholars have also developed laboratory safety risk assessment models based on AHP and fuzzy comprehensive evaluation^[11,12].

However, existing studies predominantly focus on a single dimension of laboratory management or a single type of laboratory, lacking comprehensive evaluation of the synergistic effects of teaching, research, management, safety, and economic benefits^[13]. The fragmentation of evaluation indicators makes it difficult for evaluation results to fully reflect the true operational status of laboratories and impedes the provision of systematic support for management decision-making. Therefore, constructing a multi-dimensional, operational, and verifiable comprehensive management effectiveness evaluation system for university laboratories holds significant theoretical importance and practical value.

Taking a university in Wenzhou as the research subject, this paper addresses the core question of “how to construct a comprehensive effectiveness evaluation system that fully reflects the management level of university teaching and research laboratories” and undertakes the following work: (1) Based on principles of scientific rigor, systematicity, and operability, an evaluation indicator system comprising 12 indicators across four dimensions—teaching support, research output, resource utilization, and safety management—is constructed; (2) The analytic hierarchy process is employed to determine indicator weights, followed by consistency checks; (3) Reliability and validity tests are conducted to verify the scientific soundness and rationality of the indicator system; (4) An empirical application is carried out using six secondary colleges of a university in Wenzhou as examples to examine the system’s discriminative power and practicality, with management improvement recommendations proposed.

2. Construction of the evaluation index system

2.1. Principles of construction

The construction of the comprehensive management efficiency evaluation index system for university laboratories should follow the following principles:

Principle of Scientificity. The selection of indicators should be based on the objective laws of laboratory management and the actual needs of university operations. The connotation of the indicators should be clear, with a unified scope, and capable of truly reflecting the essential characteristics of laboratory management efficiency^[8].

Principle of Systematicity. The comprehensive management efficiency of the laboratory is the result of the synergistic effects of multiple dimensions such as teaching, research, management, safety, and economic benefits. The indicator system should cover the entire process of laboratory operation and management, with each dimension and each indicator being interrelated yet independent, to reflect the overall comprehensive management level of the laboratory^[13].

Principle of Operability. The data for the indicators should be easy to obtain and quantifiable, and the evaluation process should be simple and feasible, avoiding excessive detail in the indicator system that could make the evaluation difficult to implement^[9].

Principle of Guidance. The indicator system should reflect the development direction of university laboratory construction and management, guiding the laboratories to shift from “emphasizing construction” to “emphasizing efficiency,” and promoting the open sharing and efficient use of resources^[14].

2.2. Determination of indicator dimensions

Based on literature research and expert consultations, and in conjunction with the functional positioning of teaching and research laboratories in higher education institutions, this paper divides the comprehensive management effectiveness of university laboratories into four evaluation dimensions:

Teaching Support Dimension. This reflects the laboratory’s ability to support experimental teaching, practical education, and other talent development activities, and is the core manifestation of the management effectiveness of teaching-oriented laboratories^[9].

Research Output Dimension. This reflects the laboratory’s support and contribution to scientific research, technology transfer, and other research activities, and demonstrates the construction effectiveness of research-oriented laboratories^[15].

Resource Utilization Dimension. This reflects the efficiency of resource utilization and the level of open sharing of facilities, equipment, and funding, and is a key measure of the input-output benefits of the laboratory^[10,14].

Safety Management Dimension. This reflects the construction of safety management systems, risk prevention and control, and emergency management capabilities, and is the basic guarantee for the normal operation of the laboratory^[11,16].

2.3. Screening of evaluation indicators

Based on the above construction principles and dimension divisions, a preliminary pool of evaluation indicators was proposed through a combination of literature review, expert interviews, and questionnaire surveys. After two rounds of expert consultation, the indicators were screened, merged, and revised, ultimately forming an evaluation indicator system consisting of four dimensions and 12 secondary indicators,

as shown in **Table 1**.

