



Comprehensive Optimization Design of Hospital Health Human Resources Recruitment and Training System Based on Competency Modeling

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SUMMARY: *Human resource management is an important part of hospitals and plays an important role in hospital human resource management, and competency will directly affect the quality of hospital human resource recruitment and training system. On the basis of competency iceberg model and competency onion model, 31 competency factors are screened to meet the hospital health human resources recruitment and training system, and the feasibility of competency factors is verified with the help of statistical analysis of questionnaires. Subsequently, the weights of the 31 competency factors were determined by solving the judgment matrix in the form of hierarchical analysis, and the construction of the competency model for the recruitment and training system of the hospital was also completed, and the model was used to carry out an empirical analysis of the current health human resources recruitment and training system of the hospital. Within one year after the model was implemented, the job satisfaction of hospitals that recruited new employees was significantly improved. The proportion of "very dissatisfied" decreased from 9% to 1%, "dissatisfied" from 34% to 7%, "average" from 28% to 30%, "relatively satisfied" from 22% to 36%, and "satisfied" from 7% to 26%. Based on the analysis results, verify the optimization role of the model in the recruitment and training system of hospital health human resources.*

KEYWORDS: *hierarchical analysis; judgment matrix; competency model; human resource recruitment; training system*

1 Introduction

In the development of today's health care industry, the strategic nature of health human resources management cannot be ignored. A healthcare organization is not only a place to provide medical services, but also a complex system involving multiple aspects, levels and fields. In this system, health human resource is the most crucial element, which determines the core competitiveness and market position of healthcare organizations [1]. Due to the special characteristics of the healthcare industry, health human resource management not only needs to satisfy the basic recruitment function, but also needs to strategically consider how to train talents to provide higher quality healthcare services and ensure that healthcare organizations can gain a strong competitive advantage in the fierce market competition [2-4]. However, traditional recruitment and training are faced with problems such as rigid standards, neglect of job analysis and job characteristics, imperfect evaluation mechanisms, and disconnection between training content and business needs. In this context, the optimal design of recruitment

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and training system based on competency model has become a necessary choice for hospital health human resource management [5].

Competency model refers to the sum of the competencies required to perform a specific task role, which is the structural form of competency, and is one of the new trends in the current corporate recruitment and training needs analysis [6, 7]. The optimal design of health human resources recruitment based on the competency model helps to fully realize the match between employees' intrinsic qualities (values, personality, needs, motivations, attitudes, etc.) and positions [8, 9]. Regarding the impact of competency modeling on health human resources recruitment in hospitals, literature [10] describes the application of competency-based modeling in the field of nursing, pointing out that the model is widely used in recruitment, training, career planning, etc., which is conducive to the improvement of employees' competency development, work motivation and satisfaction. Literature [11] emphasized that competency modeling is commonly used in the healthcare field, such as in medical education, while in medical and healthcare organizations, it also plays an important role in areas such as talent recruitment and training. Literature [12] analyzed the accurate recruitment strategy of hospital talents based on competency model, pointed out the current situation and problems of hospital talent recruitment, and elaborated the construction method and significance of job competency model, aiming to provide scientific and effective theoretical guidance for hospitals in talent recruitment.

For training, competency-based employee training system not only focuses on the gap between the explicit knowledge and skills required for a particular job responsibility and the implicit skills, but also focuses on the gap between the relevant competency characteristics of employees to adapt to a particular job, comprehensive analysis of the individual competency of the employees and the organizational competency of the enterprise, the ultimate goal is to narrow or disappear the gap through training, and to promote the personal performance of employees and the overall performance of the enterprise to improve! [13-16]. Literature [17] examined the impact of a competency model-based training system and work environment on the performance of non-healthcare administrators within a private hospital, and the findings indicated that there was a correlation between the competency model-based training system, work environment, and all items in the employee performance variables. Literature [18] emphasized the importance of the application of the competency model in ensuring the competence of frontline nurse managers, as indicated by the results of the evaluation of the model in the areas of training and assessment, career planning and development, reward system, recruitment and selection. Literature [19] describes the importance of applying the competency-based model to the effectiveness assessment of clinical training for new nurses, and reveals the effectiveness of the method through literature review and comparative experiments, providing a reference basis for nurse management.

In addition to the hospital health field, competency-based modeling plays an important role in other fields as well in talent recruitment and training in enterprises. Literature [20], based on existing findings, emphasized that ineffective recruitment in the business sector may cause huge losses for companies, and in order to avoid this loss, traditional recruitment models are gradually being replaced by competency-based recruitment models. Literature [21] pointed out the shortcomings of the traditional tools supporting the recruitment process and proposed a competency model based recruitment process tool, which was revealed to be effective through comparative experiments, significantly reducing the time consuming and costly activities of human resource personnel. Literature [22] describes the current competitive market pressures faced by private enterprises and, based on event interviews, examines the application of competency modeling in the enterprise human resource management system from the aspects of human resource planning, recruitment and allocation, training and development, and

proposes talent management suggestions. Literature [23] systematically introduces the competency model and combines it with the employee career management system, proposes a five-dimensional framework for assessing the training needs of new employees, verifies the effectiveness of the model in practice, and improves the training effect of new employees in enterprises. Literature [24] introduces certain important competency definitions and major competency specifications, such as HR-XML specification and IMS reusable competencies, and proposes a competency-based training model based on these specifications. Literature [25] emphasizes the important role of on-the-job training and analyzes the advantages and disadvantages of competency-based training and demonstrates the value of organizational knowledge systems for improving the quality of training for industrial employees.

Based on the theoretical foundation of competency model, this paper understands that there are two commonly used competency models, which are competency iceberg model and competency onion model, and lays an important theoretical basis for the next research work. With reference to the current research data on hospital human resources competency model, 31 competency factors are selected, and the feasibility of competency factors is confirmed through the statistical analysis of the questionnaire, and then the 31 competency elements are classified with the help of principal component analysis for the preliminary screening, and the hierarchical characteristics of competency factors are finally determined. Finally, the hierarchical analysis was used to determine the weights of the 31 competency factors and construct a competency model for the recruitment and training system of the hospital, and then the model was used to explore and analyze the health human resource management of the hospital, aiming to provide theoretical guidance for the comprehensive and optimal design of the recruitment and training system of the human resources of the hospital.

2 Human Resource Recruitment and Training System Based on Competency Modeling

2.1 Theoretical Foundations of Competency Modeling

2.1.1 Competence

Competency is a relative concept, i.e., the position or role will require different levels of competency depending on the job. Overall, competency is a comprehensive concept of ability that describes the knowledge, skills, attitudes, and behaviors that a person needs to have for a particular task or responsibility. It is a key component of individual and organizational success and can be continuously enhanced through learning and development.

2.1.2 Competency Modeling Definition

A competency model is a set of qualities that a person needs to have in order to do well at work, these qualities include intrinsic drive, knowledge and skills, self-image and social roles. Competency modeling is very important for companies because it can help them determine if an employee is capable of performing a certain position, and it also lets them know which qualities to recruit. The model can also be used as a reference for various HR modules, so that companies know how to recruit, assess and pay. In addition, the competency model can also provide guidance for employee training and development, helping them to better plan their own career.

