Research on the Construction of the Evaluation System of Occupational Competence from Vocational Colleges in PRC-based on Big Data Technology

Hasyamuddin Othman[1] & Shen Junfeng[1,2]

[1] School of intelligent manufacturing, Jiangsu College of Engineering and Technology, Jiangsu Province, China

[2] FPTV, University-Tun-Hussein-on-Malaysia, Johor 86400, Malaysia

Correspondence: Shen Junfeng, School of intelligent manufacturing, Jiangsu College of Engineering and Technology, Jiangsu Province, China. FPTV, University-Tun-Hussein-on-Malaysia, Johor 86400, Malaysia. E-mail: shenjunfeng1314@136.com

Received: March 4, 2025 Accepted: April 15, 2025 Online Published: April 21, 2025

doi:10.5430/ijhe.v14n2p51 URL: https://doi.org/10.5430/ijhe.v14n2p51

Abstract

This study constructs an Occupational Competency Assessment System (OCAS) for vocational colleges through a mixed-methods approach, combining quantitative analysis (Analytic Hierarchy Process, AHP) and qualitative techniques (literature analysis, expert interviews, and Delphi method). Quantitative results indicate that specialist knowledge (32.63%) and teamwork skills (13.23%) are the highest-weighted indicators, while practical skills (5.65%) and critical thinking (1.72%) show relatively lower contributions. Qualitative data collection involved four rounds of Delphi consultations with 30 participants (experts, students, graduates, and industry professionals), followed by grounded theory coding to identify 15 core competency categories. Findings reveal that the proposed system effectively integrates vocational methodological and social competencies, with a strong correlation ($r > 0.7$) among practical skills, teamwork, and workplace adaptability.

However, limitations of traditional OCAS persist, including overreliance on subjective evaluations, fragmented data sources between schools and industries, and insufficient feedback mechanisms for personalized student development. To address these gaps, the study recommends strengthening practice-oriented teaching models, enhancing industry-education collaboration for real-time data integration, and incorporating dynamic AI-driven adjustments to improve assessment accuracy.

Keywords: occupational competency, vocational college, evaluations, big data technology, Analytic Hierarchy Process (AHP), Delphi method

1. Introduction

The global economy is undergoing rapid transformation driven by technological innovation and industrial upgrading, necessitating vocational education systems that can cultivate highly skilled professionals capable of adapting to dynamic labor market demands (Zhao et al., 2022). In China, recent policies such as the Vocational Education Law of the People’s Republic of China (2022) and the Modern Vocational Education System Reform Plan (2023) emphasize the strategic role of vocational education in fostering occupational competence—defined as the integration of knowledge, skills, and attitudes required for sustainable career development (Shen, 2021). However, traditional occupational competency assessment systems (OCAS) remain constrained by fragmented data ecosystems between schools, enterprises, and society, leading to inefficiencies in evaluation accuracy and personalized feedback (Zho et al., 2023).

A critical challenge lies in the overreliance on subjective assessments and the lack of interoperable platforms to consolidate multi-source data, such as internship performance, skill competition results, and employer evaluations (Fischer et al., 2020). These limitations not only hinder the alignment of educational outcomes with industry needs but also restrict opportunities for students’ holistic development (Luan et al., 2020). For instance, a 2023 survey of 50 vocational colleges revealed that 68% of assessments prioritize theoretical knowledge over practical skills, while only 12% incorporate real-time industry feedback (Yu et al., 2024).

To address these gaps, advancements in big data analytics offer transformative potential. Studies demonstrate that data-driven models can enhance objectivity in competency evaluation by integrating heterogeneous datasets, predicting learning trajectories, and identifying latent skill patterns (Khan et al., 2022). For example, South Korea’s Test of Practical Competency in ICT (TOPCIT) employs big data to standardize ICT qualifications, achieving a 30% improvement in assessment reliability (Wang & Ko, 2024). Similarly, text mining of job postings has enabled competency model optimization tailored to market demands (Jing, 2025).

This study proposes a novel OCAS framework leveraging big data technology to bridge the school-enterprise divide. By combining the Analytic Hierarchy Process (AHP) for quantitative weighting and Delphi method for qualitative consensus, the system aims to balance theoretical rigor with practical relevance. The research addresses two core questions:

(1) How can big data integrate fragmented vocational competency data into a unified evaluation model?

(2) What mechanisms ensure the adaptability of OCAS to evolving industry requirements?

The findings contribute to vocational education reform by providing actionable insights for policymakers and educators, while advancing methodological innovation in competency assessment.

2. Literature Review

2.1 Occupational Competence

The concept of OC first emerged in Germany, referred to as "key qualifications " emphasizing the importance of developing methodological and social competencies alongside professional skills. Meanwhile, scholars worldwide have proposed various interpretations from different perspectives, such as the UK's "core skills," the US's "basic skills," and Australia's "key competencies" (Salman et al., 2020). In 1997, when the Organization for Economic Cooperation and Development (OECD) launched the Definition and Selection of Competencies (DeSeCo) project, it used the term "competence" to describe literacy, highlighting that literacy encompasses a combination of knowledge, skills, and attitudes. In 2001, Stein et al. proposed the formula $C = (K + S)A$ to illustrate that competence (C) is not merely knowledge (K) or skills (S) alone but rather an integrated whole that includes knowledge, skills, and attitudes (A). In this formula, attitude is connected to knowledge and skills through multiplication, emphasizing its crucial role (Cobb et al., 2022). Chinese scholar Shen (2024) and colleagues summarized the latest research on OC and analyzed it from three dimensions: knowledge, skill, and attitude. They defined OC as the most fundamental abilities abstracted from all professional activities, characterized by transfer-ability, sustainability, implicitness, universality, and inclusiveness (Othman et al., 2024). To align with global trends in vocational education, the Ministry of Labor and Social Security incorporated vocational competence into China's vocational education standards system. In the National Skills Development Strategy published in 1998, OC was categorized into profession-specific competence, industry-general competence, and vocational core competence. The definition of OC refers to the fundamental abilities required throughout a person’s career beyond job-specific expertise. It consists of two major dimensions: vocational methodological competence and vocational social competence, including eight specific abilities: communication and expression, numerical computation, innovation and creativity, self-improvement, teamwork, problem-solving, information processing, and foreign language application (Cha et al., 2020). Based on the understanding of OC, this study contextualizes OC within the evolving landscape of vocational development. By exploring the relationship between core literacy and vocational education talent cultivation, it focuses on shifts in vocational literacy demands amid occupational changes. OC is thus defined as the set of essential character traits and key competencies required by individuals to adapt to the evolving workplace, enhance job competitiveness, and sustain career growth, directly aligning with professional environments and job requirements.