Table 1. Comprehensive management efficiency evaluation index system for university laboratories

Target layer	Criteria layer (dimension)	Indicator layer	Indicator description
Comprehensive Management Efficiency of University Laboratories A	Support for Teaching B ₁	Experiment Implementation Rate C ₁₁	The ratio of the number of actual experiments conducted to the number of planned experiments in the teaching schedule
		Innovation and Reform in Experimental Teaching C ₁₂	The effectiveness of experimental teaching reform projects, virtual simulation experiment projects, etc.
		Satisfaction with Experimental Teaching C ₁₃	The evaluation scores of teachers and students on the organization and service of experimental teaching
	Research Output B ₂	Research Projects and Programs C ₂₁	The number and level of research projects undertaken by the laboratory
		Publications and Patents C ₂₂	The quantity and quality of papers published and patents obtained through the laboratory
		Technology Transfer and Services C ₂₃	The situation regarding technology transfer, horizontal cooperation, and social services
	Resource Utilization B ₃	Equipment Utilization C ₃₁	The proportion of effective usage time of large-scale equipment
		Laboratory Openness and Sharing C ₃₂	The open hours of the laboratory, the number of people served, and the usage hours
		Funding Efficiency C ₃₃	The execution rate and output efficiency of the laboratory construction and operation funds
	Safety Management B ₄	Safety Regulations and Responsibility Implementation C ₄₁	The completeness of safety management systems and the implementation of responsibilities
		Safety Inspections and Hazard Rectification C ₄₂	The frequency of safety inspections, the discovery of hazards, and the completion rate of rectifications
		Safety Education and Emergency Management C ₄₃	The coverage of safety education and training and the conduct of emergency drills

This indicator system takes into account four dimensions: teaching, research, resources, and safety. It embodies the core concept of multi-dimensional collaborative evaluation, avoiding the limitations of single-dimensional evaluation systems in the past ^[7,13]. Among these, considerations related to “economic benefits” are reflected through indicators such as “efficiency of fund utilization” and “transformation and service,” without setting up a separate dimension, to ensure the simplicity and operability of the indicator system.

3. Evaluation model and methods

3.1. Determining weights using analytic hierarchy process

The analytic hierarchy process (AHP) is a multi-criteria decision-making method that combines qualitative and quantitative approaches, suitable for determining the weights of indicators ^[6,17]. The basic steps are as follows:

Step 1: Construct the judgment matrix. Invite experts to use Saaty’s 1–9 scale to compare the relative importance of each indicator within the same level, and construct the judgment matrix $A = (a_{ij})_{n \times n}$. where a_{ij}

represents the importance of indicator i relative to indicator j , $a_{ij} > 0$, $a_{ij} = 1/a_{ji}$.

Step 2: Calculate the weight vector. Use the square root method to calculate the eigenvector corresponding to the maximum eigenvalue λ_{max} of the judgment matrix, and then normalize it to obtain the weight vector for each indicator $W = (w_1, w_2, \dots, w_n)^T$, where

$$w_i = \frac{(\prod_{j=1}^n a_{ij})^{1/n}}{\sum_{k=1}^n (\prod_{j=1}^n a_{kj})^{1/n}}, i = 1, 2, \dots, n$$

Step 3: Consistency check. Calculate the consistency index $CI = \frac{\lambda_{max} - n}{n - 1}$, and the consistency ratio $CR = \frac{CI}{RI}$, where RI is the average random consistency index. When $CR < 0.1$, the judgment matrix is considered to have satisfactory consistency; otherwise, the judgment matrix needs to be adjusted^[17,18].

Step 4: Hierarchical overall ranking. Multiply the weights of the criterion layer by the weights of the indicator layer to obtain the composite weights of each secondary indicator relative to the goal layer, which are $w_{ij} = w_{B_i} \cdot w_{C_{ij}}$.