2.1.3 Types of competency models

According to related literature and information, competency model is more commonly used mainly iceberg model and onion model.

(1) Iceberg model

The iceberg model is shown in Figure 1. The proportion of the "invisible part" presented by the "iceberg model", namely the "invisible competency", is greater than that of the "visible part", namely the "explicit competency". Based on the provided image information, we can draw the following six important components of competency, which are knowledge, skills, self-awareness, traits, role positioning and motivation. Together, these factors are effective in measuring a person's level of competence in a particular area and help him or her to be better equipped for the job task. One of the traits is more long-term and stable, and it is different from the other five factors.

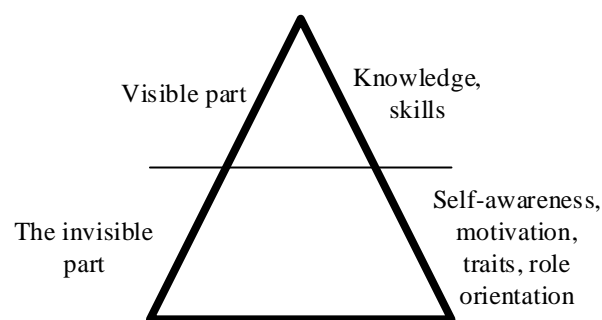


Figure 1: Iceberg model

(2) Onion model

The onion model is shown in Figure 2, which clearly reflects the structure and level of different factors. Combined with the model, it can be seen that personal qualities are divided into extrinsic qualities and intrinsic qualities, of which extrinsic qualities are more intuitive, including knowledge and skills, which are easy to be found and can be cultivated later. Intrinsic qualities include personality motivation, values and attitudes, etc., which are not easy to detect and difficult to cultivate.

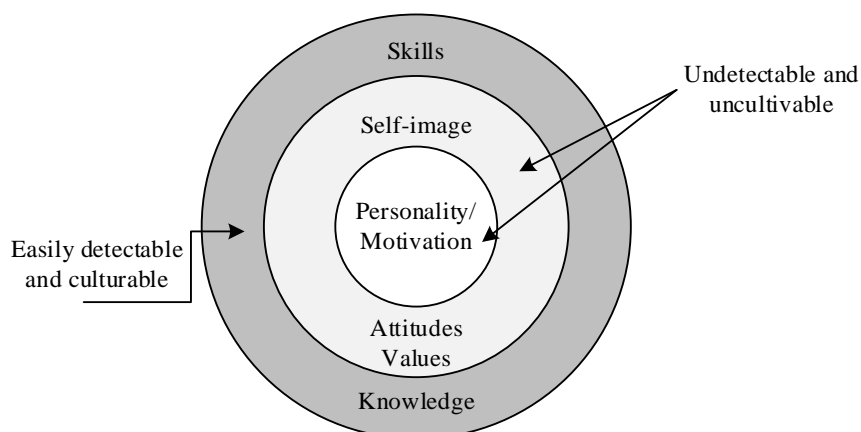


Figure 2: Onion model

2.2 Competency Model for Hospital Recruitment and Training Systems

In the construction of competency model, experts and scholars at home and abroad, research methods, research content is relatively rich and diversified characteristics, the main methods

used at present include questionnaire research method and hierarchical analysis method, in the competency iceberg model and the onion model on the basis of this paper for the construction of competency model of hospital recruitment and training system, the construction process is mainly the following steps:

(1) Through the study of related literature, job responsibilities and with the help of behavioral event interview method and expert interview method, the initial screening is in line with the hospital health human resources recruitment and training system competency model requirement factors.

(2) Through the statistical analysis of the questionnaire, aiming to verify the reliability and validity of the questionnaire and the feasibility of the competency factors.

(3) Using principal component analysis to classify the 31 competency factors initially screened and finally determine the hierarchical characteristics of the competency factors.

(4) Using hierarchical analysis to determine the weights of the 31 competency factors, construct a competency model for the hospital's recruitment and training system, and formulate evaluation criteria for each indicator of competency.

2.2.1 Development of questionnaires

In order to verify whether the competency model is suitable for the hospital health human resources recruitment and training system, therefore, a competency questionnaire survey is conducted to summarize and screen out the competency elements that are in line with the hospital health human resources recruitment and training system, and extract the required factors of the competency model that are in line with the hospital health human resources recruitment and training system.

The 31 competency elements are screened out by studying relevant literature, job responsibilities and with the help of behavioral event interview method and expert interview method, specifically, the questionnaire survey will finally test the 31 competency elements, and the questionnaire is set up with two parts, one part of which is for the survey respondents to fill in the basic personal information, and the other part of which is for arranging for the survey respondents to score the 31 competency elements obtained, and the questionnaire adopts the Likert The questionnaire uses a Likert scale of 5, the users participating in the questionnaire survey according to their own understanding to determine whether the competency elements of the hospital health human resources recruitment and training system for the existence of the necessity of 1 is very unnecessary, 2 is unnecessary, 3 is necessary, 4 is more necessary, 5 is very necessary.

In order to ensure the reliability of the data, the object of the questionnaire survey in this study is all the employees of Hospital A, a total of 472 people, from the perspective of the managers and the managed and the middle managers themselves to select the competency elements that the middle managers need to have. Before doing the survey, the purpose of the survey is fully publicized, indicating that the survey is only for academic research, and the participants need to fill out the questionnaire in accordance with the facts, to ensure that the data obtained to build out the competency model is true and effective. Questionnaire survey as shown in Table 1, the questionnaire survey issued a total of 472 questionnaires, recovered 466 valid questionnaires, effective recovery rate of 98.73%.

Table 1: Questionnaire survey situation

Distribute questionnaires	Return questionnaire	Recovery rate	Eliminate invalid questionnaires	Valid questionnaire	Effective recovery rate
472	472	100.00%	6	466	98.73%

2.2.2 Statistical results

(1) Descriptive analysis of the sample

Based on the questionnaire data above, the basic situation of the questionnaire sample is shown in Table 2.

Gender: the male to female ratio of the questionnaire recovered this time is 70.39% male and 29.61% female, this situation is caused by the status quo of the male to female ratio in Hospital A, which is basically consistent with the actual gender ratio.

Age: the distribution of the largest number of people between the ages of 28-35, accounting for 42.49%, more than half of the employees under 35 years old, the overall staff of Hospital A is relatively young.

Education: From the distribution of education, the majority of employees have a bachelor's degree, accounting for 57.08%. This is due to the geographical location and working environment of Hospital A, which makes it difficult to attract and retain highly educated talents.

Years of working experience: the majority of employees who have worked for less than 10 years, which also means that the overall staff of Hospital A is young and lacks working experience.