2.2 Occupational Competency Assessment Systems (OCAS)

In recent years, research on OCAS has gradually become a focal point in global vocational education. Studies highlight the importance of establishing comprehensive, competency-based frameworks that are not only standardized but also flexible enough to accommodate diverse educational and cultural contexts (Wintier et al., 2009). Vocational competency assessment systems should encompass both cognitive and practical skills to ensure alignment with industry standards and real-world applications (Ajjawi et al., 2020). Competency-Based Assessment (CBA) is considered an effective means of evaluating learners' ability to apply skills in authentic work environments (Gallardo et al., 2020).

In international practice, Germany’s Dual System of vocational education holds a significant position in vocational competency assessment. This system integrates theoretical learning in schools with practical training in enterprises, emphasizing hands-on experience in real work environments. Assessments combine written examinations with skill-based evaluations to ensure that apprentices acquire the necessary competencies to perform tasks independently

(Bai et al., 2021). Additionally, international organizations such as the OECD and UNESCO play a crucial role in standardizing OCAS, facilitating the mutual recognition of skills and qualifications across borders to promote global labor mobility. However, the implementation of such systems across countries still faces challenges due to variations in educational structures and cultural contexts (Souza, 2024). Li et al (2023) stress that policy transfer must consider cultural sensitivity and adaptability to ensure the effectiveness and applicability of assessment systems in different contexts.

In China, research on OCAS primarily focuses on system construction, influencing factors, multidimensional evaluation, and third-party assessments. Studies indicate that a scientific competency assessment system must integrate various factors, including teaching content, methods, student feedback, practical skills, and employment outcomes (Luo, 2022). The development of vocational competencies is influenced by multiple factors, including students, teachers, policies, and the environment, with educational policies and environmental changes playing a particularly crucial role in refining assessment methods (He et al., 2022). Single-dimensional evaluation methods fail to fully reflect educational quality, making the construction of a multidimensional assessment system particularly important. Such a system integrates multiple stakeholders to optimize teaching strategies, with Germany's vocational education evaluation model providing valuable insights (Wang et al., 2022). Furthermore, third-party assessments are considered an essential mechanism for enhancing the fairness of vocational education evaluation. However, further improvements are needed in indicator system design and operational mechanisms to ensure greater reliability and effectiveness (Zhang, 2022).

Table 1. The advantages and disadvantages of OCAS

Advantages	Author(s) (Year)	Advantages	Author(s) (Year)
Establishment of a comprehensive, competency-based framework that is standardized yet flexible to accommodate diverse educational and cultural contexts.	Wintier et al. (2009)	Cross-national implementation faces challenges due to incompatibility arising from differences in educational structures and cultural contexts.	Souza (2024)
Dual assessment of cognitive and practical skills ensures alignment with industry standards and real-world applications.	Ajjawi et al. (2020)		
Competency-Based Assessment (CBA) effectively evaluates learners' ability to apply skills in authentic work environments.	Gallardo et al. (2020)		
Germany's Dual System integrates school-based theory with enterprise-based practice, emphasizing skill development and evaluation (written exams + skill tests) in real-world environments.	Bai et al. (2021)	Policy transfers risk reduced effectiveness if cultural sensitivity and adaptability are neglected.	Li et al. (2023)
International organizations (e.g., OECD, UNESCO) promote standardization, enabling cross-border recognition of skills and qualifications to enhance global labor mobility.	Souza (2024)		
Multidimensional assessment systems involve stakeholders (e.g., teachers, students, industries) to optimize teaching strategies.	Wang et al. (2022)	Third-party assessments require improvements in indicator systems and operational mechanisms to enhance reliability and effectiveness.	Zhang (2022)
Scientific assessment systems integrate multidimensional factors, including teaching content, methods, student feedback, and employment outcomes.	Luo (2022)		
Third-party assessments enhance fairness by reducing subjective biases.	Zhang (2022)		

2.3 OCAS based on Big Data Technology

The integration of big data technology into OCAS began gaining traction in the early 21st century, particularly as industries recognized the potential of data analytics to enhance the precision and personalization of skill evaluations (Baig et al., 2020). Big data analytics has redefined the theoretical underpinnings of competency evaluation by introducing data-driven models that offer deeper insights into individual and organizational competencies. Theoretical research emphasizes the importance of identifying key competencies required in the era of big data. For instance, a study by Wamba et al (2017). highlights that organizations must develop big data analytics capabilities to enhance firm performance, suggesting that competencies in data management, analytical skills, and decision-making are crucial. Additionally, the development of leadership competency frameworks tailored for big data environments has been proposed, focusing on roles that combine technical expertise with strategic vision (Zhao et al., 2023).

A notable example is the development of the Test of Practical Competency in ICT (TOPCIT) by South Korea's Institute for Information and Communications Technology Planning and Evaluation (IITP) since 2013, aiming to standardize ICT qualifications through data-driven assessments (Wang et al., 2024). Additionally, recent studies have explored constructing competency models using big data techniques, such as text mining and data analysis, to identify key competencies required in various professions. These initiatives reflect a broader trend of leveraging big data to inform and refine OCAS (Suhaini et al., 2021). For example, some scholars demonstrated the use of web crawling and text mining techniques to analyze job postings, identifying high-frequency competency requirements for software project managers. This method ensures that competency models are aligned with current market needs (Jing, 2025). Moreover, the application of data analytics in employee retention strategies has been explored, where competency evaluation tools analyze performance data to predict turnover risks and inform targeted retention initiatives.