3.2. Comprehensive evaluation model

Let the set of laboratory evaluation units be $U = \{U_1, U_2, \dots, U_m\}$, and the evaluation index system consists of 4 criteria layers and 12 indicators. For qualitative indicators, a 5-level Likert scale (1–5 points) is used for quantification. For quantitative indicators, the range standardization method is employed to convert them into standardized scores within the (0, 1) interval.

$$x_{ij}^* = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}$$

where x_{ij} is the original indicator value, $\max(x_j)$ 、 $\min(x_j)$ are the maximum and minimum values of the indicator across all evaluation units. The comprehensive evaluation score S_i is calculated using a linear weighted method:

$$S_i = \sum_{k=1}^4 w_{B_k} \sum_{j \in J_k} w_{C_{kj}} x_{ijk}^*$$

Here, w_{B_k} represents the weight of the criterion layer, $w_{C_{kj}}$ represents the weight of the indicator layer, and x_{ijk}^* is the standardized score of evaluation unit i on the j indicator of the k criterion layer. A higher comprehensive score indicates better overall management efficiency of the laboratory.

4. Empirical analysis

4.1. Case overview and data sources

To validate the scientific rigor and practicality of the evaluation system, this study conducted an empirical study using a university in Wenzhou as an example. The university is positioned to cultivate applied talents and has established various types of laboratories, including basic teaching laboratories, specialized laboratories, and research innovation platforms. Laboratory management involves multiple secondary colleges and functional departments, making it highly representative. The study selected the laboratory management units of six secondary colleges—School of Economics and Management, School of Data

Science and Artificial Intelligence, School of Robotics Engineering, School of Electronic and Electrical Engineering, School of Architecture and Energy Engineering, and School of Design and Art—as the evaluation subjects.

The data sources are from three aspects: (1) A questionnaire was distributed to students, experimental teachers, and laboratory managers at the school, with 198 valid responses collected. These were used to evaluate the importance of indicators and subjective assessments of laboratory management effectiveness; (2) Management ledger data, including equipment usage records, experimental data, and safety inspection records, were obtained from the school’s laboratory management department, academic affairs office, and research office; (3) Fifteen experts in laboratory management (including 5 experimentalists, 3 laboratory directors, 2 academic affairs administrators, 2 professors, 2 senior experimentalists, and 1 associate professor) were invited to score the AHP judgment matrices. Among these experts, 60% were involved in research management, 53.3% in experimental teaching, 46.7% in laboratory management, and 33.3% in safety management. The distribution of their years of experience is as follows: 13.3% with less than 5 years, 26.7% with 5–10 years, 40.0% with 10–20 years, and 20.0% with more than 20 years. The AHP criterion layer judgment matrices all passed the consistency test, with a 100% pass rate.

4.2. Calculation results of indicator weights

Based on the pairwise comparison scores from 15 experts on the four dimensions of teaching support, research output, resource utilization, and safety management, the criteria layer weights and their statistical characteristics were calculated after geometric mean aggregation, as shown in **Table 2**.

Table 2. Calculation results of criterion layer weights

Dimension	Average weight	Standard deviation	Ranking
Safety Management B ₄	0.2615	0.0411	1
Resource Utilization B ₃	0.2545	0.0487	2
Teaching Support B ₁	0.2459	0.0495	3
Research Output B ₂	0.2380	0.0400	4

Note: The consistency test for the criterion layer judgment matrix of 15 experts passed with a 100% rate, and the average coefficient of variation of expert opinions was 0.2226, indicating moderate agreement.

The results show that in the context of a university in Wenzhou, the dimension of safety management has the highest weight (0.2615), followed by resource utilization (0.2545) and teaching support (0.2459), while the weight of the research output dimension is relatively lower (0.2380). The standard deviation of the weights of the four dimensions is 0.0102, indicating that the weights are relatively balanced with no significant bias. This aligns with the university’s educational orientation, which emphasizes “teaching-centered and application-oriented talent cultivation”: in an applied university, the safe operation of laboratories is a fundamental guarantee, and equal importance is given to teaching support and resource utilization, while the relatively lower weight of research output is consistent with the current stage of such universities where the focus is primarily on talent cultivation.

The judgment matrices for the internal indicators within each criterion layer were calculated using the same method. After consistency testing, the composite weights of the secondary indicators were obtained, as shown in **Table 3**.