Table 2: The basic situation of the questionnaire survey sample

Project	Category	N	Proportion
Gender	Male	328	70.39%
	Female	138	29.61%
Age	28 years old and under	136	29.18%
	Aged 28 to 35	198	42.49%
	Aged 35 to 45	36	7.73%
	45 years old and above	96	20.60%
Educational background structure	Junior college and below	114	24.46%
	Undergraduate	266	57.08%
	Postgraduate degree or above	86	18.45%
Years of working experience	Five years or less	157	33.69%
	Five to ten years	198	42.49%
	10 to 15 years	57	12.23%
	15 years or more	54	11.59%

(2) Descriptive analysis of variables

Descriptive analysis mainly refers to the basic description of data. After analysis using SPSS26.0 software, a descriptive analysis of the competency characteristics of the hospital's health human resources recruitment and training system was obtained. The results of the variable descriptive analysis are shown in Table 3. In the table, C1 to C31 respectively represent humanistic spirit, scientific spirit, spirit of fairness, view of practicing medicine in accordance with the law, view of integrity and dedication, view of responsibility, view of society, view of progress, basic medical knowledge, specialized medical knowledge, medical ethics knowledge, basic medical skills, specialized operation skills, decision-making ability in diagnosis and treatment, ability to communicate well with patients, ability to communicate with patients' families, and coordination within the department Ability, coordination ability among departments, active participation and organization of teamwork, self-learning ability, awareness of lifelong learning, awareness of conducting medical research, independent thinking, problem-solving ability, medical popular science, clinical teaching, public health care services, information retrieval ability, information management application ability, ability to reasonably

control patients' medical expenses, planning ability, foreign language proficiency. Based on the data presentation in the table, it can be known that the average value of the 31 competency elements ranges from 3.88 to 4.666, which indicates that all the listed 31 elements are competency elements in the recruitment and training system of hospital health human resources.

Table 3: Descriptive analysis results of variables

Symbol	Minimum value	Maximum value	Sample size	Average value	Standard deviation
C1	1	5	466	4.471	0.859
C2	1	5	466	3.987	1.054
C3	1	5	466	4.584	0.952
C4	1	5	466	3.974	1.138
C5	1	5	466	4.666	0.859
C6	1	5	466	3.973	0.826
C7	1	5	466	3.91	1.16
C8	1	5	466	4.363	1.071
C9	1	5	466	4.273	1.047
C10	1	5	466	4.485	0.929
C11	1	5	466	3.941	0.955
C12	1	5	466	4.51	0.92
C13	1	5	466	4.418	1.082
C14	1	5	466	4.313	0.961
C15	1	5	466	4.409	0.833
C16	1	5	466	4.19	1.074
C17	1	5	466	4.278	0.985
C18	1	5	466	4.486	0.998
C19	1	5	466	4.474	1.064
C20	1	5	466	3.927	0.909
C21	1	5	466	4.502	0.881
C22	1	5	466	3.976	1
C23	1	5	466	4.488	0.959
C24	1	5	466	4.44	0.864
C25	1	5	466	3.998	0.976
C26	1	5	466	4.089	0.857
C27	1	5	466	3.88	0.923
C28	1	5	466	4.207	1.049
C29	1	5	466	4.133	0.903
C30	1	5	466	4.665	0.887
C31	1	5	466	4.078	1.021

(3) Reliability and validity

The reliability analysis of the questionnaire was based on Cronbach's alpha coefficient as the internal consistency reliability index, and the Cronbach's alpha value was 0.889, indicating that the questionnaire had high reliability and met the requirements. The KMO test coefficient of the questionnaire is 0.716, and the chi-square value of Bartlett's test of sphericity is $p < 0.001$, which indicates that the questionnaire validity is high.

2.2.3 Identification of competency factors

The data of 31 items in the questionnaire were analyzed by factor analysis, using principal component analysis and maximum variance rotated factor method, and the loading level was set to be more than 0.4, and finally the eligible items and their factor loadings were obtained, and the results of principal component analysis are shown in Table 4. Synthesizing the results of the data in the table, finally the initial generalization of A hospital health human resources

recruitment and training system competency model indicators total 6 aspects.

Professional spirit and core qualities B1: humanistic spirit, scientific spirit, spirit of fairness, view of practicing medicine in accordance with the law, view of integrity and dedication, view of responsibility, view of society, and view of enterprise.

Medical Professional Knowledge and Skills B2: basic medical knowledge, medical specialty knowledge, medical ethics knowledge, basic medical skills, specialty operation skills, diagnosis and treatment decision-making ability.

Communication and Coordination Ability B3: the ability to communicate well with patients, the ability to communicate with patients' families, the ability to coordinate within the department, the ability to coordinate between departments, and the ability to actively participate in and organize teamwork.

Research and Development Competency B4: Self-learning ability, lifelong learning awareness, awareness of conducting medical research, independent thinking and problem solving ability.

Medical Communication Competency B5: Popularization of medical science, clinical teaching, public health care service.

Information and Management Competency B6: information retrieval ability, information management and application ability, ability to reasonably control patients' medical costs, planning, foreign language ability.

Table 4: Principal component analysis results

Symbol	B1	B2	B3	B4	B5	B6
C1	0.687	0.158	0.254	0.254	0.164	0.225
C2	0.808	0.123	0.284	0.284	0.222	0.268
C3	0.784	0.286	0.149	0.149	0.197	0.128
C4	0.464	0.244	0.13	0.13	0.146	0.245
C5	0.771	0.296	0.246	0.246	0.175	0.245
C6	0.699	0.19	0.29	0.29	0.261	0.247
C7	0.5	0.159	0.234	0.234	0.107	0.234
C8	0.807	0.139	0.239	0.239	0.109	0.258
C9	0.251	0.754	0.179	0.179	0.215	0.207
C10	0.324	0.557	0.193	0.193	0.104	0.244
C11	0.322	0.434	0.216	0.216	0.127	0.262
C12	0.203	0.667	0.134	0.134	0.179	0.238
C13	0.164	0.609	0.11	0.11	0.104	0.264
C14	0.16	0.756	0.247	0.247	0.219	0.146
C15	0.343	0.185	0.678	0.127	0.173	0.246
C16	0.2	0.207	0.693	0.186	0.164	0.206
C17	0.307	0.159	0.481	0.113	0.223	0.253
C18	0.263	0.248	0.599	0.216	0.215	0.121
C19	0.235	0.238	0.567	0.244	0.274	0.217
C20	0.336	0.294	0.218	0.633	0.23	0.132
C21	0.277	0.216	0.185	0.516	0.173	0.117
C22	0.236	0.162	0.158	0.423	0.272	0.135
C23	0.239	0.103	0.188	0.436	0.168	0.22
C24	0.213	0.27	0.115	0.234	0.731	0.201
C25	0.332	0.248	0.122	0.279	0.517	0.14
C26	0.277	0.286	0.264	0.217	0.669	0.215
C27	0.347	0.249	0.286	0.286	0.144	0.582
C28	0.164	0.155	0.147	0.147	0.196	0.636
C29	0.311	0.176	0.121	0.121	0.141	0.751
C30	0.283	0.166	0.161	0.161	0.247	0.727
C31	0.184	0.178	0.232	0.232	0.17	0.582

2.2.4 Determination of weights

In this paper, the weight of each competency characteristic will be determined by the hierarchical analysis method (AHP), which involves quantitative and qualitative research, and the decision maker can judge the relative importance of the indicators based on his/her own experience in order to measure whether the goal can be achieved or not, and reasonably give the weight of each criterion for each decision-making option, and find out the order of importance of each option by using the weights. Hierarchical analysis method can solve complex problems and has high feasibility. Through this method, the research objectives can be subdivided into multiple objectives at different levels to form an objective tree, the elements at the same level are compared in pairs, the judgment matrix is constructed based on the relative importance of the two elements, and the weights of the importance of each indicator are calculated using the matrix.