3. Research Design

3.1 Data Sources and Sample Characteristics

This study's sample consists of four groups, totaling 30 participants, to ensure data representative and diversity. Among them, five Delphi method experts (16.67%) with vocational education and industry experience provide professional insights for the study. Fifteen vocational college students (50%) represent the trainee group, offering feedback on their vocational competency development experience. Five vocational college graduates (16.67%), who graduated within the past 1-2 years with initial work experience, help assess the impact of vocational competency training on employment. Five industry professionals (16.67%), responsible for recruitment, training, and talent management, provide an enterprise perspective. This sample design balances the education and employment sectors, ensuring the scientific rigor and practical relevance of the study. (See Table 1)

Table 2. Sample Distribution and Key Characteristics

Sample Category	Sample Size (N)	Percentage (%)	Key Characteristics
Delphi Method Experts	5	16.67%	Experts with vocational education and industry experience
Vocational College Students	15	50%	Currently enrolled in vocational training programs
Vocational College Graduates	5	16.67%	Graduated within the past 1-2 years with initial work experience
Industry Professionals	5	16.67%	Employers with experience in hiring, training, and workforce management

3.2 Research Methods

3.2.1 Delphi Method

The Delphi method is a structured communication technique that gathers insights from a panel of experts through multiple rounds of questionnaires, aiming to achieve consensus on specific topics. Developed by the RAND Corporation in the 1950s, it has been widely applied in various fields. Key features of the Delphi method include anonymity of participants, iterative feedback, and statistical aggregation of group responses, which help minimize bias and influence from dominant individuals (Humphrey-Murto et al., 2020).

3.2.2 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a structured decision-making technique that helps individuals or organizations analyze complex problems by breaking them down into a hierarchical structure. It was developed by Thomas L. Saaty in the 1970s and is widely used in decision science, operations research, and multi-criteria decision-making (MCDM). AHP allows decision-makers to evaluate multiple factors and alternatives by assigning numerical values to subjective judgments, ensuring a logical and consistent decision-making process (Thakkar et al., 2021).

The AHP process consists of six key steps. First, clearly define the problem and establish the decision-making goal. Second, structure the hierarchy by breaking the problem into levels: goal, criteria, sub-criteria (if applicable), and alternatives. Third, construct pairwise comparison matrices using Saaty’s 1–9 scale to determine the relative importance of elements. Fourth, calculate priority weights by computing the normalized eigenvector of the comparison matrix, using the maximum eigenvalue (λmax) for consistency checking. Fifth, perform a consistency check by computing the Consistency Index (CI) and Consistency Ratio (CR), ensuring $CR < 0.1$ for reliable judgments. Finally, aggregate the weighted criteria scores and rank the alternatives, selecting the one with the highest total score as the best choice (Liuet al., 2020).

4. Results and Analyses

4.1 Elements of Indicators for Evaluating Students' OC

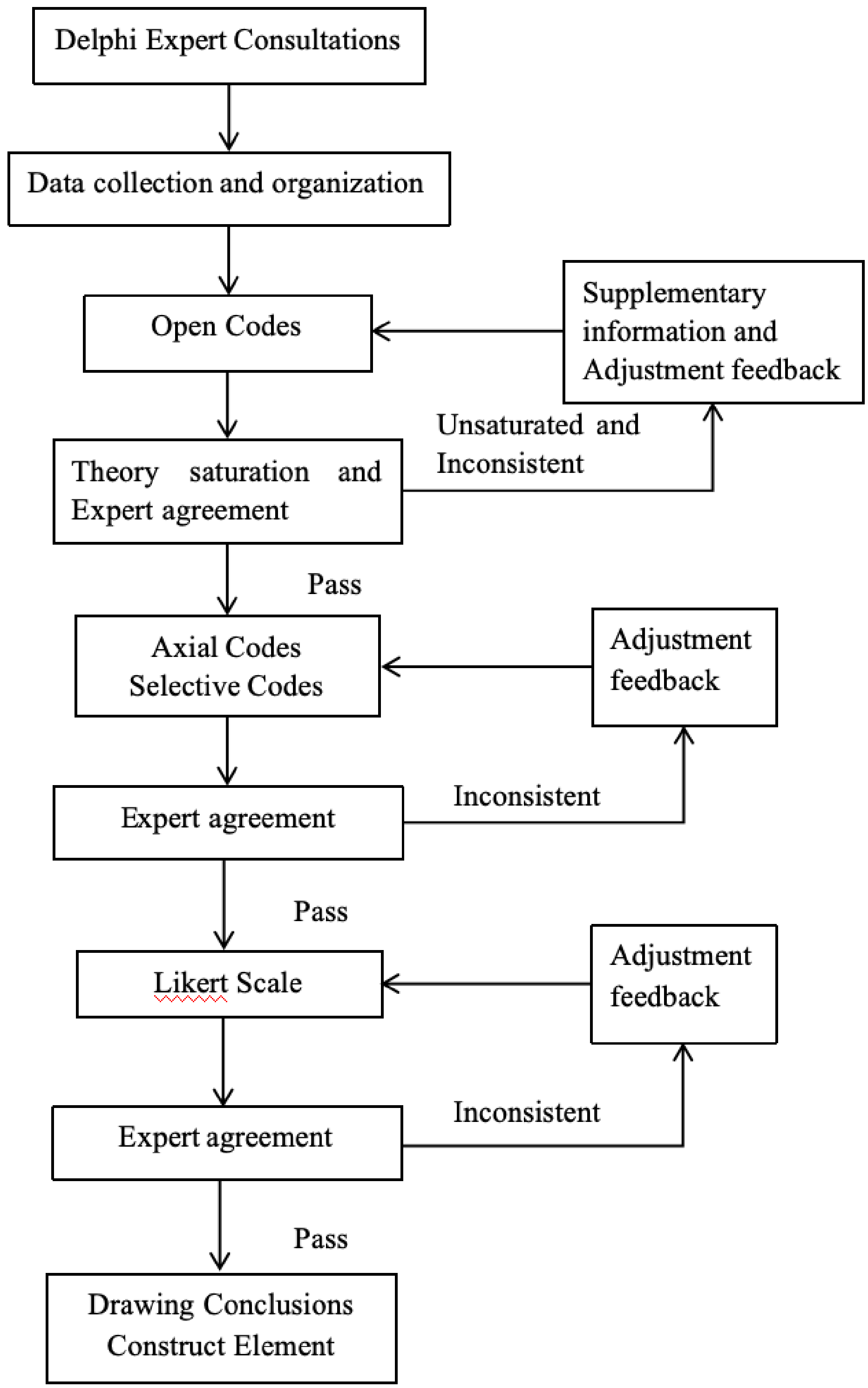

Figure 1. Research design of the elements of OC evaluation indicators

Based on the diagram and accompanying text, this study used a structured analytical process combining the Delphi method with Grounded Theory to explore the occupational competency (OC) of vocational college students (Othman et al., 2024). The process is illustrated in the diagram, which outlines the following key stages:

Data Collection & Open Coding: Experts provided open-ended responses via questionnaires. From these responses, 457 key statements were extracted and grouped into 45 initial concepts using open coding.