Table 3. Composite weights of evaluation indicators

Criterion layer	Criterion layer weight	Indicator layer	Indicator layer weight	Synthetic weight	Ranking
Teaching Support B ₁	0.2459	Experiment implementation rate C ₁₁	0.3420	0.0841	5
		Satisfaction with experimental teaching C ₁₃	0.3327	0.0818	7
		Reform and innovation in experimental teaching C ₁₂	0.3253	0.0800	9
Research Output B ₂	0.2380	Research Topics and Projects C ₂₁	0.3433	0.0817	8
		Transformation of Achievements and Services C ₂₃	0.3311	0.0788	10
		Papers and Patents Output C ₂₂	0.3256	0.0775	11
Resource Utilization B ₃	0.2545	Laboratory Open Sharing C ₃₂	0.3595	0.0915	1
		Funding Utilization Efficiency C ₃₃	0.3371	0.0858	4
		Instrument and Equipment Utilization Rate C ₃₁	0.3037	0.0773	12
Safety Management B ₄	0.2615	Safety Inspection and Hazard Rectification C ₄₂	0.3400	0.0889	2
		Safety Education and Emergency Management C ₄₃	0.3396	0.0888	3
		Safety Regulations and Responsibility Implementation C ₄₁	0.3208	0.0839	6

Note: The weights of the indicator layer are obtained by dividing the composite weights by the corresponding criterion layer weights, with the total composite weights summing to 1.0000.

From the composite weights, it can be seen that laboratory openness and sharing (0.0915), safety inspections and hazard rectification (0.0889), and safety education and emergency management (0.0888) rank in the top three, indicating that resource openness and sharing, as well as safety management, have received the closest attention in expert evaluations. In contrast, the utilization rate of instruments and equipment (0.0773), paper and patent output (0.0775), and technology transfer and service (0.0788) have relatively lower weights, with a maximum difference of only 0.0142. This suggests that the various dimensions and indicators of laboratory management effectiveness are relatively balanced in the experts' perception, with no significant weak indicators. It also reflects the practical requirements for the coordinated development of teaching, research, resources, and safety in application-oriented universities where different types of laboratories coexist.

4.3. Reliability and validity testing

Reliability testing: Cronbach's α coefficient was used to test the internal consistency of the questionnaire and the indicator system. The calculated Cronbach's α coefficient for the total scale is 0.861, and the α coefficients for the four criterion layers are 0.853 (teaching support), 0.792 (research output), 0.838 (resource utilization), and 0.871 (safety management), all of which exceed the acceptable standard of 0.7, indicating that the evaluation indicator system has good internal consistency reliability^[7].

Validity testing: Exploratory factor analysis was used to test the construct validity of the indicator system. The KMO test value was 0.824, and the approximate chi-square value of Bartlett's test of sphericity was 1,208.46 ($P < 0.001$), indicating that the data were suitable for factor analysis. Principal component analysis was used to extract common factors. After varimax orthogonal rotation, four common factors were extracted, with a cumulative variance contribution rate of 76.82%. The loadings of each indicator on its respective common factor were all greater than 0.6, and there were no significant cross-factor loadings. This is consistent with the pre-assumed four-dimensional structure, indicating that the indicator system has good

construct validity ^[7,19]. See **Table 4**.

Table 4. Comprehensive efficiency scores and rankings of each evaluation unit

Evaluation unit	Teaching support	Research output	Resource utilization	Safety management	Comprehensive score	Ranking
School of Data Science and Artificial Intelligence	3.92	4.35	3.80	4.05	4.03	1
School of Electronic and Electrical Engineering	3.96	4.13	3.69	4.04	3.95	2
School of Robotics Engineering	3.82	4.10	3.62	4.04	3.90	3
School of Design and Art	3.63	3.81	3.48	3.97	3.72	4
School of Architecture and Energy Engineering	3.75	3.62	3.43	3.95	3.69	5
School of Economics and Management	3.61	3.39	3.38	4.01	3.60	6

Note: The score for each dimension is the weighted average of the scores of the secondary indicators within that dimension, with a range of 1 to 5 points. The comprehensive score is calculated by weighting the scores of the four dimensions according to the criteria layer weights.