(1) Establishment of hierarchical model

The hierarchical model is shown in Figure 3. The utility of hierarchical analysis is reflected in its ability to subdivide a complex problem into multiple elements and group these elements by attributes to form a hierarchy. Level Z is the highest level and is known as the target level for credit evaluation and selection. Layer B is located in the middle layer, which can be referred to as the elemental layer, specifically the elements that will affect the target. Layer C is at the lower level, which can be referred to as the indicator level and covers the indicators corresponding to each factor. The P-layer is located at the bottom of the hierarchy and this layer is known as the solution layer, which refers to giving a solution to a problem.

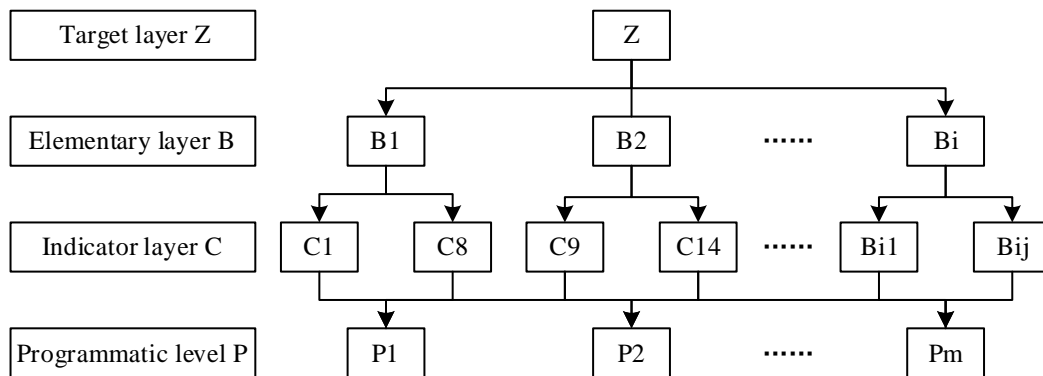


Figure 3: Analytic Hierarchy Process Model

(2) Establishment of judgment matrix

Hierarchical analysis model in the construction of the completion of the need to calculate the degree of influence between the indicator layer and the standard layer, and through the comparison between the two to assess the layer occupies the weight.

The relative importance of the two indicators of the same level is judged, and the hierarchical analysis method of significance evaluation scale is defined as shown in Table 5, and the hierarchical analysis method of sub-importance scale is defined as shown in Table 6. Comparison is made through the evaluation scale of 1-9, which exists in two categories, namely, the significance definition scale and the secondary importance definition scale.

Table 5: Definition of significance evaluation scale in the Analytic Hierarchy Process

Evaluation scale	Definition	Explanation
1	Equally important	The two indicators are of equal importance
3	Relatively important	When comparing the two indicators, one is slightly more important than the other
5	More important	When comparing the two indicators, one is more important than the other
7	Very important	When comparing the two indicators, one is much more important than the other
9	Extremely important	When comparing the two indicators, one is extremely important than the other
2,4,6,8	Median value of adjacent scales	It is at the middle value of two adjacent indicators

Table 6: The definition of secondary important scales in the Analytic Hierarchy Process

Evaluation scale	Define e	Explanation
1/3	Slightly secondary	When comparing the two indicators, one is slightly less important than the other
1/5	Relatively secondary	When comparing the two indicators, one is less significant than the other
1/7	Very secondary	When comparing the two indicators, one is much less important than the other
1/9	Absolutely secondary	When comparing the two indicators, one is definitely less important than the other
1/2,1/4,1/6,1/8	The median value of adjacent scales	It is at the middle value of two adjacent indicators

The tools used for the comparison of the relative importance of the indicators at the criterion level are the Analytical Hierarchy Process (AHP) model and the Evaluation Scale Definition Table, which presents the results of the comparison through the judgment matrix b .

$$B = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{pmatrix} \quad (1)$$

In this matrix, the element b_{ij} refers to the comparative scale of the relative importance of the B_i row indicators to the B_j column indicators, which compares the characteristics of the two-two indicators in the matrix B . In turn, it is possible to understand the characteristics of the matrix $b_{ij} > 0, b_{ij} = 1$ and $b_{ij} = \frac{1}{b_{ji}} (i, j = 1, 2, \dots, n)$.

When $b_{ij} > 1$, it means that B_i is not important with respect to B_j .

When $b_{ij} = 1$, it means that B_i is equally important as B_j .

When $b_{ij} < 1$, it means that B_i is more important than B_j .

(3) Calculate the weights of the single-ordering, and carry out the consistency test at the

same time.

a) Multiply the elements of the judgment matrix A , and multiply the product by the n th power to obtain the following equation.

$$w_{ij} = \left(\prod_{j=1}^n b_{ij} \right)^{\frac{1}{n}} \tag{2}$$

b) The root vector is normalized to obtain the following ranking weight vector.

$$w_i^0 = \frac{w_i}{\sum_i w_i} \tag{3}$$

(4) Based on the maximized utilization of hierarchical single sorting, the normalized eigenvector corresponding to the largest eigenvalue λ_{\max} of the judgment matrix A is selected as the weight vector for consistency test.

a) Comparison of the largest eigenvalue λ_{\max} corresponding to the judgment matrix:

$$\lambda \sum_{i=1}^n \frac{(Bw)_i}{nw_{i\max}} \tag{4}$$

b) After deriving the largest eigenvalue λ_{\max} , its consistency is tested.

Consistency test can find logical errors in the judgment matrix, when the judgment matrix test meets the consistency criteria, it means that the judgment matrix can work, in most cases, the consistency index is expressed as CI. That is:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{5}$$

In most cases, the CI is judged according to the following principles: $CI=0$, indicating that it is a completed consistency; CI is about the same as 0, indicating a higher degree of consistency. When the CI value is bigger and bigger, its corresponding degree of consistency will be lower and lower.

c) Average random consistency ratio RI

Randomly establish several pairs of judgment matrices, and test the matrix consistency index to derive the CI value, and then judge the degree of consistency. The average random consistency index RI is shown in Table 7, and the rank of the matrix can be judged by the corresponding value of this index, and the specific judgment basis can be referred to the following table.

