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International Journal of Earthquake Engineering
Anno XLIII - Num. 2 - 2026

Design of a Framework for Evaluating the Effectiveness of Vocational Skills Training Based on Comprehensive Data Support

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SUMMARY: *Training is a powerful method that can maintain the matching between work posts and people. This is a main method for increasing the worth of manpower capital inside enterprises, therefore it is extensively liked by numerous companies. With the support of abundant data, this research puts its focus on WR Enterprise. By using investigations that are based on questionnaires, this paper inspects the present situation and already existing problems which relate to vocational skill training among workers of WR. According to the results of these researches, the present study carries out the exploration of an evaluation frame design for measuring the effect of professional ability training. We have utilized expert evaluation to identify evaluation metrics for the effectiveness that vocational skills training possesses. We have utilized the Analytic Hierarchy Process (AHP) to establish weight relations between these metrics, therefore we have constructed an evaluation framework for the effect of vocational skills training. This framework then was put into the practical application through the evaluation of the effect of WR Company's marketing training project. Through the utilization of the Fuzzy Comprehensive Evaluation Method, this program has obtained a comprehensive evaluation score that is 93.39 points, which is therefore classified as being located at an outstanding level.*

KEYWORDS: *training effectiveness evaluation; vocational skills; analytic hierarchy process; fuzzy comprehensive evaluation method*

1 Introduction

In today's extremely competitive job market, the cultivation of vocational abilities has become an important path for enhancing individual competitive ability, satisfying the demands of career development, improving the quality of labor force, and promoting economic development [1 - 3]. The teaching of occupation abilities generally includes a broad scope of industry and commerce fields. Along with the alterations of market demands in the passage of time, the primary objective which it holds is the transmission of specialized knowledge and ability capacities. This assists in satisfying work-connected requirements and promote individuals' overall capacities in the working circumstance. These education related projects can include both technique ability training and the nurturing of soft abilities. Technical ability cultivation can include items such as software code writing, the running of factory machines, or good oral communication. The cultivation of soft capabilities, on the other hand, contains the polishing of interactive ways, the capacity of cooperating in groups, the sharp insight of leading, and the

*yangbz0943@163.com
https://doi.org/10.65102/is2026618
Published: 30 April, 2026

thinking of imagination [4 - 7].Nevertheless, confirming the true effect of training—especially, whether it really enhances the professional abilities of participants and produces good results in real work—requires a scientific and comprehensive evaluation to strengthen the outcomes of vocational skill training [8-10].

Quite a lot of commercial units and training organs hold that training evaluation is not a necessary work, and they omit the establishment of overall evaluation system frameworks. Actually, training schemes very often finish with no any kind of evaluation or check after the training [11, 12]. The great majority of appraisals concerning training effect are still located in a primary condition. At the first, many organizations distribute not enough resources to evaluation. This therefore leads to the condition that training outcomes cannot be measured, and hence decreases the value of some training efforts. Secondly, the evaluation methods which are used are not good enough. They are either badly thought, copied without thinking from other materials, or have no custom-made working steps.Thirdly, the assessments are of superficial nature, because they do not carry out monitoring on changes of employees' work place behavior after the training or the follow influences on business performance. Actually, quite many first-stage and second-stage evaluations finally are only perfunctory processes [13-17]. The results of training are both of delayed nature and of indirect character. The superiorities only become obvious after a specific period of time, and it is very difficult for people to measure the concrete promoting effects. This special property brings extremely great complexity to the procedure of measurement. Therefore, for many companies and training organizations, the work of evaluating training effectiveness is one that cannot be put into practice [18 - 20].

Traditional training evaluations often rely on single data points like post-training assessments, questionnaires, or interviews, subjected to simple computational analysis. Chamadia and Mubarik [21] employed quasi-experimental methods—including paired t-tests, independent t-tests, and one-way ANOVA—to assess vocational training programs targeting employment or employee productivity. Their study used monthly income as the outcome metric, lacking diversity indicators such as career development. Sudana et al.[22] developed a 4C assessment management model based on project-based learning strategies for soft skills (creativity, critical thinking, communication, collaboration) among vocational school students. They integrated test and non-test methods to manage cognitive and affective-psychological dimension data, using these results to refine the soft skills learning process. Tiwari and Malati [23] collected learner data via questionnaires, combined with socioeconomic data. Through statistical analysis and exploratory factor analysis, they identified vocational competency factors for vocational education students and assessed the significance of these factors to evaluate students' vocational competencies. Su and Li [24] conducted questionnaire surveys (cognitive and acceptance) and semi-structured interviews (experiential) with trainees. They designed an evaluation framework for translation technology training effectiveness using the Kirkpatrick model. Paul et al.[25] constructed a comprehensive Kirkpatrick evaluation model for Indian farmer training effectiveness using range indicator standardization, principal component analysis for weighting indicators, correlation ranking, and sensitivity testing. However, the data relied solely on interview-based information. Traditional evaluation methods overlook multidimensional data such as the training process, job-seeking process, work performance (work logs, competencies, achievements, practical skills, service recipient evaluations), career development, and socioeconomic and employment market data. Furthermore, data collection is challenging, evaluation cycles are lengthy, and timely adjustments to training content are difficult to implement. For instance, as noted by Konopasek et al. [26], evaluating communication skills training outcomes in medical education should extend beyond trainee satisfaction surveys to include self-efficacy, skill demonstration, patient satisfaction, and health outcomes.

The development of intelligent technologies permits the gathering of multi-aspect data via the Internet of Things (IoT), blockchain, and artificial intelligence (AI) for long-time observation of training receivers. This procedure therefore assists in the accurate locating of the elements which possess an influence upon the effectuality of training. Therefore, it promotes the evaluation that is for vocational skill training. (Guo and other persons)Ref. [27] made use of head-installed eye-tracking apparatus to record measurement targets such as fixation duration, saccade happening frequency and length, pupil dimension, and pupil activity metric during robotic training and other distant operation tasks which are completed by space operating personnel. Through carrying out statistical analysis upon single elements and cut-apart data, the cognitive work burden of the operators could be estimated, and their operation performance could be evaluated by us.Hristova and work companions [28] used block chain technology to make the tracking flow smoother and give digital proof of the academic training time lengths of electrical engineers. Additionally, it was utilized to verify their technical proficient degrees, innate abilities, and skill growth during the whole period of their employment, hence guaranteeing credible evaluations of their abilities.Castillo-Segura and his work team [29] have proposed two technical schemes: a learning environment that is given power by the Internet of Things (IoT) and content picture display which depends on visual study data analysis. The IoT-enabled study circumstance utilizes sensing devices to track operation apparatuses and judge the strength which is put forth by operating doctors on human internal organs. This method assists in the reduction of the expenditures which are connected with data gathering.The latter carries out an analysis and visual display of the collected data, therefore provides feedback and thus evaluates the effect of surgical skill training. This research handles the problems of subjective factors in assessments by specialists.