From the evaluation results, the comprehensive efficiency scores of the six evaluation units range from 3.60 to 4.03, generally at a moderately high level, and show significant hierarchical differences. The School of Data Science and Artificial Intelligence has the highest comprehensive score (4.03), excelling in research output (4.35) and safety management (4.05). The School of Economics and Management has the lowest score (3.60), with relatively low scores in resource utilization (3.38) and research output (3.39), indicating considerable room for improvement. Comparing the evaluation results with the annual assessment and performance feedback information held by the university's laboratory management department, the ranking of the evaluation results is generally consistent with the actual situation, preliminarily validating the criterion-related validity of the evaluation system.

At the dimensional level, the average score for safety management is the highest (4.01), reflecting the effectiveness of the university's recent work on laboratory safety systems, inspections, and safety education. The average score for resource utilization is the lowest (3.57), with equipment utilization (3.54) and laboratory openness and sharing (3.56) being among the lowest of all 12 indicators, indicating issues such as low equipment utilization, limited open hours, and an inconvenient reservation system. The IPA analysis results show that the performance of indicators such as experiment implementation rate (importance 4.54, gap +0.83), laboratory openness and sharing (importance 4.26, gap +0.70), and satisfaction with experimental teaching (importance 4.45, gap +0.64) is significantly lower than the expectations of faculty and students, and should be prioritized for management improvement. In contrast, the performance scores for research projects and programs (gap -0.11), paper and patent output (gap -0.21), and technology transfer and services (gap -0.40) are higher than their importance scores, placing them in the advantage zone. This is consistent with the relatively low weight given to the research output dimension, reflecting the current optimistic performance relative to the limited expectations of faculty and students regarding the university's research output. The comprehensive evaluation results and IPA analysis mutually corroborate, collectively revealing the structural characteristics of the university's laboratory management, where resource utilization and openness are the weak points, and safety management is the strong point.

5. Discussion

The evaluation system constructed in this paper has the following characteristics compared to existing studies:

Multidimensional synergy. Unlike current research that often focuses on a single dimension such as safety ^[11,12], resource utilization ^[14], or open sharing ^[8], this study comprehensively examines laboratory management effectiveness from four dimensions: teaching support, research output, resource utilization, and safety management. It emphasizes the synergistic effects among these dimensions, providing a more comprehensive reflection of the overall operational status of the laboratory ^[13]. Economic benefit-related indicators (cost-effectiveness, technology transfer, and services) are embedded within the dimensions of resource utilization and research output, avoiding an overly expansive indicator system and balancing scientific rigor with practicality.

Integration of subjective and objective methods. The methodological chain includes initial indicator selection through literature review, expert consultation for indicator screening, Analytic Hierarchy Process (AHP) for weight determination, factor analysis for structural validity verification, and Cronbach's α for reliability testing. This complete methodological chain, where subjective weighting is complemented by objective validation, mitigates the strong subjectivity inherent in the AHP method alone ^[6,19]. Additionally, all 15 experts passed the consistency test for the judgment matrix, and the average coefficient of variation of 0.2226 indicates moderate agreement among experts, suggesting good group reliability in the weight results.

Adaptability to applied universities. Unlike previous studies where teaching support was given the highest weight, this study, in the context of a university in Wenzhou, found that the safety management dimension had the highest weight (0.2615), followed closely by resource utilization (0.2545) and teaching support (0.2459). The standard deviation of the weights across the four dimensions was only 0.0102, indicating a "balanced but slightly inclined towards safety and resources" structure. This result reflects the dual emphasis on laboratory safety and resource efficiency in applied universities, and it aligns with the reality of the university, which has multiple types of laboratories and is at an early stage of safety management. This suggests that the weight settings in the evaluation system have strong contextual adaptability, and different types of universities can adjust the judgment matrix according to their own positioning and recalibrate the weights.

Consistency between evaluation results and perceptions of faculty and students. The comprehensive effectiveness evaluation and IPA analysis results are highly consistent: the safety management dimension received the highest score, while the resource utilization dimension received the lowest. The high weight but low performance of equipment utilization and laboratory open sharing provide clear signals for improvement. The evaluation system not only distinguishes inter-departmental differences but also identifies specific weaknesses at the dimensional level, providing targeted evidence for management decisions.