Table 7: Average stochastic consistency index RI

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52

d) Consistency ratio CR:

$$CR = \frac{CI}{RI} \quad (6)$$

In the conventional case, when the matrix judgment is acceptable, the normalized eigenvectors can be used to represent the weight vector, on the contrary, the elements in the matrix need to be adjusted, and when the consistency test meets the requirements to stop the adjustment of the matrix elements.

(5) Calculate the total hierarchical ranking weights, and expand the consistency test.

a) The specific combination of the elements of each level represents the formula:

$$w_i^k = w^k \dots w^3 w^2 \quad (7)$$

b) Formula for the expression of the overall coherence indicator:

$$CI_K = (CI_K^1, \dots, CI_K^m) w^{k-1} \quad (8)$$

c) Overall average random consistency ratio representation formula:

$$RI_K = (RI_K^1, \dots, RI_K^m) w^{k-1} \quad (9)$$

d) Overall random consistency ratio representation formula:

$$CR_K = CR_{K-1} + \frac{CI_K}{RI_K} \quad (10)$$

The CI_k^i and RI_k^i specifically refer to the CI and RI values corresponding to the judgment matrix under the i th criterion of the $K-1$ level, and when $CR_k < 0.1$, it means that the recursive level can satisfy the consistency test criteria of the $K-1$ level. Decisions can be formulated according to the order of decision levels.

3 Analysis of empirical studies

3.1 Competency weighting analysis

3.1.1 Constructing the judgment matrix

Based on the competency model of the recruitment and training system for the health human resources of Hospital A already established in the previous text, the management of Hospital A was invited to conduct pairwise comparisons and scores of the importance of the first-level and second-level indicators respectively, using the average value obtained from the competency survey questionnaire as a reference. The judgment matrix of professional spirit and core literacy B1 is shown in Figure 4. The judgment matrix for medical professional knowledge and skills B2 is shown in Figure 5, the judgment matrix for communication and coordination ability B3 is shown in Figure 6, the judgment matrix for research and development ability B4 is shown in Figure 7, the judgment matrix for medical communication ability B5 is shown in Figure 8, the judgment matrix for information and management ability B6 is shown in Figure 9, and the overall judgment matrix is shown in Figure 10. Equally important scale 1, slightly important scale 3, obviously important scale 5, strongly important scale 7, absolutely important scale 9,

and taking 2, 4, 6, and 8 as the intermediate values of the above adjacent scales, the following judgment matrix is obtained.

C8	2	0.333	1	0.5	3	1	1	1
C7	0.333	1	2	1	2	2	1	1
C6	2	0.5	2	1	0.333	1	0.5	1
C5	0.5	1	0.5	0.333	1	3	0.5	0.33
C4	1	2	0.5	1	3	1	1	2
C3	0.5	0.333	1	2	2	0.5	0.5	1
C2	3	1	3	0.5	1	2	1	3
C1	1	0.333	2	1	2	0.5	3	0.5
	C1	C2	C3	C4	C5	C6	C7	C8

Figure 4: The B1 Judgment matrix of Professional Ethics and Core literacy

C14	2	2	1	2	2	1
C13	3	1	1	0.5	1	1
C12	1	1	2	1	2	0.5
C11	0.5	0.333	1	0.5	1	1
C10	0.5	1	3	1	1	0.5
C9	1	2	2	1	0.333	0.5
	C9	C10	C11	C12	C13	C14

Figure 5: Medical Professional Knowledge and Skills B2 Judgment Matrix

C19	0.5	2	3	0.333	1
C18	2	1	0.333	1	3
C17	0.333	2	1	3	0.333
C16	3	1	0.5	1	0.5
C15	1	0.333	3	0.5	2
	C15	C16	C17	C18	C19

Figure 6: The B3 judgment matrix for communication and coordination skills

C23	0.333	1	2	1
C22	1	2	1	0.5
C21	2	1	0.5	1
C20	1	0.5	1	3
	C20	C21	C22	C23

Figure 7: Research and development capability B4 judgment matrix

	C24	C25	C26
C26	3	0.5	1
C25	0.5	1	2
C24	1	2	0.333
	C24	C25	C26

Figure 8: B5 Judgment Matrix for Medical Communication Capability

	C27	C28	C29	C30	C31
C31	0.333	3	1	2	1
C30	1	1	3	1	0.5
C29	0.5	2	1	0.333	1
C28	3	1	0.5	1	0.333
C27	1	0.333	2	1	3
	C27	C28	C29	C30	C31

Figure 9: Information and Management Capability B6 Judgment Matrix

	B1	B2	B3	B4	B5	B6
B6	1	3	0.333	0.5	2	1
B5	0.5	0.333	1	2	1	0.5
B4	2	0.5	3	1	0.5	2
B3	0.333	2	1	0.333	1	3
B2	3	1	0.5	2	3	0.333
B1	1	0.333	3	0.5	2	1
	B1	B2	B3	B4	B5	B6

Figure 10: Overall judgment matrix

3.1.2 Solving the judgment matrix

Hierarchical analysis is used to solve the judgment matrix using yaahp software to get the weight value of each competency indicator, the maximum characteristic root of the target and intermediate layers λ_{\max} and the consistency ratio CR. If the value of CR is less than 0.1, the judgment matrix satisfies the consistency test, and the results of solving the judgment matrix are shown in Table 8. After calculation, it can be concluded that the CR values of professionalism and core qualities B1, medical professional knowledge and skills B2, communication and coordination ability B3, research and development ability B4, medical communication ability B5, and information and management ability B6 are 0.01165, 0.01369, 0.01196, 0.008502, 0.001731, and 0.008304, which satisfy the consistency test. The CR value is less than 0.1, indicating that the above judgment matrix satisfies the consistency test.

Table 8: Solve the result of the judgment matrix

Symbol	Symbol	Weight value	λ max	CR
B1	C1	0.1214	6.0734	0.011651
	C2	0.1834		
	C3	0.0971		
	C4	0.1520		
	C5	0.0815		
	C6	0.1059		
	C7	0.1373		
	C8	0.1214		
B2	C9	0.1477	8.1351	0.013688
	C10	0.1506		
	C11	0.1044		
	C12	0.1774		
	C13	0.1691		
	C14	0.2508		
B3	C15	0.1994	5.0536	0.011964
	C16	0.1883		
	C17	0.1838		
	C18	0.2291		
	C19	0.1994		
B4	C20	0.2760	4.0227	0.008502
	C21	0.2494		
	C22	0.2494		
	C23	0.2252		
B5	C24	0.2894	3.0018	0.001731
	C25	0.3313		
	C26	0.3793		
B6	C27	0.2272	5.0372	0.008304
	C28	0.1722		
	C29	0.1588		
	C30	0.2146		
	C31	0.2272		

3.1.3 Determination of weights

The weights of the above second-level indicators are multiplied with the weights of the first-level indicators to get the final weights of the two-level competency indicators, and the results of the weights of the competency indicators are shown in Table 9. For example, for humanism C1, the weighted weight = $0.1214 \times 0.1645 \approx 0.0200$, and the same for the remaining 30 items. Subsequently, the management scored the evaluation weights of patients and doctors separately, and the arithmetic average was obtained to obtain the ratio of the two, which was applied to the weights of the three first-level indicators of “professionalism and core qualities, medical professional knowledge and skills, and communication and coordination skills”.