In the domain of artificial intelligence algorithm and model usages, Wang and the research team [30] put together cognitive diagnostic models, higher-order hidden Markov models, and Bayesian equations to construct a framework which brings in covariates. This frame system is constructed for the purpose of supervising students' obtaining of abilities and evaluating the effect of teaching interference measures in many kinds of environments.Islam and his work colleagues [31] put forward fuzzy set qualitative comparative analysis and artificial neural networks from the perspective of the four stages of the Kripke model (that is, reaction, learning, behavior, and outcome). The goal that they had was to work out a post-training evaluation frame for yearly performance contracts that are inside the public sector.This framework puts focus on the connections between the four stages, therefore it enables evaluations of training effect which are based on authenticity. Yanik and his work group [32] have measured surgical abilities through checking motion and video data which is connected with surgical methods in the training of resident doctors by means of deep neural networks.This neural network is combined with multimodal data, hence it facilitates the analysis which integrates structured data and unstructured data. Bhatia and his work companions [33] have put forward one AI-aided training assessment tool. This instrument carries out inspection on training data in order to provide customization, no-bias, and right-now evaluation and feedback. Therefore, this action carries out the refinement on the training procedures and the content.

Furthermore, Cao and his work group [34] made use of three kinds of methods: chi-square automatic mutual check decision trees, chi-square check, and relevance evaluation. Their goal was to accurately find out the factors which influence the effect of work place health and safety training. After that they gave a rank to these elements on the basis of their influence degree. The investigation of the factors which give contribution to training effectiveness is helpful for the establishment of evaluation criteria.Lv [35] carried out improvement on the kernel function and parameters of the Support Vector Machine (SVM) algorithm, for the purpose of constructing an intelligent model for talent matching. This model makes use of term frequency

- inverse document frequency (TF - IDF) to process data, hence it makes clear the relation between job seekers' capability and post promotion.Under the circumstance of Support Vector Machine (SVM) classification work, this thing enables dynamic matching which is corresponding to the demands of market. These assessment models, which are supported by progressed technology, solve the problems which are met in combining multi-origin data and gathering procedure-based data.Even so, all-embracing data-dependent evaluation frameworks still have to solve problems connected with private information in the gathering of biometric data. Here also exist problems, for example the differences in data interfaces between different organizations (such as training suppliers and business units), and the lack of standardization systems for assessment indicators.In the opinion of Fathiazar and his co-workers,[36] when one carries out an ideal assessment of skill classes inside effective training systems, it is a necessity that several elements be taken into consideration. These components include the assessment procedures and outcomes, assessors who hold various viewpoints, both formative and summative assessments, and normalized evaluation standards.

For the purpose of achieving the research objective of designing an evaluation framework for the effect of occupational skill training, this research chooses WR Company to be the study object. We utilized the “WR Company Vocational Skills Training Current Situation Investigation Questionnaire” to collect research data about the effect of WR Company's vocational skills training. This procedure has the goal of probing into the current condition and the hard points which are met in its carrying out.Through utilizing the above analysis, a optimization scheme and strategies that have scientific solid basis were designed in order to construct the evaluation framework that is for the effect of professional skill training. After that, we used the Analytic Hierarchy Process (AHP) to confirm the weight relationships between the indicators that are inside the framework.In the end, the practical value and effect of the made evaluation frame have been confirmed. The marketing training item which was conducted by WR Company in the period from March to June 2025 is used as the case analysis of this practice research.The Fuzzy Overall Evaluation Method is employed by us to conduct an overall evaluation of the marketing training project. This procedure proves the effect of the activity and ensures that the smooth carrying out of the established vocational skill training effect appraisal frame.

2 Study Design

Along with the economy’s continuous steady advancement and market competition getting more and more fierce, enterprises are now confronting higher demands in the aspects of production efficiency and product quality. Therefore, vocational ability training is getting more and more attention because of its capacity to promote staff ability quality, push business creation innovation, and assist sustainable development[37]. Under this background, this paper will carry out an analysis on the design of an assessment framework for the effect of occupational skill training. This paper will take WR Enterprise to be a case research, and it depends on overall data. The goal of the present analysis is to provide viewpoints and references for other enterprises which are carrying out similar assessment work.

2.1 Research Subjects

WR Enterprise, which is one important state-owned business, carries out many kinds of operational activities. These business activities cover many different fields including comprehensive services, express delivery services, finance services, and countryside electronic commerce. This enterprise all along has laid high emphasis on the training of working ability

for its staff members. For this purpose, it has already established training centers at both group level and municipal level. These centers have got strong course developing groups which have very high capability in making training study programs. Nevertheless, the mechanism that appraises the effect of occupation-oriented training still lies in an initial phase. Through past many years, this company has not had the ability to establish a science-based reasonable high-efficiency training appraisal system.

2.2 Research Objectives

This current research has the purpose of investigating the current status of occupational skill training inside WR enterprises, together with the actual conditions and defects in their occupational skill training assessment work. By means of the usage of document summarization, specialist discussions, and the Analytic Hierarchy Process (AHP), an evaluation frame will be built up. This frame will be utilized to work out a scientifically correct and usable optimization scheme for assessing the effect of occupation skill training.

2.3 Research Methods

In the course of carrying out the writing and design work of this paper, the below research methods were mainly employed by us:

2.3.1 Literature Review Method

By means of an all-around examination of a large amount of documents and relevant specialized publications, we have obtained an understanding of theoretical frameworks and the current situation of research on the assessment of training effect, both in our nation and foreign nations. According to this knowledge, we have made a systematic research method and model. This model is designed to be a direction for follow-up researches on the formulation of an evaluation system for the effect of occupational skill training.

2.3.2 Questionnaire Survey Method

Real actual data from WR enterprises were collected through making customized question forms and sending them out to related participants. This provides a foundation for the combination of quantitative and qualitative research, therefore guaranteeing the validity and reliability of the research outcomes.

Dependability refers to the stability and consistency of the results that are got from a scale or questionnaire, while validity mainly measures the accuracy and effectiveness of that scale. This questionnaire has passed the examinations of both reliability and validity.

1) Reliability Test

Table 1 gives a comprehensive itemization of the results of reliability tests. From what we can observe, the Cronbach's Alpha value of this investigation tool is located at 0.902. This numerical value exceeds the 0.8 reference standard, which is an obvious manifestation that the questionnaire has been elaborately produced.

Table 1: Reliability test

Cronbach's Alpha	Cronbach 's Alpha based on standardized items	Number of terms
0.902	0.908	14

2) Validity Testing

The validity testing results for the questionnaire obtained in this study are detailed in Table 2. As shown, the KMO value is 0.894, significantly exceeding 0.5, while Bartlett's P-value is less than 0.05. This indicates that the questionnaire possesses high reliability and validity, suggesting an optimal design.

Table 2: Validity test

KMO and Bartlett tests		
KMO sampling appropriateness quantity		0.894
Bartlett sphericity test	Approximate chi-square	1146.015
	Freedom	261
	Significance	0.001

2.3.3 Analytic Hierarchy Process

The Analytic Hierarchy Process, abbreviated as AHP[38], involves researchers decomposing complex problems into multiple levels and indicators for qualitative and quantitative decision analysis. Experts assign weights to the relative importance of any two indicators based on experience. Using the AHP method, the eigenvector of the judgment matrix is calculated and subjected to consistency testing. Weight coefficients objectively reflect the relative importance of different evaluation factors in the assessment.