However, this study also has some limitations: First, the case study is based on a single applied university, limiting the sample coverage, and the cross-university generalizability of the evaluation system needs further validation; second, the AHP weights rely on expert subjective judgments, and the composition of experts can influence the weight results. This can be improved by expanding the expert pool or combining it with objective weighting methods such as entropy weight; third, some qualitative indicators depend on subjective scoring, which may introduce evaluation bias. Future work could integrate with laboratory information management platforms to obtain more objective and dynamic operational data ^[1,20].

6. Conclusion and recommendations

6.1. Conclusion

This paper addresses the issue of fragmented evaluation dimensions and the lack of comprehensive effectiveness measurement in university laboratory management. It constructs a comprehensive management effectiveness evaluation index system for university laboratories, encompassing four dimensions—teaching support, research output, resource utilization, and safety management—and 12 indicators. The Analytic Hierarchy Process (AHP) was used to determine the weights of the indicators, and the scientific and rational nature of the system was verified through consistency testing, reliability testing, and validity testing. Case applications show that this system can effectively distinguish the management effectiveness levels of different college laboratories: the comprehensive effectiveness scores of six secondary colleges at a university in Wenzhou range from 3.60 to 4.03. Safety management and resource utilization have the highest weights, with resource utilization having the lowest performance score. The evaluation results are consistent with the actual management and perceptions of faculty and students, demonstrating good discriminability, operability, and practical value. This system can provide quantitative evidence for decision-making in university laboratory management.

6.2. Recommendations

Based on the empirical analysis results, the following suggestions are proposed for the laboratory management of a university in Wenzhou:

Strengthen safety management and maintain existing advantages. With the highest weight and leading evaluation score (4.01), it is recommended to continuously implement the laboratory safety responsibility system, improve the closed-loop mechanism for safety inspections and hazard rectification, organize regular safety drills and emergency management training, and use information technology to achieve dynamic monitoring and early warning of safety risks, thereby consolidating this relative advantage ^[16,20].

Enhance resource utilization and open sharing. Although the resource utilization dimension has the second-highest weight (0.2545), it has the lowest performance score (3.57). Equipment utilization (3.54) and laboratory open sharing (3.56) are the two lowest-scoring indicators among the 12. It is suggested to improve the open sharing mechanism of laboratories and link it with performance evaluations, extend opening hours, optimize the reservation system, establish a platform for shared large-scale equipment and a system for publicizing usage benefits, and simplify the financial process to promote efficient resource utilization ^[14,21].

Reinforce the supporting role of experimental teaching. The weight and importance of the teaching support dimension are both high. The experiment implementation rate (performance 3.71, importance 4.54, gap +0.83) is the indicator with the largest gap in the IPA analysis. It is recommended to ensure the experiment implementation rate and quality, increase virtual simulation experiment projects, strengthen the construction of experimental teaching staff, and continuously improve services with a focus on satisfaction in experimental teaching ^[9].

Promote balanced development among colleges. The comprehensive scores of the College of Data Science and Artificial Intelligence and the College of Economics and Management differ by 0.43 points. It is suggested to establish a mutual assistance and experience-sharing mechanism among colleges, develop targeted improvement plans for colleges with weak resource utilization and research output, and reduce the management-level gaps between colleges.

Use evaluation to drive improvement and form a management loop. It is recommended to include the comprehensive management effectiveness evaluation in the annual assessment of laboratories, link the evaluation results with resource allocation and performance distribution, conduct regular re-evaluations, and form a virtuous cycle of “evaluation–feedback–improvement–re-evaluation”^[10].

Future research could expand the sample size, conduct comparative validations in comprehensive and research universities, and explore the introduction of fuzzy comprehensive evaluation, entropy weight method for combined weighting, and big data dynamic evaluation methods based on information platforms, to further enhance the universality, objectivity, and dynamism of the evaluation system^[1,17].

Disclosure statement

The author declares no conflict of interest.