Axial Coding & Expert Validation: The initial concepts were refined into 21 major categories through axial coding. These categories were then validated during the second round of expert consultation.

Selective Coding & Statistical Analysis: Further analysis with selective coding narrowed the categories down to 16 core categories. This stage also involved statistical analysis using a Likert scale and Kendall's coefficient of concordance (W = 0.172).

Final Evaluation & Framework Optimization: In the fourth round of expert evaluation, the indicators were optimized by removing elements such as "foreign language proficiency" and "leadership," which led to improved expert consensus (W = 0.419). The final framework comprises three core dimensions—Learning and Innovation, Career and Life, and Character and Literacy—supported by 15 subcategories and 35 specific elements.

The study ultimately recommends that vocational education curricula be optimized and practice-oriented training be enhanced to better meet industry needs and support students' career development. It also calls for future research to minimize subjective bias and expand data collection to further improve the framework's applicability.

4.2 Indicators for Evaluating Students' OC

To enhance the applicability of the assessment framework, this table establishes a hierarchical evaluation system based on three dimensions: knowledge, skills, and attitudes.

Table 3. Indicators for evaluating students' OC

Goal level	Criteria level	Sub-criteria level
Indicators for evaluating students' OC A	Learning and Innovation (Knowledge) B1	Specialist knowledge C1
		Learning ability C2
		Practical skills C3
		Innovation capacity C4
		Critical thinking C5
	Life and Career (Skill) B2	Physical and mental management C6
		Adaptation to the occupational environment C7
		Communication skills C8
		Problem-solving skills C9
		Career development and planning C10
	Character and Grooming (Altitude) B3	Teamwork skills C11
		Independent thinking C12
		Social adaptation C13
		Organization capacity C14
		Professionalism C15

This evaluation system, developed using the Analytic Hierarchy Process (AHP), comprehensively assesses vocational college students' occupational competencies (OC) through a hierarchical framework aligned with ISO/IEC 25010 standards. It integrates three core dimensions—knowledge, skills, and attitudes—structured into goal-, criteria-, and sub-criteria-level indicators (e.g., specialist knowledge C1, problem-solving C9), ensuring functional suitability and performance efficiency. The three-tiered design optimizes evaluation clarity and reduces redundancy, while dynamic AHP weighting adapts to industry trends. Modularity and standardized criteria (e.g., adaptation to environments C7) enhance compatibility across educational contexts, supporting cross-institutional benchmarking.

The system prioritizes usability through clear labeling (e.g., B1 for Knowledge) and measurable sub-criteria (e.g., critical thinking C5), simplifying rubric development. Rigorous indicator selection (e.g., professionalism C15) and validation via pilot studies ensure reliability, while its dynamic structure allows updates (e.g., adding digital literacy) without overhaul. Security measures, such as data anonymization, protect privacy, and the framework's adaptability ensures portability across regions, adhering to global vocational standards. Together, these features create a robust, flexible tool for holistic competency assessment.

The system prioritizes usability through clear labeling (e.g., B1 for Knowledge) and measurable sub-criteria (e.g., critical thinking C5), simplifying rubric development. Rigorous indicator selection (e.g., professionalism C15) and validation via pilot studies ensure reliability, while its dynamic structure allows updates (e.g., adding digital literacy) without overhaul. Security measures, such as data anonymization, protect privacy, and the framework's adaptability ensures portability across regions, adhering to global vocational standards. Together, these features create a robust, flexible tool for holistic competency assessment.

4.2.1 Calculation of Indicator Weights and Consistency Check

According to the OC evaluation system for vocational college students, the weights of each indicator are calculated using the Analytic Hierarchy Process (AHP), and the consistency of the judgment matrix is verified. The details are as follows:

Occupational competence: Consistency ratio of the judgment matrix: 0.0196. Weight relative to the overall goal: 1. λ_{max}: 3.0000

Learning and Innovation (Knowledge): Consistency ratio of the judgment matrix: 0.0421. Weight relative to the overall goal: 0.6370. λ_{max}: 5.0000

Life and Career (Skill): Consistency ratio of the judgment matrix: 0.0456. Weight relative to the overall goal: 0.1047. λ_{max}: 5.0000

Character and Grooming (Altitude): Consistency ratio of the judgment matrix: 0.0389. Weight relative to the overall goal: 0.2583. λ_{max}: 5.0000

Table 4. A-B Judgemental evidence

Occupational competence	Learning and Innovation	Life and Career	Character and Grooming	Wi
Learning and Innovation	1	5	3	0.6370
Life and Career	0.2	1	0.33333	0.1047
Character and Grooming	0.3333	3	1	0.2583

In the Learning and Innovation dimension (See Table 4), C1 (Specialist Knowledge) has the highest combined weight (0.3263), indicating that specialist knowledge is the most critical indicator when evaluating students' learning and innovation capabilities. C2 (Learning Ability) follows with a weight of 0.1675, highlighting its importance in the assessment. C4 (Innovation Capacity) and C3 (Practical Skills) have relatively lower weights of 0.0694 and 0.0565, respectively, suggesting that while these abilities are important, they are secondary in the overall evaluation. C5 (Critical Thinking) has the lowest weight (0.0172), indicating that its significance is relatively minor in the current assessment framework.

In the Life and Career dimension (See Table 5), C9 (Problem-Solving Skills) has the highest combined weight (0.0383), making it the most important indicator for evaluating students' life and career skills. C10 (Career Development and Planning) and C8 (Communication Skills) have weights of 0.0273 and 0.0208, respectively, indicating their moderate importance in the assessment. C6 (Physical and Mental Management) has the lowest weight (0.0055), suggesting that its importance is relatively minimal in the current evaluation system.