The process of establishing evaluation factor weights using the AHP method is as follows:

1) Judgment Matrix.

The comparative scale meanings between factors A_i and A_j are detailed in Table 3.

Table 3: The comparative scale meaning of A_i and A_j

Scale	Meaning
1	Indicates that A_i and A_j are equally important
3	It indicates that the influence of A_i is slightly stronger than that of A_j
5	It indicates that A_i has stronger influence than A_j
7	It indicates that the effect of A_i is obviously stronger than that of A_j
9	It indicates that the influence of A_i is absolutely stronger than that of A_j
2, 4, 6, 8	The ratio of the influence of A and A_j is between the two adjacent levels.
Reciprocal	The ratio of the influence of A_i and A_j is the reciprocal number of A_{ij} above.

Based on the comparison scale between factors A_i and A_j in the table above, the importance of evaluation indicators is assessed and scored. Researchers compile expert results to establish the corresponding judgment matrix A:

$$A=\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \tag{1}$$

Among these, $a_{ij} > 0, a_{ij} = \frac{1}{a_{ji}}, a_{ij} = 1$.

2) Establish a set of evaluation factor weights. Based on expert scoring, this paper employs the AHP method to design indicator weights and conduct consistency tests. The algorithmic process is as follows:

(1) Calculate the product of each row element in the judgment matrix:

$$M_i = \prod_{ij}^{n} a_{ij} \tag{2}$$

(2) Calculate the nth root of M_1:

$$\overline{W_i} = \sqrt[3]{M_i} \tag{3}$$

(3) Normalize the vector $\bar{W}_i$:

$$W_i = \frac{\bar{W}_i}{\sum_{i}^{n} \bar{W}_i} \tag{4}$$

(4) Calculate the maximum eigenvalue of the diagonal matrix A:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(A \square W)_i}{W} \tag{5}$$

(5) Conduct consistency testing

Calculate consistency metrics:

$$CI = \frac{\lambda_{\max} - n}{\eta_{\max} - 1} \tag{6}$$

Calculate the consistency ratio:

$$CI = \frac{CI}{RI} \tag{7}$$

Calculate the CR value using the formula. If CR < 0.1, it indicates that the judgment matrix exhibits good consistency. If CR > 0.1, the judgment matrix requires revision to ultimately achieve a satisfactory level of consistency.

2.3.4 Fuzzy Comprehensive Evaluation Method

Fuzzy comprehensive evaluation is a method for integrated analysis and assessment that employs fuzzy transformation principles to evaluate target matters [39]. The specific procedure involves two steps: First, evaluate each individual factor; Second, conduct an overall comprehensive evaluation considering all factors.

1) Establishing Evaluation Indicator Items

The factor set (U) comprises various factors (U_i) influencing the subject of evaluation:

$$U = \{U_1, U_2, ..., U_n\} \tag{8}$$

2) Establishing Evaluation Indicator Weights

Typically, different factors correspond to varying degrees of importance. To effectively reflect the relative significance of each factor, weighting (with weight ω_i) must be applied to each factor (u_i). The weight set W_i can then be described by the following formula:

$$W = \{W_1, W_2, ..., W_n\} \tag{9}$$

3) Establishing Evaluation Conclusions

The set of alternatives (V), which treats the evaluator's possible judgment outcomes regarding the subject as elements (Vi) and forms a collection from them, can be expressed as:

$$V = \{V_1, V_2, ..., V_n\} \tag{10}$$

4) Single-Factor Fuzzy Evaluation

Single-factor fuzzy evaluation refers to the process of first initiating evaluation from individual factors within the factor set U to determine the evaluation object.

The membership degree of each element in the alternative set. Let the membership degree of the j th element v_j in the alternative set when evaluated by the i th factor u_i be denoted as r_{ij}. Then the evaluation result based on the i th factor u_j can be expressed as a fuzzy set:

$$R_i = \frac{ri1}{v1} + \frac{ri2}{v2} + \ldots + \frac{rim}{vm} \tag{11}$$

In the formula, R_i denotes the single-factor evaluation set, which can be simply expressed as:

$$R_i = \{R_{i1}, R_{i2}, ...R_{im}\} \tag{12}$$

5) Conducting Fuzzy Comprehensive Evaluation

Single-factor fuzzy evaluation reflects only the influence of an individual factor on the evaluation object. However, to accurately evaluate the object, it is necessary to comprehensively consider the impact of all factors based on a weight set, thereby making an accurate judgment. Therefore, when the weight set W and the single-factor evaluation matrix R are known, comprehensive evaluation can be performed through fuzzy transformation:

$$B = W \cdot R \tag{13}$$

That is:

$$B=\left(\omega_1,\omega_2,\ldots,\omega_n\right)\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}=b_1,b_2,\ldots,b_m \tag{14}$$

In the formula, B represents the fuzzy comprehensive evaluation set: $b_j(j=1,2,...,m)$ denotes the fuzzy comprehensive evaluation indicators, where:

$$b_j=V_{i-1}^{n}(w_i\wedge r_{ij}) \tag{15}$$

6) Evaluation Metric Assessment

Taking b_j as the weighting factor and applying a weighted average to each alternative element v_j, then:

$$V=\sum_{j=1}^{m}b_j v_j\div\sum_{j=1}^{m}b_j \tag{16}$$

Then V is the result of the fuzzy comprehensive evaluation.

3 Analysis of the Current Status of Vocational Skills Training Outcomes

3.1 WR Company Overview

WR Corporation is a large enterprise with tens of thousands of employees. Established in 2010, it has established branches in multiple provinces, autonomous regions, and municipalities directly under the central government across China. The company focuses on universal services, delivery operations, financial services, and rural e-commerce, implementing diversified operations primarily covering letter mail, delivery services, newspaper distribution, logistics, and e-commerce. The company's internal organizational structure is detailed in Figure 1. WR Company comprises the following departments: General Manager's Office, Deputy General Manager's Office, Operations Management Department, Human Resources Department, General Affairs Office, Asset Management and Customer Service Department, North Station Management Department, and Financial Management Department.

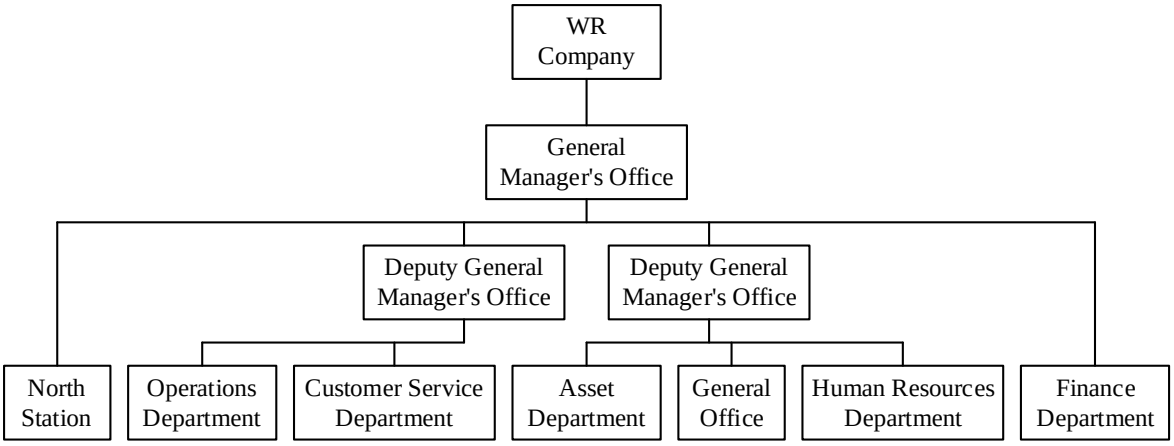

Figure 1: WR company's organizational structure

3.2 Analysis of the Implementation Level of Vocational Skills Training

3.2.1 Training Funding Allocation

Table 4 details WR Company's vocational skills training budget allocation from 2018 to 2024. Data indicates that WR Company has progressively increased its vocational skills training budget in recent years.Beginning from the year 2018, every year’s funding has continuously been in the increase. In the year 2022, it had a quite notable large increase speed of 53.12%. These money expenditures have given more strong money support for the company's training projects.