Table 9: The weight results of competency indicators

Symbol	Weight	Symbol	Weight coefficient (Before)	Weight coefficient (After)
B1	0.1645	C1	0.1214	0.0200
		C2	0.1834	0.0302
		C3	0.0971	0.0160
		C4	0.1520	0.0250
		C5	0.0815	0.0134
		C6	0.1059	0.0174
		C7	0.1373	0.0226
		C8	0.1214	0.0200
B2	0.1976	C9	0.1477	0.0292
		C10	0.1506	0.0298
		C11	0.1044	0.0206
		C12	0.1774	0.0351
		C13	0.1691	0.0334
		C14	0.2508	0.0496
B3	0.1537	C15	0.1994	0.0307
		C16	0.1883	0.0289
		C17	0.1838	0.0283
		C18	0.2291	0.0352
		C19	0.1994	0.0307
B4	0.1976	C20	0.2760	0.0545
		C21	0.2494	0.0493
		C22	0.2494	0.0493
		C23	0.2252	0.0445
B5	0.1221	C24	0.2894	0.0353
		C25	0.3313	0.0405
		C26	0.3793	0.0463
B6	0.1645	C27	0.2272	0.0374
		C28	0.1722	0.0283
		C29	0.1588	0.0261
		C30	0.2146	0.0353
		C31	0.2272	0.0374

3.2 Model analysis

3.2.1 Elaboration models

In order to present the competency model more intuitively, the author carries out the hospital health human resources recruitment and training system competency model drawing, the model structure is shown in Figure 11. And the specific assessment weights of the competency model of health human resources recruitment and training system in hospital A are shown in Table 10. From this, we find that the hospital pays more attention to the cultivation of the following competencies: professionalism and core qualities, medical professional knowledge and skills, communication and coordination skills, research and development skills, medical communication skills, and information and management skills, with values of 0.1645, 0.1976, 0.1537, 0.1976, 0.1220, and 0.1645, with a view to realizing the comprehensive optimization of the hospital's health human resources Recruitment and training system comprehensive

optimization.

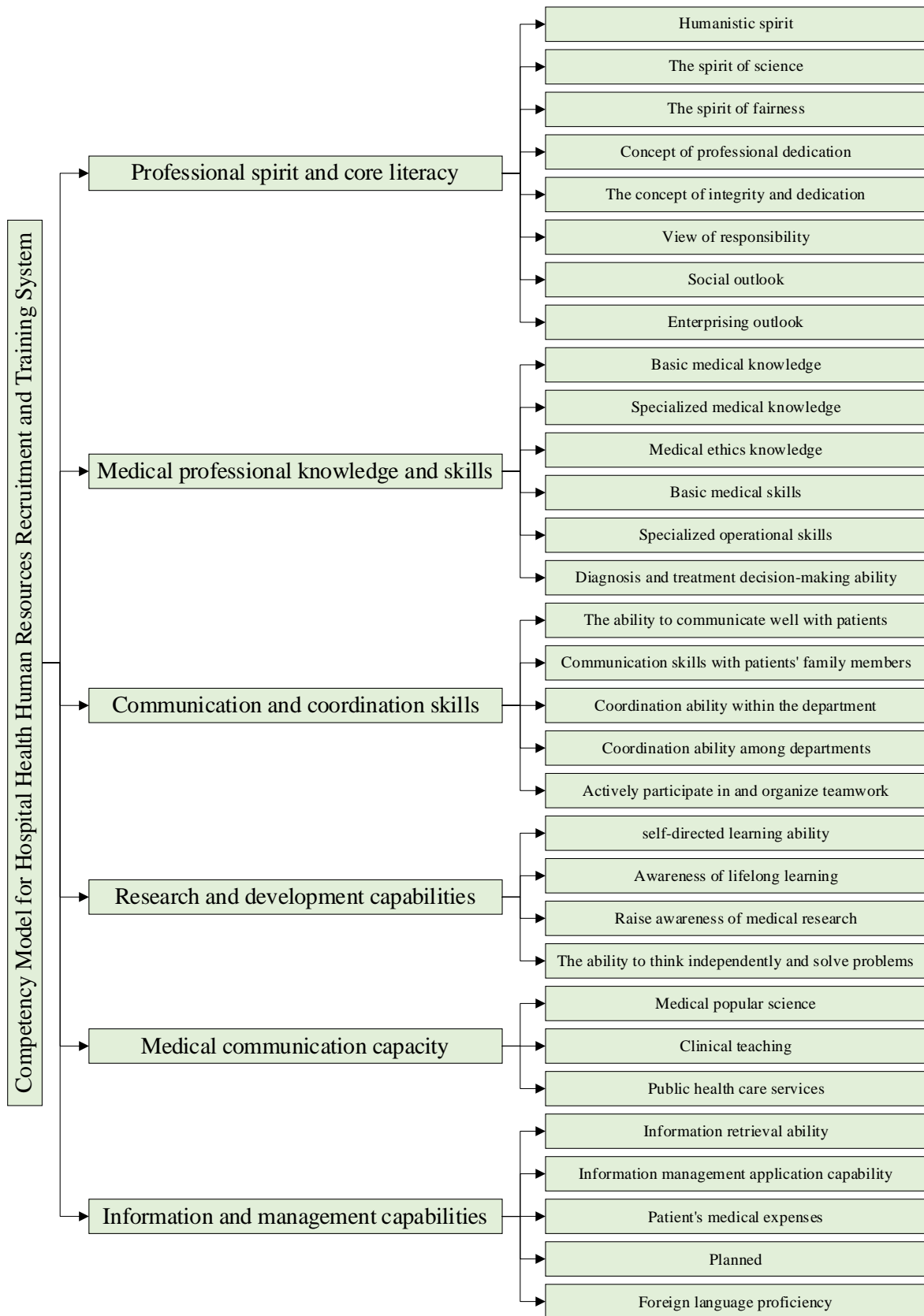


Figure 11 Model structure

Table 10: The specific assessment weight values of the competency model

Symbol	Weight	Assessor	Symbol	Weight coefficient (After)
B1	0.1645	Doctor (0.1316) Patient (0.0329)	C1	0.0200
			C2	0.0302
			C3	0.0160
			C4	0.0250
			C5	0.0134
			C6	0.0174
			C7	0.0226
			C8	0.0200
B2	0.1976	Doctor (0.15808) Patient (0.03952)	C9	0.0292
			C10	0.0298
			C11	0.0206
			C12	0.0351
			C13	0.0334
			C14	0.0496
B3	0.1537	Doctor (0.12296) Patient (0.03074)	C15	0.0307
			C16	0.0289
			C17	0.0283
			C18	0.0352
			C19	0.0307
B4	0.1976	Doctor	C20	0.0545
			C21	0.0493
			C22	0.0493
			C23	0.0445
B5	0.1221	Doctor	C24	0.0353
			C25	0.0405
			C26	0.0463
B6	0.1645	Doctor	C27	0.0374
			C28	0.0283
			C29	0.0261
			C30	0.0353
			C31	0.0374