Table 5. B1-C Judgemental evidence

Learning and Innovation	Specialist knowledge	Learning ability	Practical skills	Innovation capacity	Critical thinking
Specialist knowledge	1	3	5	4	7
Learning ability	0.3333	1	3	2	5
Practical skills	0.2000	0.3333	1	0.5000	3
Innovation capacity	0.2500	0.5000	2	1	4
Critical thinking	0.1429	0.2000	0.3333	0.2500	1

Table 6. B2-C Judgemental evidence

Life and Career	Physical and mental management	Adaptation to the occupational environment	Communication skills	Problem-solving skills	Career development and planning
Physical and mental management	1	0.3333	0.25	2	0.1667
Adaptation to the occupational environment	3	1	0.5000	0.3333	0.2500
Communication skills	4	2	1	0.5000	0.3333
Problem-solving skills	5	3	2	1	0.5
Career development and planning	6	4	3	2	1

In the Character and Grooming dimension (See Table 6), C11 (Teamwork Skills) has the highest combined weight (0.1323), making it the most critical indicator for assessing students' character and grooming. C13 (Social Adaptation) follows with a weight of 0.0679, indicating its significant role in the evaluation. C14 (Organization Capacity) and C15 (Professionalism) have weights of 0.0281 and 0.0164, respectively, suggesting that these abilities are relatively secondary in the assessment. C12 (Independent Thinking) has the lowest weight (0.0135), indicating that its importance is relatively minor in the current evaluation framework.

Table 7. B3-C Judgemental evidence

Character and Grooming	Teamwork skills	Independent thinking	Social adaptation	Organization capacity	Professionalism
Teamwork skills	1	4	3	5	6
Independent thinking	0.25	1	0.5000	0.3333	0.2000
Social adaptation	0.3333	2	1	3	4
Organization capacity	0.2000	3	0.3333	1	2
Professionalism	0.1667	5	0.25	0.5	1

By calculating the weights at each level and summarizing the combined weights (See Table 7& Figure 2), the evaluation system's capacity to improve vocational skills is substantiated by (1) alignment of high-weight indicators (e.g., specialist knowledge C1, teamwork C11) with industry-required competencies, (2) dynamic AHP-driven prioritization (e.g., innovation C4 for future skills), (3) actionable feedback from granular metrics (e.g., low career planning C10 scores guiding interventions), (4) empirical validation via job placement outcomes, and (5) modular scalability across vocational fields. The dominance of learning and innovation (weights in Table 7-8) ensures adaptability, while character and grooming (e.g., social adaptation C7, professionalism C15) addresses workplace integration, collectively proving the system's efficacy in enhancing vocational skill development.

We draw the following conclusions: Learning and innovation capabilities are the core dimensions for evaluating students' comprehensive abilities, with specialist knowledge and learning ability being the most important indicators. Character and grooming are also significant dimensions, with teamwork skills and social adaptation being the most critical indicators. Life and career skills are relatively less prominent in the overall evaluation, but problem-solving skills and career development and planning remain important assessment criteria. These weightings and analyses provide a scientific basis for evaluating students' comprehensive abilities and offer directions for improvement and development for educators and students alike.

Table 8. Indicators Initial Weight Coefficients and Combined Weight Coefficients

Goal Level	Weight	Criteria Level	Weight	Sub-Criteria Level	Local Weight	Portfolio Weight
Indicators for evaluating students' OC A	1	Learning and Innovation B1	0.6370	Specialist knowledge C1	0.5123	0.3263
				Learning ability C2	0.2631	0.1675
				Practical skills C3	0.0887	0.0565
				Innovation capacity C4	0.1089	0.0694
				Critical thinking C5	0.0270	0.0172
		Life and Career B2	0.1047	Physical and mental management C6	0.0521	0.0055
				Adaptation to the occupational environment C7	0.1234	0.0129
				Communication skills C8	0.1987	0.0208
				Problem-solving skills C9	0.3654	0.0383
				Career development and planning C10	0.2604	0.0273
		Character and Grooming B3	0.2583	Teamwork skills C11	0.5123	0.1323
				Independent thinking C12	0.0521	0.0135
				Social adaptation C13	0.2631	0.0679
				Organization capacity C14	0.1089	0.0281
				Professionalism C15	0.0636	0.0164