Table 4: Training expenditure table

Year	Training funding (million yuan)	Growth ratio (%)
2018	2.16	-
2019	2.88	33.33%
2020	3.12	8.33%
2021	4.65	49.04%
2022	7.12	53.12%
2023	9.34	31.18%
2024	11.82	26.55%

3.2.2 Training Program Types and Quantity

In the past several years, WR Company has on a large scale increased its efforts in the cultivation of talented people. This circumstance mainly is manifested in the increment of training projects and the promotion in the quality of training materials. The number of worker occupation skill training classes that WR Company holds is shown in Figure 2. In the time period from 2018 to 2024, the company organized more than 300 training activities, among which there existed over 100 out-of-company training projects. This project has been cultivating more than one thousand staff members every year, thus providing powerful motive force for the future development of the company.

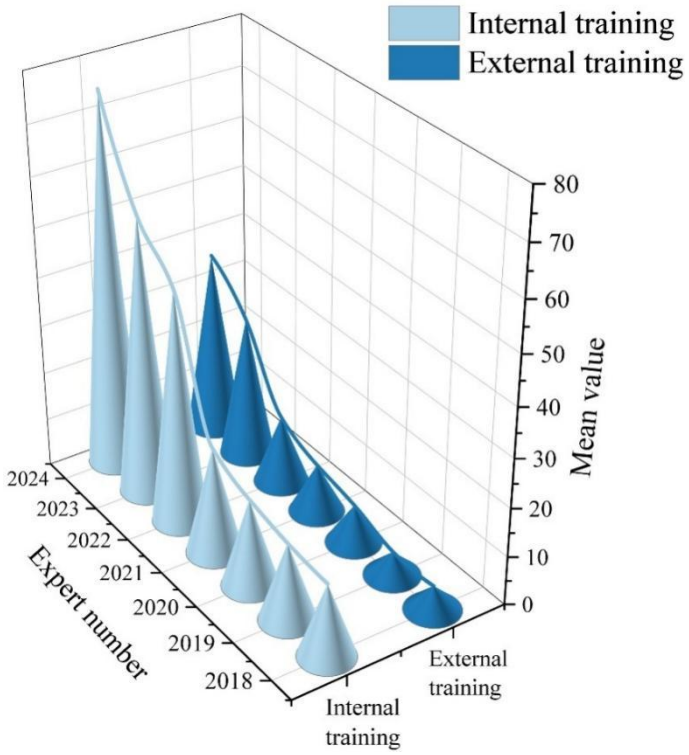

Figure 2: Number of staff vocational skills training project periods

3.3 Analysis of Issues in Vocational Skills Training

One investigation question paper named "WR Enterprise Work Ability Training Current Condition Investigation" was distributed among the work staff of WR enterprises. In this investigation, we altogether dispatched 1,069 investigation papers. All 1,069 investigation papers were got back, and 1,058 among them were considered as effective.

3.3.1 Overall Satisfaction with Training

Figure 3 gives a decompose of the whole satisfaction degrees about the training projects among workers at different level ranks inside WR Corporation. The senior managers who are at director rank and above have displayed a higher degree of satisfaction toward the overall carrying out of the training projects. A very great proportion of them have expressed that they hold the satisfaction. For giving more concrete description, 60% among this crowd put forward they had satisfaction, and 32% made clear that they held very high satisfaction. It is worth noticing that, there did not exist any reports about dissatisfaction coming from this group of people.When we make comparison with senior management, the overall satisfaction degree of employees who are at section-chief level and below, together with team leaders and people at lower posts, was comparatively lower. The percentages of persons who declare they are “highly satisfied” are 19% and 20% respectively. On the opposite side, the dissatisfaction proportions are 12 percent and 16 percent. As for the satisfaction degree that senior employees and lower-level employees hold toward the professional skill training projects launched by the company, a remarkable difference exists.

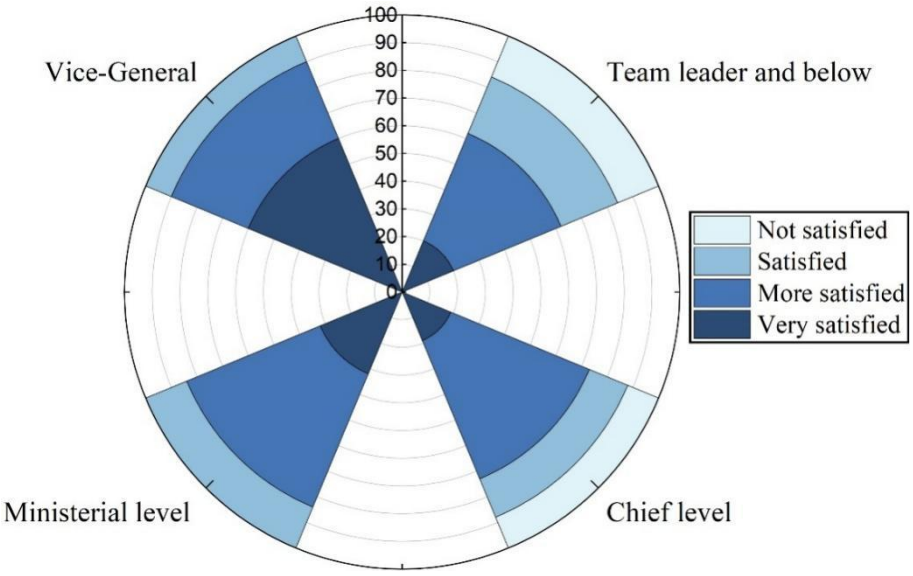

Figure 3: The overall satisfaction evaluation of vocational skills training work

3.3.2 Factors Hindering Training Efforts

Figure 4 shows the manner by which workers on different work levels look at the factors which block occupation ability training. The diagram displays that the chief elements which hinder and affect training schemes are gathered in four areas: a want of training pointedness, a lack of teacher resources, a not enough of training materials, and too much work burdens.It is worth noting that, high-rank working personnel regard the insufficiency of training materials and the lack of teacher presence as the most obvious barriers to the carrying out of training projects. For the situation of department heads and section chiefs, the too big work load is a more big contributing factor.