3.2.2 Validating the model

For model validation, a self-assessment and a questionnaire corresponding to patient evaluations were administered to 10 physicians newly recruited in Hospital A in 2023, with a threshold range of 1=very non-compliant, 2=somewhat non-compliant, 3=unsure, 4=somewhat compliant, and 5=very compliant. The results of the collected questionnaires were combined and weighted according to the proportion of weights of the competency model for the establishment of the hospital's health human resources recruitment and training system to obtain a final total score. Finally, the assessment ranking was carried out to compare with the current annual assessment results, and the statistics of the assessment results and the annual assessment results are shown in Table 11, which reveals that the physician with excellent annual assessment is the physician who is ranked first in the assessment results, the one who fails in the annual assessment is the resident who is ranked last in the assessment results, the four residents who have good results in the annual assessment happen to be the residents who are ranked 2nd-5th in the assessment results, and the residents who are qualified in the annual assessment are

ranked 6th-5th in the the 6th-9th place in the assessment results, indicating that the model is valid.

Table 11: Statistics of assessment results and annual performance evaluation results

Evaluation Ranking	Resident physician	Grade
1	GMM	Excellent
2	XWS	Good
3	CHY	Good
4	WRD	Good
5	HHH	Good
6	YRT	Qualified
7	SQW	Qualified
8	BRS	Qualified
9	LPQ	Qualified
10	JCX	Unqualified

3.3 Analysis of modeling practices

3.3.1 Clarification of human resources and training responsibilities

The comprehensive and optimized design of the hospital's health human resources recruitment and training system should first optimize the training management of the T hospital to ensure that the training activities and the training system based on the competency model are organized and planned, Table 12 shows the training responsibilities of the Ministry of Human Resources and functional departments. In order to ensure that the training effect is maximized and to increase the importance of training in each department, the training responsibilities of the personnel in each department should be clarified, and at the same time, an HR assistant should be set up in each department, who is responsible for docking and cooperating with the training activities in addition to the daily departmental position work.

Table 12: Training for the Human Resources Department and functional departments

Department	Duties
Human Resources Department and Training Team	Organize and carry out research on the training needs of the department
	Formulate company and training plans and be responsible for tracking the implementation of the plans
	Review the training courses and courseware
	Form a team of internal trainers within the company
Functional departments and HR assistants.	Put forward the training needs of the department
	Be responsible for the implementation of internal training in this department
	Train internal trainers for the department
	Follow up on the evaluation of the effectiveness of daily training

3.3.2 Improvement of the system for training internal trainers for managers

In order to ensure the smooth promotion of staff to middle-level cadres, the hospital has implemented a strict qualification assessment system for internal trainers, which requires internal trainers not only to possess appropriate professional knowledge, but also to work together with the Human Resources Department to complete the task of lecturing. In addition, if the quality and quantity of lectures delivered by internal trainers meet the prescribed standards,

they will receive additional annual salary adjustments, and the ratio of the course assessment to the granting of lecturing allowances is as shown in Table 13. . In order to recognize outstanding in-house trainers, a wide range of teaching allowances are provided depending on their level of competence. Beginning internal trainers are paid 160 yuan per class hour, intermediate internal trainers 200 yuan per class hour, and advanced internal trainers 240 yuan per class hour. Additional course development opportunities are also provided for internal trainers at 200 yuan, 300 yuan and 400 yuan per course. To better monitor the teaching quality of in-house trainers, the percentage of stipends for lectures will be determined based on the average scores of the course evaluation questionnaires.

Table 13: The proportion of course evaluation and teaching allowance distribution

Internal trainer	Hourly fee	Course price	Average score of course assessment	The percentage of teaching allowances paid
Beginner	160	200	95-100	100%
Medium	200	300	85-90	90%
Higher	240	400	≤85	80%

3.3.3 Improve the hospital training assessment and incentive system

Table 14 shows the annual credit requirements for training of managers at each level. In order to better motivate the staff, the hospital needs to improve the staff training assessment system and encouragement rules and regulations. According to the competency model to set up the annual credit mechanism, and will be included in the hospital staff training attendance in the annual evaluation of the work, which can greatly improve the enthusiasm of the hospital staff to participate in training. In addition, it is also necessary to implement a sign-in management system for personnel who participate in technical training, and record unexcused absences. If a person fails to successfully complete the annual training credits and has unexcused absences, he or she will not be promoted, and the end-of-year performance bonuses will be negatively impacted. Therefore, the hospital has made “successful completion of annual training credits, participation in training activities, no absenteeism, no tardiness, and no early departure” the focus of the annual performance appraisal, accounting for 20% of the total annual appraisal.

Table 14: Annual credit requirements for training of managers at all levels

Job grade classification	Annual credits	Remarks
Basic management	20	3 points for the first-level course
Key management team	30	2 points for the second-level course
Core management team	50	One point for the third-level course

3.3.4 Analysis of practice effects

The model practice effect analysis mainly measures whether the recruiters can realize the matching of people and jobs, and the evaluation indexes include the hospital's job satisfaction with the new employees and the evaluation of recruitment turnover rate.

(1) Employing department's satisfaction and evaluation of new employees

The satisfaction of the hospital with new employees is shown in Table 15. The survey on the job satisfaction of the hospital that recruited new employees within one year after the model was implemented shows that the proportion of satisfaction has made a considerable leap. The proportion of "very dissatisfied" has dropped from 9% to 1%, that of "dissatisfied" from 34% to 7%, that of "average" from 28% to 30%, that of "relatively satisfied" from 22% to 36%, and that of "satisfied" from 7% to 26%. This indicates that the hospital still highly recognizes the

working ability of new employees It also reflects the practical effect of the model.

Table 15: The hospital's satisfaction with new employees

Project	Before implementation	After implementation
Very dissatisfied	0.09	0.01
Dissatisfied	0.34	0.07
General	0.28	0.30
Relatively satisfied	0.22	0.36
Satisfied	0.07	0.26

(2) Recruitment turnover assessment

After one year of model implementation, the recruitment turnover rate of the hospital was evaluated and the results of the recruitment turnover rate evaluation are shown in Table 16. Based on the data in the table, it can be seen that when the hospital after the optimization of the competency model, the staff turnover situation has improved, the turnover rate from 11.70% down to 2.02%, while the new employee turnover rate from 81.80% down to 50.00%, fully validate the model optimization of the efficacy of the hospital's health human resources recruitment and training system.

Table 16: Assessment results of recruitment attrition rate

Project	Onboarding	Resignation	Resign within one year of employment	Number of people at the end of the year	Flow rate	New employee turnover rate
Before	15	11	9	94	11.70%	81.82%
After	14	2	1	99	2.02%	50.00%

4 Conclusion

Hospitals have an increasing demand for high-quality talents, and traditional recruitment and selection methods are often difficult to comprehensively assess the actual working ability of candidates, which leads to the uneven quality of human resources. This paper formulates a comprehensive optimization research program of hospital health human resources recruitment and training system based on competency model, and carries out empirical research and analysis on this research program, so as to improve the quality of hospital health human resources recruitment and training system.