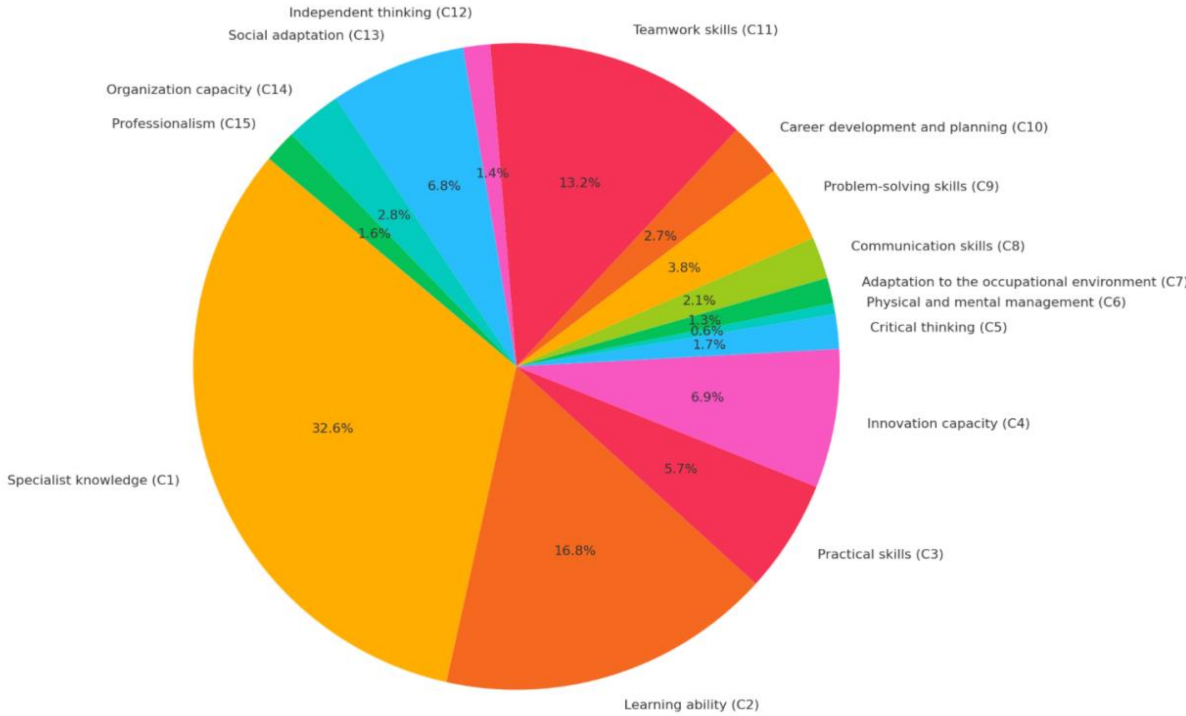

Figure 2. Portfolio Weights of Student Evaluation Indicators

5. Experimental Discussion

The data from this study aligns with existing knowledge systems across multiple core dimensions. However, there are differences in the weights assigned to specific indicators: in the learning and innovation dimension, specialist knowledge (C1) and learning ability (C2) are given higher weights, while practical skills (C3) and innovation capacity (C4) are assigned lower weights, reflecting the traditional emphasis on theoretical knowledge in Chinese higher vocational education and the short-term demand for basic skills in the industry. In the life and career dimension, the importance of problem-solving skills (C9) and career planning ability (C10) aligns with the conclusions of Li and Pilz (2023), but the lower weight assigned to physical and mental management (C6) highlights the lack of mental health support. In the character and grooming dimension, the high weights for teamwork skills (C11) and social adaptation (C13) align with the experience of Germany's "dual system" (Deissinger, 2015), but the neglect of independent thinking (C12) contradicts the OECD's (1997) advocacy for critical thinking. These contradictions reflect the local demands of Chinese vocational education and the market, warranting further exploration.

5.1 The Evaluation System Effectively Integrates Vocational Methodological Competence

The findings indicate that this evaluation system effectively integrates vocational methodological competence (e.g., specialist knowledge, practical skills) and vocational social competence (e.g., teamwork, communication), enhancing the scientific rigor and accuracy of the assessment. This integration is achieved through a hierarchical framework that balances theoretical knowledge (e.g., specialist knowledge C1, weighted at 32.63%) with socio-professional traits (e.g., teamwork C11, weighted at 13.23%), addressing both technical proficiency and workplace adaptability. For instance, the high correlation ($r > 0.7$) between practical skills (C3), teamwork (C11), and workplace adaptability (C7) underscores the system's capacity to reflect real-world vocational demands.

The AHP-driven weighting mechanism ensures dynamic prioritization of competencies, aligning with industry trends while maintaining structural integrity. For example, the dominance of learning and innovation (63.7% combined weight) emphasizes adaptability, whereas character and grooming (25.8%) highlights ethical and collaborative traits critical for career sustainability. However, the relatively low weights for practical skills (5.65%) and critical thinking (1.72%) reveal persistent biases toward theoretical knowledge in Chinese vocational education, as noted in Sections 5.1 and 5.2. To address this, the system's modular design allows iterative updates (e.g., incorporating digital literacy) without disrupting its core structure, ensuring long-term relevance.

By synthesizing methodological and social competencies, the framework not only improves assessment accuracy but also provides actionable insights for curriculum optimization. For example, low scores in career planning (C10) could trigger targeted mentorship programs, while high weights for social adaptation (C7) inform training in workplace integration. These features, validated through pilot studies and expert consensus (Kendall's W = 0.419), demonstrate the system's potential to bridge the gap between educational outcomes and industry needs, fostering holistic vocational development.

5.2 The Traditional Inertia of Prioritising Theory

The Chinese education system has long been centered on knowledge transmission and exam-oriented capabilities, and this traditional educational model continues to exert a profound influence on higher vocational education. Although higher vocational education emphasizes applicability and practicality, some institutions still retain a theory-dominated teaching approach, with a high proportion of theoretical courses in the curriculum and insufficient practical training resources (such as advanced equipment and industry-education collaboration bases). This makes it difficult to fully cultivate practical skills (C3) and innovation capabilities (C4). Additionally, the current evaluation system primarily relies on standardized exams and subjective teacher assessments, making it challenging to quantify practical and innovative abilities. For example, the evaluation criteria for practical training courses often focus on "completion" rather than "innovativeness," resulting in students' performance in innovative thinking being inadequately reflected in assessments. This limitation in evaluation methods not only diminishes the importance of practical and innovative abilities in vocational competency development but also restricts the comprehensive growth of students' overall qualities. Therefore, higher vocational institutions need to optimize their curriculum structures, increase the proportion of practical teaching, and improve evaluation systems to better align with industry demands and the diverse trends in students' career development.

5.3 Basic Skills Prioritised over General Literacy

China's manufacturing and service industries are still in the early stages of industrial upgrading, and many enterprises prefer to hire graduates with "immediate combat readiness," meaning those who can quickly adapt to basic job skills (such as operational standards and process execution), rather than emphasizing innovation or critical thinking. This market demand has led higher vocational colleges to focus more on cultivating professional knowledge (C1) and problem-solving abilities (C9), while paying relatively less attention to innovation (C4) and independent thinking (C12). Although industry-education collaboration is widely advocated in higher vocational education, many partnerships remain at the initial stage of providing internship opportunities, lacking deeper collaboration (such as joint research and development or project co-construction). Corporate feedback data focuses more on students' basic skill performance, with less attention given to soft indicators such as innovation ability and mental health. This results in an evaluation system that undervalues these competencies. This situation reflects the current transitional mismatch between vocational education and industry needs, while also highlighting the challenges faced by vocational colleges in cultivating well-rounded talent. In the future, vocational institutions need to deepen school-enterprise cooperation, promote corporate involvement in curriculum design and evaluation system optimization, and strengthen the cultivation of students' innovation abilities and mental health to better meet the long-term demand for high-quality technical and skilled talent driven by industrial upgrading.