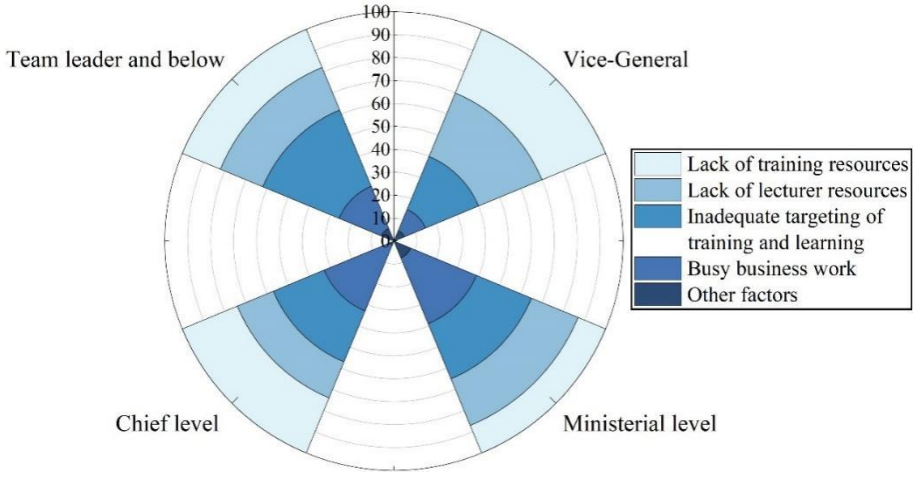

Figure 4: The main factors hindering training and learning

3.3.3 Acceptance of Training Methods

Because of differences in management abilities, thought structures, and the capacity to accept new knowledge and ideas, employees who are in different position levels show different degrees of agreement towards training methods. The most effective training methods perceived by personnel at each level are detailed in Figure 5. Currently, WR Company primarily employs classroom instruction as its main training method. However, personnel across all levels

generally perceive the effectiveness of classroom lectures as relatively low, with acceptance rates below 10% for all levels. Interviews reveal that most employees find classroom-based training monotonous and traditional. Their enthusiasm for participating in such training is low, and they show a relative preference for other training methods such as role-playing and case studies.

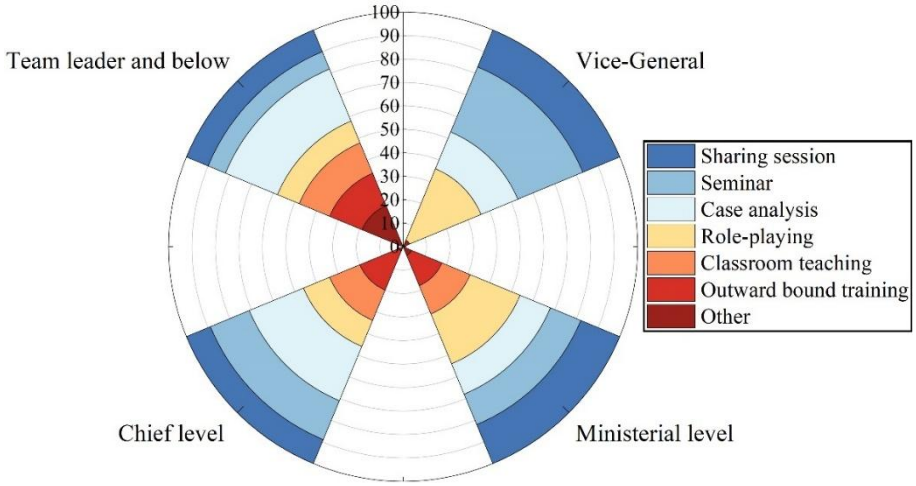

Figure 5: Personnel at all levels think that the most effective way of training

4 Research on the Design of an Evaluation Framework for Vocational Skills Training Outcomes

This chapter will develop a scientifically sound optimization plan and countermeasures based on the current status and primary issues of WR Company's existing vocational skills training system, thereby achieving research on the design of a vocational skills training effectiveness evaluation framework. To ensure the reliability and validity of the indicators proposed within the training effectiveness evaluation framework, an expert scoring method will be employed to discuss the proposed training effectiveness evaluation indicators. Ultimately, a training effectiveness evaluation indicator system suitable for WR Company's current vocational skills training programs will be finalized. Subsequently, the AHP (Analytic Hierarchy Process) will be applied to establish the weighting relationships among the various indicators.

4.1 Determination of Vocational Skills Training Effectiveness Evaluation Indicators

The specific indicators for the vocational skills training effectiveness evaluation framework established in this paper are shown in Table 5. Through the method of individual expert nomination, the first-level indicators were determined to include demand analysis indicators, curriculum design indicators, material development indicators, training implementation indicators, and training effectiveness evaluation indicators. Second-level evaluation indicators were established using the Delphi method, specifically the fuzzy evaluation approach.The main index items were decomposed, and after several rounds of specialists' voting which utilized the Delphi method, a final group of second-level assessment index items was thus constructed. This system is composed of 14 index items, include the completeness degree of post analysis and the scientific accuracy degree of work mission analysis.

Table 5: WR company vocational skills training effect evaluation index system

Indicator system	First level indicators	Second level indicators
WR company vocational skills training effect evaluation index system	Demand analysis	Comprehensive job analysis
		Scientific task analysis
		Rationality of Needs Analysis
	Curriculum Design	Clear training objectives
		The course design is reasonable.
	Material development	Trainee training approach settings
		Preparation / selection of training materials
		The training materials are rich in content.
		Training Facilities Equipment
	Training implementation	Training Plan Arrangement
		Training organization management
		Training teacher configuration
	Training effect evaluation	Students ' mastery of training objectives
		The improvement of students ' individual comprehensive working ability

4.2 Weighting of Evaluation Indicators for Vocational Skills Training Effectiveness

Based on the evaluation indicator system constructed above, the Analytic Hierarchy Process (AHP) will be applied to calculate the weights of the indicators. Given the large number of evaluation indicators, for computational and statistical convenience, we have assigned unique codes to each of the 14 secondary evaluation indicators within the system. The specific codes corresponding to each indicator are shown in Table 6. The primary indicators—including demand analysis, course design, material development, training implementation, and training effectiveness evaluation—are designated alphabetically as A through E. Subordinate secondary indicators under each primary indicator are further numbered sequentially, such as A1 through A3.

Table 6: Index encoding

First level indicators	Numbering	Second level indicators	Numbering
Demand analysis	A	Comprehensive job analysis	A1
		Scientific task analysis	A2
		Rationality of Needs Analysis	A3
Curriculum Design	B	Clear training objectives	B1
		The course design is reasonable.	B2
Material development	C	Trainee training approach settings	C1
		Preparation / selection of training materials	C2
		The training materials are rich in content.	C3
		Training Facilities Equipment	C4
Training implementation	D	Training Plan Arrangement	D1
		Training organization management	D2
		Training teacher configuration	D3
Training effect evaluation	E	Students ' mastery of training objectives	E1
		The improvement of students ' individual comprehensive working ability	E2

Experts conducted pairwise comparisons of the 14 secondary indicators using the evaluation matrix and assigned corresponding scores. Based on the principles for constructing weight judgment matrices, six such matrices should be established. The expert judgment matrix values were imported into the software to verify the consistency of the matrices. After adjusting the results, the weight values for each indicator were obtained. The maximum eigenvalues and consistency test results for each weight matrix are as follows:

1) Weight Matrix: Top-level Objective—A: λmax=3.08818; CR=0.0836. Consistency of this judgment matrix is acceptable.