References

- [1] Yan H, Gao M, 2018, Construction of a Comprehensive Management Information Platform for University Laboratories. *Computer Knowledge and Technology*, 14(2): 20–21.
- [2] Xu S, Xu B, 2015, Discussion on the Current Status and Countermeasures of University Laboratory Management. *Experimental Science and Technology*, 13(3): 185–186.
- [3] Yang X, Fang K, Lei J, et al., 2019, Research and Reflections on the Construction and Management System of University Laboratories. *Journal of Laboratory Research and Exploration*, 38(12): 270–273, 287.
- [4] Zhou Y, 2011, Research on the Current Status and Issues of Laboratory Management in China: A Case Study of Economic and Management in Universities. *China's Collective Economy*, (1): 48.
- [5] Wang X, 2014, Research on the Current Status and Issues of Laboratory Construction and Management. *Information Systems Engineering*, (2): 157–158.
- [6] Li G, Liu Y, 2009, Comprehensive Evaluation of University Laboratories Based on Analytic Hierarchy Process (AHP). *Experimental Science and Technology*, 7(4): 129–131, 134.
- [7] Liu Y, Lin B, Liao J, et al., 2024, Construction of an Evaluation Index System for Open Nursing Laboratories in Universities. *Nursing Research*, 38(6): 4190–4195.
- [8] Sun Y, 2009, Evaluation Index System and Methods for Open Management of University Laboratories. *Journal of Hebei Normal University of Science & Technology (Social Sciences Edition)*, 8(4): 31–34.
- [9] Shi J, Wu C, Chen Z, 2017, Research on the Comprehensive Evaluation System and Methods for Open Teaching Laboratories in Universities. *Laboratory Science*, 20(4): 159–162.
- [10] Chen W, Yan Z, Lan Y, 2018, Research on the Benefit Evaluation of University Teaching Laboratory Construction. *Experimental Technology and Management*, 35(4): 252–255.
- [11] Wang H, Qin S, Yang J, 2024, Safety Risk Assessment of University Laboratories Based on AHP—CRITIC—Fuzzy Comprehensive Evaluation. *Safety and Health*, (6): 50–55.
- [12] Cao Yi, Zhao Lu, Li Hongtao, et al., 2019, Safety Evaluation of Engineering Laboratories in Universities Based on AHP-Fuzzy Comprehensive Evaluation Method. *Laboratory Science*, 22(5): 191–194, 198.
- [13] Huang S, 2014, Preliminary Exploration of the Benefit Evaluation System for University Teaching Laboratories. *Journal of Laboratory Research and Exploration*, 33(4): 251–254.
- [14] Chen Q, Zeng X, Lin J, 2013, Research on the Performance Evaluation of Open Sharing in University

- Laboratories. *Experimental Technology and Management*, (4): 209–211, 216.
- [15] Wei L, 2025, Accelerating the Informatization Management Process of Scientific Research Laboratories to Support the “Double First-Class” Initiative in Universities. *Education and Science Guide (Electronic Version)*, (3): 266–268.
- [16] Liu B, Chen G, 2025, Research and Discussion on the Current Status and Issues of University Laboratory Safety Management: A Case Study of a Western Undergraduate Agricultural and Forestry University. *Laboratory Testing*, 3(3): 57–59.
- [17] Zhu S, Yang C, Li S, et al., 2006, Fuzzy Comprehensive Evaluation Model and Its Application Combined with Analytic Hierarchy Process (AHP). *Experimental Science and Technology*, 4(4): 42–44, 71.
- [18] Cheng Y, Chen L, Xin H, et al., 2023, Research on the Evaluation of Laboratory Quality Management Systems Based on AHP Analysis. *Grain Storage*, 52(10): 11–20.
- [19] Wang W, Wang H, Luo S, 2015, Fuzzy Comprehensive Evaluation of Teaching Laboratories in Universities Based on AHP. *Modern Educational Equipment in China*, (4): 32–35.
- [20] Guo J, Yang S, Jiao C, et al., 2023, Research and Practice on the Safety Management System of University Laboratories under the Background of Big Data and Dual Prevention Mechanism. *Experimental Technology and Management*, 40(11): 240–245.
- [21] Yin L, 2015, Promoting Comprehensive Open Sharing of Laboratories with a Focus on Cultivating Practical and Innovative Abilities. *Experimental Science and Technology*, 13(5): 229–231, 251.

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