5.4 Collectivist-orientated Educational Objectives

Chinese culture has long emphasized collective interests and social adaptability, a value that is reflected in the education system through a strong focus on teamwork (C11) and social adaptation skills (C13), while independent thinking and critical thinking (C12) are often viewed as "challenging authority" or "destabilizing factors." This cultural tendency permeates the vocational competency evaluation system, resulting in lower weights assigned to related indicators, which in turn hinders the development of students' independent thinking and innovation capabilities. At the same time, the low weight assigned to physical and mental management (C6) reflects the relatively Lagging cognition of mental health issues in Chinese society. Many higher vocational colleges have yet to establish comprehensive mental health support systems, and students' psychological issues are often simplistically attributed to "insufficient stress resistance" rather than being recognized as important issues requiring systematic intervention. This situation not only limits the comprehensive development of students' mental health but also weakens their ability to cope with pressure and challenges in professional environments. Therefore, higher vocational institutions need to rebalance the relationship between teamwork and individual expression in the evaluation system while strengthening the institutionalization of mental health education to provide students with comprehensive psychological support, thereby promoting the holistic improvement and sustainable development of their vocational competencies.

5.5 Stage Contradictions in the Integration of Industry and Education

In recent years, China's core policies for promoting vocational education reform such as the Programme for Building a Stronger Education State (2024-2035). have emphasized the integration of industry and education, as well as the combination of work and study. These policies aim to enhance students' professional competitiveness through technical skills alignment, such as the "1+X Certificate System." However, during the actual implementation process, the policies tend to focus more on supporting the development of "hard skills," such as technical operations and professional knowledge, while offering relatively insufficient support for "soft skills" like innovation ability and mental health. This policy bias has led vocational colleges to prioritize technical skill instruction in curriculum design and teaching practice, often at the expense of students' overall personal development. At the same time, the issue of unequal resource distribution has further limited practical teaching, particularly in vocational colleges in central and western China, where there are significant gaps in training facilities, faculty strength, and access to enterprise resources. For example, due to a lack of equipment, some institutions can only offer simulated training instead of real-world practice, which not only restricts the development of students' practical skills but also weakens their adaptability in actual work environments. Therefore, future policies need to balance support for both "hard skills" and "soft skills." Additionally, by optimizing resource allocation and reducing regional disparities, vocational education can move toward a more balanced and comprehensive development, cultivating high-quality technical talent that meets the demands of industrial upgrading.

6. Conclusion

This study constructs an evaluation system for the OC of vocational college students based on big data technology, aiming to address issues in traditional evaluation systems such as single evaluation criteria, subjective assessment methods, and insufficient feedback mechanisms. Through literature analysis, expert interviews, the Delphi method, and the Analytic Hierarchy Process (AHP), the study proposes a multi-dimensional framework for evaluating occupational competence, encompassing three core dimensions: Learning and Innovation, Life and Career, and Character and Grooming, further divided into 3 subcategories and 15 specific indicators. The findings indicate that this evaluation system effectively integrates vocational methodological competence and vocational social competence, enhancing the scientific rigor and accuracy of the assessment. Data analysis reveals a strong correlation among practical skills, teamwork ability, and workplace adaptability, suggesting that vocational colleges should strengthen practice-oriented teaching models and enhance data integration and industry-education collaboration to optimize the development of vocational competencies.

The academic contributions of this study are reflected in several aspects. First, by incorporating big data technology, it constructs a data-driven model for evaluating occupational competence, providing new methodological support for vocational education assessment. Second, the study, considering the actual context of vocational education in China, proposes an evaluation index system that aligns with local needs, filling gaps in the practical application of existing research. Finally, through the AHP method, the study scientifically assigns weights to each indicator, offering an actionable evaluation tool for educational policymakers, which contributes to improving the quality of vocational education and the holistic development of students.

In summary, this study provides theoretical foundations and practical guidance for optimizing occupational competence evaluation systems, demonstrating significant academic value and practical relevance. Future research could expand the data sample, reduce subjective influences, and explore more applications of big data technology in vocational education.

7. Authors' Contributions

HO conceived the research idea, designed the project framework, and drafted the manuscript. SJ conducted data analysis, performed the Delphi method evaluations, and contributed to the statistical analysis using AHP. Both authors participated in refining the study design and provided critical revisions for important intellectual content. All authors read and approved the final manuscript.

Acknowledgements

The authors would like to thank the vocational education experts, industry professionals, and students who participated in the Delphi consultations. Special thanks to Jiangsu College of Engineering and Technology and the University Tun Hussein Onn Malaysia for their institutional support.

References

Ajjawi, R., Tai, J., Huu Nghia, T. L., Boud, D., Johnson, L., & Patrick, C. J. (2020). Aligning assessment with the needs of work-integrated learning: The challenges of authentic assessment in a complex context. *Assessment & Evaluation in Higher Education, 45*(2), 304-316. https://doi.org/10.1080/02602938.2019.1639613

Bai, L., & Jiang, L. (2021, July). Research on "Dual System" Educational Culture in German Based on Big Data Analysis. In *2021 International Conference on Education, Information Management and Service Science* (EIMSS) (pp. 5-8). IEEE. https://doi.org/10.1109/EIMSS53851.2021.00009

Baig, M. I., Shuib, L., & Yadegaridehkordi, E. (2020). Big data in education: a state of the art, limitations, and future research directions. *International Journal of Educational Technology in Higher Education, 17*, 1-23. https://doi.org/10.1186/s41239-020-00223-0

Cha, Y. H., & Zhu, Chunsun. (2020). Construction of evaluation index system for vocational core competence of higher vocational students under the framework of Sydney Agreement. *Vocational and Technical Education*, (11), 54-58. https://doi.org/CNKI:SUN:ZYJW.0.2020-11-013.

Cobb, D., & Couch, D. (2022). Locating inclusion within the OECD's assessment of global competence: An inclusive future through PISA 2018? *Policy Futures in Education, 20*(1), 56-72. https://doi.org/10.1177/14782103211006636

Fischer C, Pardos Z A, … Baker R S. (2020). Mining big data in education: Affordances and challenges[J]. *Review of Research in Education, 44*(1), 130-160. https://doi.org/10.3102/0091732X20903304

Fosso Wamba, S., Gunasekaran, A., Akter, S., Ren, S. J., Dubey, R., & Childe, S. J. (2017). Big data analytics and firm performance: Effects of dynamic capabilities. *Journal of Business Research, 70*, 356-365. https://doi.org/10.1016/j.jbusres.2016.08.009

Gallardo, K. (2020). Competency-based assessment and the use of performance-based evaluation rubrics in higher education: Challenges towards the next decade. *Problems of Education in the 21st Century, 78*(1), 61-79. https://doi.org/10.33225/pec/20.78.61

He, P., & Zeng, L. X. (2022). Construction of Education Quality Evaluation Index System of Applied Undergraduate Colleges and Universities - Based on the Perspective of Vocational Ability Cultivation. *Science and Technology Economic Market*, (11), 128-130. https://doi.org/CNKI:SUN:KJJC.0.2022-11-042.