2) Weight Matrix: Top-level Objective—B: λmax=3.09265; CR=0.08886. Consistency of this judgment matrix is acceptable.

3) Weight Matrix: Top-level Objective—C: λmax=3.10262; CR=0.09964. The consistency of this judgment matrix is acceptable.

4) Weight Matrix: Top-level Objective—D: λmax=3.08653; CR=0.08306. The consistency of this judgment matrix is acceptable.

5) Weight Matrix: Top-level Objective—E: λmax=2; CR=0. The matrix consistency is acceptable.

6) Weight Matrix: Top-level Objective λmax=5.44622; CR=0.0996. The matrix consistency is acceptable.

Finally, the specific weights for secondary indicators relative to primary indicators are shown in Figure 6. It can be observed that the indicator with the highest weight is the secondary indicator A3 (Rationality of Requirement Analysis) under the primary indicator Requirement Analysis, with a weight as high as 0.2016.Other extra secondary indices whose weights are more than 0.1 are B2 (Reasonability of Curriculum Plan), D3 (Distribution of Training Teachers), and E2 (Promotion of Trainees' All-round Work Abilities), which hold weights of 0.1655, 0.1415, and 0.1162 separately.

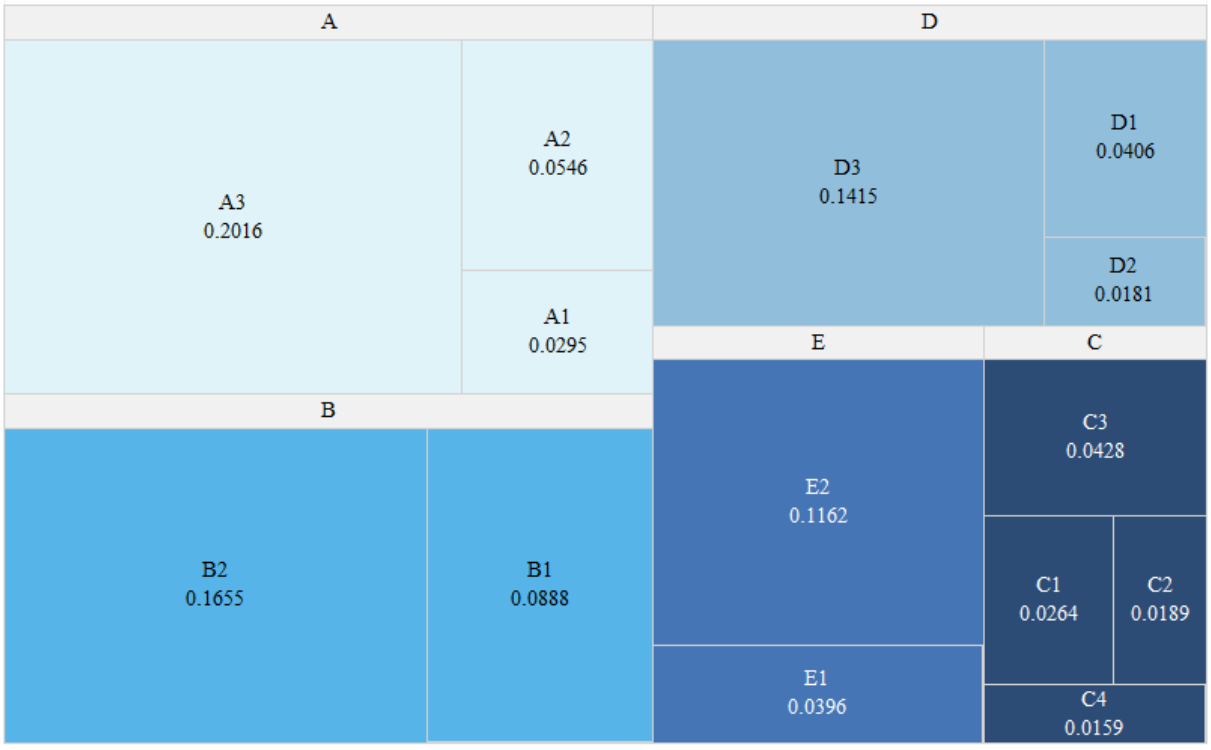

Figure 6: The weight distribution of vocational skills training effect evaluation index

5 Application Research on the Evaluation Framework for Vocational Skills Training Outcomes

For the purpose of evaluating whether the evaluation system for the effect of occupational skill training which this paper has constructed possesses practical application value and good application effects, this research selected the marketing training project which WR Company launched during March to June 2025 to be the subject of this application research. This training was composed of six separate sessions, each of which spans six days. In total, 180 trainees and five trainers were had by this study to participate in.

5.1 Evaluation Subjects and Data Acquisition

In the frame for measuring training effect that was constructed in the previous chapter, because each appraisal index has different content and different attributes, it is necessary to pick appropriate appraisal subjects for different indexes, and use varied methods to collect appraisal data.For the purpose of getting all-round feedback from every person taking part in this project, the team of appraisers has been enlarged to include trainers that participated in the training from beginning to end and training project controllers. The unique difference exists in the specific evaluation standards. These persons are able to do direct observations upon the training program in the course of training sessions and convert them into numerical score values.

5.2 Fuzzy Comprehensive Evaluation Analysis

For the purpose of obtaining the total mark for the effect of the market training item, the fuzzy comprehensive evaluation method this place will be used. This method efficaciously deals with the built-in subjective property existing in human assessment processes and the hardships in simulation encountered when carrying out objective assessments.The statistical results from every index are next put in order, and the total evaluation conclusions for every index are got through calculating the overall evaluation results by means of the fuzzy comprehensive evaluation method. The fuzzy judging matrix and the final overall evaluation outcomes, which are obtained through weighted average methods, are displayed in Table 7. According to the results obtained from the fuzzy comprehensive evaluation:

1) Researches on the Demands of Training: All three second-class indexes have achieved an excellent ratio that exceeds 80 percent. The whole evaluation score was 95.93, and this score was considered to be the Outstanding level.

2) Training Curriculum Design: With regard to the sub-index B1, that relates to the trainees' clearness about training aims, the excellent ratio was located at 59%. On the opposite side, regarding sub-indicator B2, which touches upon the rationality of curriculum arrangement, the rate of excellent performance was 20%. The overall evaluating score for this domain was 79.93. In the five main index, this score is the lowest one. This thing clearly makes clear that this special region needs instant attention and improvement.

3) Development of Training Materials and Resources: The performance on all three sub-indicators which are related to the development of training materials was extremely excellent, each of which exceeds the 90% achievement mark. The overall grading on this aspect has attained a very high 98.85. This high score has reflected the strong approvement that training participants give to both the training materials and the relevant facilities. This thing clearly gives confirmation that the selections which people did in material picking, and also the content inside them, are in very close accordance with the real demands of those participating persons. Furthermore, the training materials and the facilities have already successfully achieved the training standards on a high-quality level.