(1) By solving the judgment matrix form, determine the hospital health human resources recruitment and training system competency model weight values, its C1 ~ C30 values are 0.0200, 0.0302, 0.0160, 0.0250, 0.0134, 0.0174, 0.0226, 0.0200, 0.0292, 0.0298, 0.0206, 0.0351, 0.0334, 0.0496, 0.0307, 0.0289, 0.0283, 0.0352, 0.0307, 0.0545, 0.0493, 0.0493, 0.0445, 0.0353, 0.0405, 0.0463, 0.0374, 0.0283, 0.0261, 0.0353, 0.0374, which provide important theoretical basis for model practice optimization.

(2) In the questionnaire survey analysis of self-assessment and corresponding patient evaluation of 10 doctors newly recruited in Hospital A in 2023, it was found that neither one doctor out of 10 was unqualified, with a qualification rate of 90.00%, which indicates the effectiveness of the competency model of the hospital's health human resources recruitment and training system.

(3) Carry out the comprehensive optimization design of the hospital health human resources recruitment and training system based on the competency model from three aspects. After the

optimization of the competency model, the turnover rate of the hospital staff was reduced from 11.70% to 2.02%, and the departure rate of the new employees was reduced from 81.80% to 50.00%, which shows the optimization effectiveness of the model in the hospital health human resources recruitment and training system. .

References

- [1] Nobakht, S., Shirdel, A., Molavi-Taleghani, Y., Doustmohammadi, M. M., & Sheikhbardsiri, H. (2018). Human resources for health: A narrative review of adequacy and distribution of clinical and nonclinical human resources in hospitals of Iran. *The International journal of health planning and management*, 33(3), 560-572.
- [2] Reese, S. M., Gilmartin, H., & Smathers, S. (2021). Challenges and opportunities in recruiting, hiring and training infection preventionists across facility settings. *American Journal of Infection Control*, 49(8), 973-977.
- [3] Abdollahi, A., Tabibi, J., & Komeili, A. (2018). Selection, recruitment and training of nursing managers in hospitals: A comparative study. *Modern Care Journal*, 15(3).
- [4] Gupta, I., Siddiqui, Z. K., Phillips, M. D., Singh, A., Eid, S. M., Wortman, L., ... & CONQUER COVID Consortium. (2023). Recruitment, readiness, and retention of providers at a field hospital during the pandemic. *Disaster medicine and public health preparedness*, 17, e102.
- [5] Staškeviča, A. (2019). The importance of competency model development. *Acta Oeconomica Pragensia*, 27(2), 62-71.
- [6] Podmetina, D., Soderquist, K. E., Petraite, M., & Teplov, R. (2018). Developing a competency model for open innovation: From the individual to the organisational level. *Management Decision*, 56(6), 1306-1335.
- [7] Skorková, Z. (2016). Competency models in public sector. *Procedia-Social and Behavioral Sciences*, 230, 226-234.
- [8] Zhang, Z. (2023). The HRM Model Based on Competency Model in the Context of New Age Intelligence. *Wireless Communications and Mobile Computing*, 2023(1), 6030183.
- [9] Liu, Y., & Shen, Y. C. R. (2019). Human Resource Management Framework Construction under Competency Model. *Int. J. Learn*, 5(3), 252-256.
- [10] Gunawan, J., Aunguroch, Y., & Fisher, M. L. (2019, January). Competence-based human resource management in nursing: A literature review. In *Nursing forum* (Vol. 54, No. 1, pp. 91-101).
- [11] TANG, C. M., & CHENG, X. (2017). Research on the application of competency model in medical and health field. In *2nd International Conference on Education, E-learning and Management Technology (EEMT)*.—Beijing (pp. 559-564).
- [12] Wu, J. (2024). Research on precise recruitment strategy of hospital talents based on post competency model. *Sci. Soc. Res*, 6, 338-343.

- [13] Karami, A., Farokhzadian, J., & Foroughameri, G. (2017). Nurses' professional competency and organizational commitment: Is it important for human resource management?. *PloS one*, 12(11), e0187863.
- [14] Wang, S., Tong, J., Wang, Y., & Zhang, D. (2022). A study on nurse manager competency model of tertiary general hospitals in China. *International Journal of Environmental Research and Public Health*, 19(14), 8513.
- [15] Wayan, S. N., & Putra, S. I. G. N. (2020). Implementation of human resources competency in nursing services field in industrial revolution 4. 0 era: a study at Regional General Hospital of Klungkung. *Russian Journal of Agricultural and Socio-Economic Sciences*, 98(2), 31-36.
- [16] Jayaraman, S., Sethi, D., Chinnock, P., & Wong, R. (2014). Advanced trauma life support training for hospital staff. *Cochrane Database of Systematic Reviews*, (8).
- [17] Sapitri, R., Sukarya, Y., & Priyono, A. (2025). The Effect of Competency-Based Training and the Work Environment on the Performance of Non-Medical Administrative Employees at a Private Hospital in Tangerang Regency. *Journal of Industrial Engineering & Management Research*, 6(5), 21-29.
- [18] Gunawan, J., Aunguroch, Y., Fisher, M. L., McDaniel, A. M., & Liu, Y. (2022). Competence-based human resource management to improve managerial competence of first-line nurse managers: A scale development. *International journal of nursing practice*, 28(1), e12936.
- [19] Chen, S., Zhang, C., & Li, W. (2022). The effects of competency-based training model in the training of new nurses: A meta-analysis and systematic review. *PLoS One*, 17(11), e0277484.
- [20] Peregrin, T. (2014). Competency-based hiring: The key to recruiting and retaining successful employees. *Journal of the Academy of Nutrition and Dietetics*, 114(9), 1332-1335.
- [21] Spychała, M., Goliński, M., Szafranski, M., & Graczyk-Kucharska, M. (2019, May). Competency models as modern tools in the recruitment process of employees. In *Proceedings of the 10th European Conference on Intangibles and Intellectual Capital ECIIC* (pp. 282-291).
- [22] Gong, X., & Liu, R. (2020, August). Research on the application of competency model in personnel management of private enterprises. In *Journal of Physics: Conference Series* (Vol. 1621, No. 1, p. 012034). IOP Publishing.
- [23] Tian, C., Ma, Y., Feng, D., Zhang, J., & Guan, L. (2024). Application of Career Management and Competency Model in the Construction of New Employee Training System in Enterprises. In *Disruptive Human Resource Management* (pp. 342-350). IOS Press.
- [24] El Asame, M., & Wakrim, M. (2018). Towards a competency model: A review of the literature and the competency standards. *Education and Information Technologies*, 23(1), 225-236.

- [25] Sekerin, V. D., Gaisina, L. M., Shutov, N. V., Abdrakhmanov, N. K., & Valitova, N. E. (2018). Improving the quality of competence-oriented training of personnel at industrial enterprises. *Calitatea*, 19(165), 68-72.