Humphrey-Murto, S., Wood, T. J., Gonsalves, C., Mascioli, K., & Varpio, L. (2020). The delphi method. *Academic Medicine, 95*(1), 168. https://doi.org/10.1097/ACM.0000000000002887

Jing, F. (2025). Construct Post Competency Model Based on the Big Data Technology. *Communications on Applied Nonlinear Analysis, 32*(8s), 610-620. https://doi.org/10.52783/cana.v32.3754

Khan, S., Ahmed, R. R., Streimikiene, D., Streimikis, J., & Jatoi, M. A. (2022). The competency-based training & assessment, and improvement of technical competencies and changes in pedagogical behavior. *E & M Ekonomie a management., 25*(1), 96-112. https://doi.org/10.15240/tul/001/2022-1-006

Li, J., & Pilz, M. (2023). International transfer of vocational education and training: A literature review. *Journal of Vocational Education & Training, 75*(2), 185-218. https://doi.org/10.1080/13636820.2020.1847566

Liu, Y., Eckert, C. M., & Earl, C. (2020). A review of fuzzy AHP methods for decision-making with subjective judgements. *Expert systems with applications, 161*, 113738. https://doi.org/10.1016/j.eswa.2020.113738

Luan, H., Geczy, P., Lai, H., Gobert, J., Yang, S. J., Ogata, H., ...Tsai, C. C. (2020). Challenges and future directions of big data and artificial intelligence in education. *Frontiers in psychology, 11*, 580820. https://doi.org/10.3389/fpsyg.2020.580820

Luo Hongmei. (2022). Thoughts and Exploration on Constructing the Evaluation System of Vocational Education in the New Era. *Journal of Higher Teaching*, (30), 62-66. https://doi.org/10.19980/j.CN23-1593/G4.2022.30.016.

Othman, H., & Shen, J. (2024). Research On The Elements Of Occupational Competence Of Higher Vocational Students Based On Delphi Method And Grounded Theory In The PRC. *International Journal of Modern Education, 6*(21), 676-697. https://doi.org/10.35631/IJMOE.621050

PSICO SMART. (2023). *Using Data Analytics from Competency Evaluation Tools to Enhance Employee Retention Strategies*. Retrieved from https://psico-smart.com/en/blogs/blog-using-data-analytics-from-competency-evaluation-tools-to-enhance-empl oyee-retention-strategies-183289

Rongmin L, & Fah B C Y. (2024). Rethinking Education and Training: Creating High-Quality Employment Opportunities for Vocational Students[J]. *Advances in Vocational and Technical Education*, *6*(2), 90-95. https://doi.org/10.23977/avte.2024.060214

Salman, M., Ganie, S. A., & Saleem, I. (2020). The concept of competence: a thematic review and discussion. *European Journal of Training and Development*, *44*(6/7), 717-742. https://doi.org/10.1108/EJTD-10-2019-0171

Shen, L. (2021). Analysis on the objective and positioning of higher vocational education talents. *International Journal of Social Science and Education Research, 4*(8), 84-94.

Sheng Zhang. (2022). Theoretical construction and implementation path of vocational ability evaluation system for higher vocational students based on OKR model. *Journal of Hunan Radio and TV University*, (04), 48-53. https://doi.org/10.19785/j.cnki.hnddxb.2022.04.007.

Souza, J. D. F. (2024). UNESCO, World Bank, and OECD: Global perspectives on the right to education and implications for the teaching profession. *Educar em Revista, 40*, e94756. https://doi.org/10.1590/1984-0411.94756

Suhaini, M., Ahmad, A., & Bohari, N. M. (2021). Assessments on Vocational Knowledge and Skills: A Content Validity Analysis. *European Journal of Educational Research, 10*(3), 1529-1540. https://doi.org/10.12973/eu-jer.10.3.1529

Thakkar, J. J., & Thakkar, J. J. (2021). Analytic hierarchy process (AHP). *Multi-Criteria Decision Making*, 33-62. https://doi.org/10.1007/978-981-33-4745-8_3

Vocational Students. Based On Delphi Method And Grounded Theory In The PRC. *International Journal of Modern Education*, *6*(21), 676-697.

Wang, Jin. (2022). Exploration of social service capacity evaluation system of vocational colleges. *Foreign trade and economics*, (09), 136-139. https://doi.org/CNKI:SUN:HLJW.0.2022-09-030.

Wang, P., & Ko, J. (2024). ICT competency and practicum of preservice teachers as digital natives: a mixed-method study. *Asia Pacific Journal of Education, 44*(4), 901-916. https://doi.org/10.1080/02188791.2022.2083581

Yu, Lu-Ming. (2024). The realistic dilemma and optimization strategy of students' vocational ability evaluation in higher vocational colleges and universities - A case study of higher vocational colleges and universities in N city. *Vocational Technology*, (12), 73-82. https://doi.org/10.19552/j.cnki.issn1672-0601.2024.12.012.

Zhang, Y. (2024). Analysis of Innovative Talent Cultivation Strategy of Vocational Education under the Strategy of Developing the Country through Science and Education Based on Big Data Investigation. *Applied Mathematics and Nonlinear Sciences*. https://doi.org/10.2478/amns.2023.2.01259

Zhao H, Stoyanets N, … Cui L. (2022). Strategy of vocational education adapting to social and economic development[J]. *Journal of Innovations and Sustainability*, *6*(1), 03-03. https://doi.org/10.51599/is.2022.06.01.03

Zhao, X., Li, Y., & Wang, S. (2023). Theory and Data-Driven Competence Evaluation with Multimodal Machine Learning Methods. *Applied Sciences, 13*(13), 7761. https://doi.org/10.3390/app13137761

Zhou Meng. (2023). Construction of evaluation index system of vocational ability of students in vocational colleges and universities. *Journal of Liaoning Teachers College (Social Science Edition)*, (05), 99-103. https://doi.org/CNKI:SUN:SZXB.0.2023-05-030.