4)Training Implementing: The total score has achieved 97.7 points, which has obtained an excellent level. Most of the three metrics have obtained the excellent grades, hence the total excellent proportion has exceeded 85%. Inside these, the relatively not so strong sub-metric is Trainer Resource Distribution (D3), which has been given a middle-level grade at 1%. Even although this proportion is small, it is possible that individual factors might have exerted influence on this result. The problems which are pointed out by this measuring tool ought to be given the attention that is deserved.

5) Evaluation on Training Effectiveness: The total score has achieved 92.64, thus obtaining an excellent grade. However, the sub-index which is connected with the promotion of participants' overall working abilities (E2) possessed a thin rate of excellent grade, which is only 51%. This points out that quite a few participants hold the opinion that the training did not attain enough good effect after this program was finished. Therefore, this condition is worthy of deep careful examination.

On the whole, the marketing training project which was conducted by WR Company in the period from March to June 2025 has got a total evaluation score of 93.39. This score is located in the 80-100 scope, hence it gives the program the classification of outstanding. This result can clearly manifest the total victory of this project, and hence the approval that it obtains from the great majority of the participants.Nevertheless, the results of assessment also reveal aspects which have need of improvement. The training’s goals and the courses’ design should comprehensively absorb suggestions that come from both trainees and instructors. After deficiencies have been found out, they must be handled at once, together with a overall check of the root reasons.Furthermore, it is of great necessity that we closely carry out the monitoring work on the feedback which is related to the promotion of skills after the completion of training. The training projects and steps should be optimized in accordance with the suggestions that are put forward by the persons who receive training. By this means, we are able to ensure that the training sufficiently satisfies the company's production and operation demands.

Table 7: Results of fuzzy comprehensive evaluation

First level indicators	Second level indicators	Excellent	Satisfied	General	Difference	Very poor	Evaluation score	Results of comprehensive evaluation
A	A1	0.87	0.09	0.04	0	0	95.93	93.39
	A2	0.93	0.044	0.03	0	0		
	A3	0.87	0.04	0.09	0	0		
B	B1	0.59	0.07	0.14	0.18	0.03	79.93	
	B2	0.2	0.5	0.27	0.03	0		
C	C1	0.94	0.04	0.02	0	0	98.85	
	C2	0.98	0.02	0	0	0		
	C3	0.95	0.05	0	0	0		
	C4	0.97	0.03	0	0	0		
D	D1	0.91	0.09	0	0	0	97.7	
	D2	0.89	0.11	0	0	0		
	D3	0.89	0.1	0.01	0	0		
E	E1	0.86	0.11	0.03	0	0	92.64	
	E2	0.51	0.46	0.03	0	0		

6 Conclusion

The present research has selected WR Company to be the object of its investigation. At the

beginning, through questionnaire-centered investigations, this research has explored the current situation and hardships that WR Company’s vocational skill training projects are encountering. Beginning from the year 2018, the vocational training budget of WR Company has been on an upward path each year. Year 2022 has been witnessed by us to have the most big growth, with a rate of increase being 53.12%.In the time from 2018 to 2024, over 300 vocational training projects have been organized by relevant sides. Each year, the count of staff members who take part in the training continuously exceeded several thousand. Although high-level managers (persons at director rank and above) displayed a high degree of overall satisfaction with the training, the satisfaction degrees dropped among department heads and group supervisors. Concretely speaking, the satisfaction rates on section chiefs and team leaders are 12% and 16% separately. This therefore exposes a quite obvious discrepancy between high-rank and low-rank administrative management.The personnel who are in higher positions mainly attribute the difficulties of training to the insufficiency of sufficient resources and the insufficient supply of teachers. By comparison, the functionaries who are at ministerial and section chief levels regard the too big work burden as the main obstacle that stops the training. Regarding the methods of training, all circles at every level hold the view that traditional teaching which bases on classrooms is relatively low in efficiency.

For the purpose of solving the problems which WR Company meets when it carries out vocational skill training, this paper has constructed an evaluation framework that assesses the effect of the training. The one-level and two-level indicators were established through the way of expert nomination and the Delphi method.We have employed the Analytic Hierarchy Process (AHP) to confirm the weight connections among all indicators. In the secondary indicators, "Rationality of Demand Analysis" (A3) possesses the highest weight, which attains 0.2016.Finally, for the purpose of verifying the effect and actual application usability of the constructed evaluation framework, the marketing training program which was conducted by WR Company in the period from March to June 2025 has been selected to serve as the case analysis.We have utilized the Fuzzy Comprehensive Evaluation Method to carry out the assessment on the training program. About the main index items, which contain the analysis of training demands, the planning of training courses, the making of training materials, the carrying out of the training, and the assessment of training effects, their each whole scores are 95.93, 79.93, 98.85, 97.7, and 92.64. Training curriculum design received the lowest score, indicating it should be a key focus for future improvement. The final comprehensive evaluation score for the marketing training program was 93.39, achieving an excellent rating. Overall, the vocational skills training effectiveness evaluation framework designed in this paper provides valuable insights and reference for enterprises conducting vocational skills training effectiveness assessments.

Funding

This work was supported by Department of Agriculture and Rural Affairs of Jiangsu Province (Grant 25ASS070); by Higher Education Association of Jiangsu Province (Grant 2025JGZZ58); by Jiangsu Society of Technical and Vocational Education (Grant XHZDB2025042).

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References

[1] Samoliuk, N., Bilan, Y., & Mishchuk, H. (2021). Vocational training costs and economic benefits: exploring the interactions. Business Economics and Management (JBEM), 22(6), 1476-1491.

[2] McGrath, S., & Yamada, S. (2023). Skills for development and vocational education and training: Current and emergent trends. International Journal of Educational Development, 102, 102853.

[3] Singh, R. K. (2022). Role of Vocational Education and Skill Training to Stimulate Human Development. Indian Journal of Social Science and Literature, 2(1), 31-36.

[4] Barrera-Osorio, F., Kugler, A., & Silliman, M. (2023). Hard and soft skills in vocational training: Experimental evidence from Colombia. The World Bank Economic Review, 37(3), 409-436.

[5] Martin, C. J. (2017). Skill builders and the evolution of national vocational training systems. The Oxford handbook of skills and training. Oxford University Press, Oxford, 36-53.

[6] Aranda, J. R., Campos, I., Cosculluela, C., San Martin, J., & De Pablos, C. (2023). Continuous vocational training in response to the challenge of industry 4.0: Required skills and business results. Journal of Industrial Engineering and Management, 16(2), 319-341.

[7] Bechichi, N., Jamet, S., Kenedi, G., Grundke, R., & Squicciarini, M. (2019). Occupational mobility, skills and training needs. OECD Science, Technology and Industry Policy Papers.

[8] Silwal, U. K., & Bhatta, K. (2017). Assessing the effectiveness of Vocational Education and Trainings (VET) in improving employability: A case study of skills for employment programs in Nepal. International Journal of English Literature and Social Sciences, 2(5), 239226.

[9] Nalbandi, H., & Zonoozi, S. J. (2019). Determine the impact of market-orientated skill training on satisfaction and effectiveness of trainees in technical and vocational training: a case study in western azarbaijan province, Iran. Dutch Journal of Finance and Management, 3(1), 1-5.

[10] Mustajab, D., & Irawan, A. (2023). The effectiveness of vocational training programs on employment outcomes. Advances in Community Services Research, 1(2), 54-63.

[11] Popescu, M. E., & Roman, M. (2018). Vocational training and employability: Evaluation evidence from Romania. Evaluation and program planning, 67, 38-46.

[12] Li, J., Wiemann, K., Shi, W., Wang, Y., & Pilz, M. (2019). Vocational education and training in Chinese and German companies in China: a ‘home international’comparison.

International Journal of Training and Development, 23(2), 153-168.

[13] Lee, J. W., Han, J. S., & Song, E. (2019). The effects and challenges of vocational training in Korea. International Journal of Training Research, 17(sup1), 96-111.

[14] Güngör, G. (2020). Problems and Solution Suggestions Encountered in Vocational Skill Training in Vocational High Schools: Teachers' Views. Online Submission, 7(4), 233-253.

[15] Babu, A. R., Rajavenkatanarayanan, A., Abujelala, M., & Makedon, F. (2017, May). Votre: A vocational training and evaluation system to compare training approaches for the workplace. In International Conference on Virtual, Augmented and Mixed Reality (pp. 203-214). Cham: Springer International Publishing.

[16] Doufexi, T., & Pampouri, A. (2022). Evaluation of employees' vocational training programmes and professional development: A case study in Greece. Journal of Adult and Continuing Education, 28(1), 49-72.

[17] Pham, V. M. H., Schlüter, N., & Löwer, M. (2024, September). Development of an Evaluation Process in Vocational Education Organizations Addressing SMEs' Requirements. In International Conference on Interactive Collaborative Learning (pp. 543-554). Cham: Springer Nature Switzerland.

[18] Hadı, S., Andrıan, D., & Kartowagıran, B. (2019). Evaluation model for evaluating vocational skills programs on local content curriculum in Indonesia: Impact of educational system in Indonesia. Eurasian Journal of Educational Research, 19(82), 45-62.

[19] Tang, C. W., & Nguyen, H. T. (2023). An evaluation of the effectiveness of Vietnam's vocational training project for rural laborers. Adult Education Quarterly, 73(3), 286-309.

[20] Ambu-Saidi, B., Fung, C. Y., Turner, K., & Lim, A. S. S. (2024). A critical review on training evaluation models: a search for future agenda. Journal of Cognitive Sciences and Human Development. Vol, 10(1).

[21] Chamadia, S., & Mubarik, M. S. (2021). Assessing the effectiveness of vocational training programs in Pakistan: an experimental study. Education+ Training, 63(5), 665-678.

[22] Sudana, I. M., Apriyani, D., & Suryanto, A. (2019, November). Soft Skills evaluation management in Learning processes at Vocational school. In Journal of Physics: Conference Series (Vol. 1387, No. 1, p. 012075). IOP Publishing.

[23] Tiwari, P., & Malati, N. (2020). Employability skill evaluation among vocational education students in India. Journal of Technical Education and Training, 12(1).

[24] Su, W., & Li, D. (2023). The effectiveness of translation technology training: a mixed methods study. Humanities and Social Sciences Communications, 10(1), 1-12.

[25] Paul, S., Burman, R. R., & Singh, R. (2024). Training effectiveness evaluation: Advancing a Kirkpatrick model based composite framework. Evaluation and Program Planning, 107, 102494.

[26] Konopasek, L., Rosenbaum, M., Encandela, J., & Cole-Kelly, K. (2017). Evaluating communication skills training courses. Oxford Textbook of Communication in Oncology and Palliative Care. 2nd ed. Oxford: Oxford University Pres, 399-404.

[27] Guo, Y., Freer, D., Deligianni, F., & Yang, G. Z. (2021). Eye-tracking for performance evaluation and workload estimation in space telerobotic training. IEEE Transactions on Human-Machine Systems, 52(1), 1-11.

[28] Hristova, T., Stoyanov, I., Mitev, I., & Aleksandrov, R. (2023, November). Automated Tracking of Electrical Engineer Competencies through Blockchain Technology. In 2023 4th International Conference on Communications, Information, Electronic and Energy Systems (CIEES) (pp. 1-8). IEEE.

[29] Castillo-Segura, P., Fernández-Panadero, C., Alario-Hoyos, C., Muñoz-Merino, P. J., & Kloos, C. D. (2021). A cost-effective IoT learning environment for the training and assessment of surgical technical skills with visual learning analytics. Journal of biomedical informatics, 124, 103952.

[30] Wang, S., Yang, Y., Culpepper, S. A., & Douglas, J. A. (2018). Tracking skill acquisition with cognitive diagnosis models: A higher-order, hidden Markov model with covariates. Journal of Educational and Behavioral Statistics, 43(1), 57-87.

[31] Islam, M. Z., Abdul Kader Jilani, M. M., & Karim, M. R. (2024). Enhancing post-training evaluation of annual performance agreement training: A fusion of fsQCA and artificial neural network approach. PloS one, 19(6), e0305916.

[32] Yanik, E., Intes, X., Kruger, U., Yan, P., Diller, D., Van Voorst, B., ... & De, S. (2022). Deep neural networks for the assessment of surgical skills: A systematic review. The Journal of Defense Modeling and Simulation, 19(2), 159-171.

[33] Bhatia, S., Arora, V., & Batra, S. (2024). The Role of Artificial Intelligence in Developing an Effective Training Assessment Tool. In AI-Oriented Competency Framework for Talent Management in the Digital Economy (pp. 244-255). CRC Press.

[34] Cao, Z., Chen, T., & Cao, Y. (2021). Effect of occupational health and safety training for Chinese construction workers based on the CHAID decision tree. Frontiers in Public Health, 9, 623441.

[35] Lv, Y. (2025). Support vector machine (SVM) algorithm optimization and innovative talent matching model for employment needs. Journal of Computational Methods in Sciences and Engineering, 14727978251325084.

[36] Fathiazar, E., Mikaeiloo, G., Adib, Y., & Khallaghi, A. A. (2018). Examining the optimal methods of evaluation in productive training system in vocational schools. Educational Measurement and Evaluation Studies, 8(22), 79-108.

[37] Abelaka Icssrnerc. (2022). The Role of Rural Women's Vocational Skills Training in Improving Their Entrepreneurial and Employability. Journal of Educational Research and Policies,4(2).

[38] Guoqing Fan,Yu Wang,Shengnan Zhao,Xuning Qiao,Guanwei Yang & Zhongyun Lin.

(2025). Optimization of social values for ecosystem services assessment based on the analytic hierarchy process: A case study of the core district parks in Zhengzhou. Environmental and Sustainability Indicators,27,100786-100786.

[39] Hendra Hidayat,Aan Komariah,Bambang Budi Wiyono & Yasdinul Huda. (2025). Impact of the Use of Fuzzy Comprehensive Evaluation Applications towards Computational Thinking Skill Students in Engineering Education. International Journal of Information and Education Technology,15(1).