

A Method for University Middle-level Manager Assessment Based on Multi-Objective Attribute Model

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Abstract. Quantitative assessment for university middle-level manager were affected by a number of factors, it belongs to multi-objective decision-making problem. Multi-objective attribute model based on the analytic hierarchy process and setting value statistic and attribute mathematics for university middle-level manager assessment has been established. The rationalization of the model is verified with an example.

Introduction

Management staff evaluation has become an important means of management assessment. Management staff evaluation mainly includes the following aspects, namely, "Virtue, Ability, Diligence, Performance and Integrity." The current method is commonly used by the relevant evaluating people who give respective assessment for each management staff, according to the performance, excellent, good, qualified and unqualified grade votes can be granted, then votes can be accumulated, thus the number of votes becomes the main basis for assessment.

Among the middle-level management staff in universities and colleges, there are a lot of positions such as administrative management, teaching supplementary and so on, the duties, workloads well as work contents vary greatly, moreover the different evaluating people may have various assessments on the management staff in the following aspects, such as "virtue, ability, diligence, performance and integrity", therefore, using the amount of the votes is a simple evaluation that can not accurately reflect the comprehensive performance of management staff in different positions, the assessment results are not comparable.

The assessment on middle-level management staff in universities and colleges is a multi-objective evaluation problem. Based on Analytic Hierarchy Process (AHP) and attribute mathematics principle, it can set up a mathematical model, so as to test the quantitative assessment of middle-level management staff in universities and colleges.

Comprehensive Evaluation Index System on Cadre Assessment

Factors that affect the comprehensive evaluation results of middle-level management staff in universities and colleges occur in many aspects, service object, management object and the leadership of the dean will have different evaluations on the same individual from different angles, the aspects from the factors of "virtue, ability, diligence, performance and integrity"

can both have qualitative index and quantitative index, these indexes are in a clear hierarchic relationship.

The Principle of Comprehensive Hierarchic Assessment with Multi-Objective Attributes on Management Staff

The evaluation system of management staff can contain both quantitative index and qualitative index, according to the provisions of the quantitative indicators, as well as the index value to determine the size of the evaluation value; it is difficult when the qualitative index is determined according to the evaluation of the scoring, while the scope of the given scoring is much easier, which can adopt the statistic method of interval score processing to determine the evaluation value.

The qualitative description of things can be called attributes, attribute mathematics can regard the attribute as a set from the angle of thinking, then the attribute measure space can be set up, the nature of things can be distributed and described by the measurement of the attribute set in attribute space. The attribute synthetic evaluation system includes single index of attribute measure, multi-index of attribute measure and recognition, as for ordinal evaluation class, it can adopt confidence criterion. The principle of comprehensive hierarchic assessment with multi-objective attributes on management staff can be shown in Fig.1.

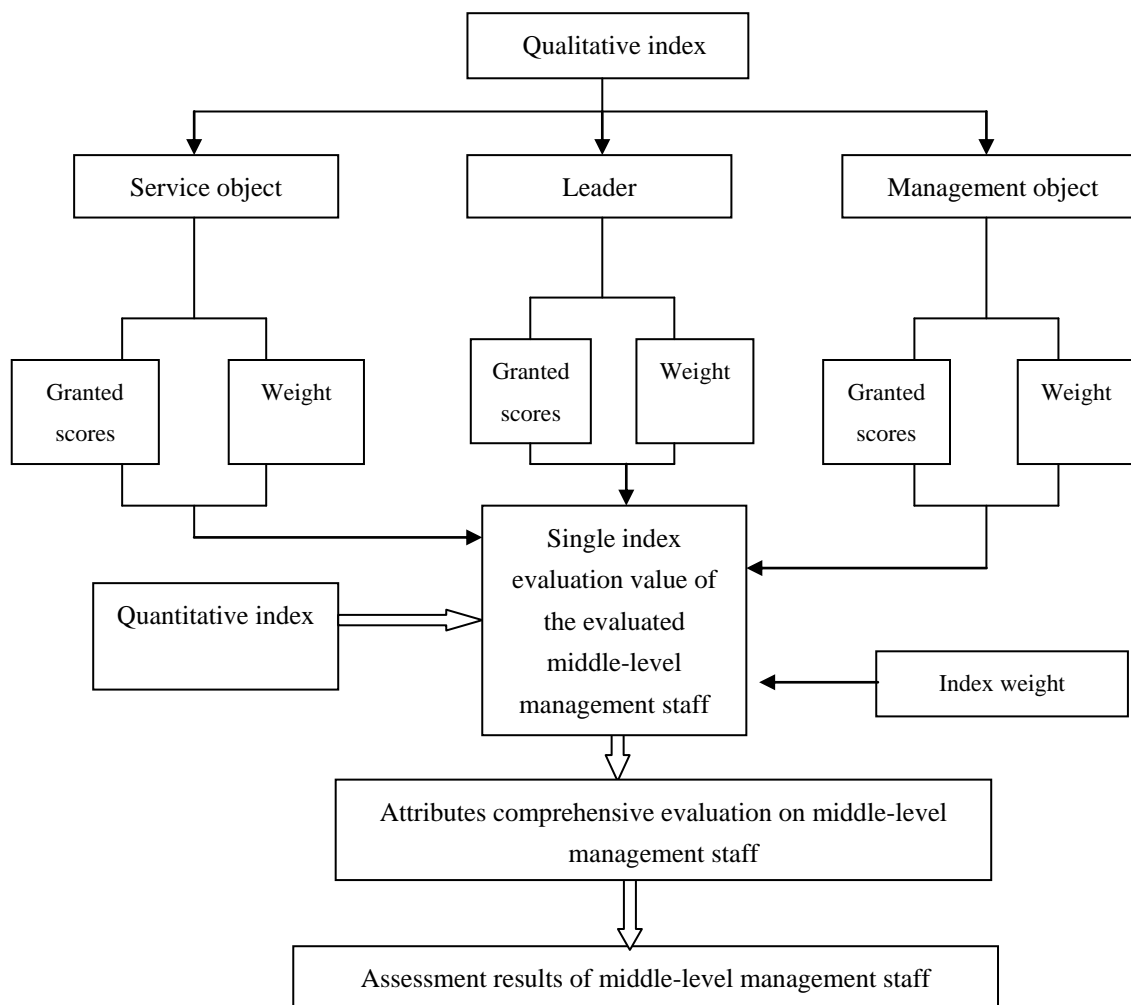


Fig.1 The Principle of Comprehensive Hierarchic Assessment with Attributes

Comprehensive Evaluation Model and Method

Determining Weight with AHP

AHP can compare the influence degree of each factor on the target, and the judgment matrix can be quantified by the scale of "1~9". Each time, two factors are used to make comparison, so as to reduce the difficulty of comparison and improve the accuracy as well. The maximum eigenvalue and eigenvector of the judgment matrix can be calculated, and the weight value of each factor can be determined after having consistency test.

Determining the Weights of Various Evaluating People

The influence degree of service object, management object and leaders on the evaluation of the middle-level management staff is quite different, it can construct judgement matrix based on the analysis of influence of the experts' evaluation, so as to determine the weight of ω_i by using AHP.

Determining Weight of Each Evaluation Index

According to Fig. 1 the hierarchic diagram, AHP is adopted to determine the weight of layer on the target layer, as well as index layer on the criterion layer, using synthetic weights calculation method to calculate the weight of the lowest layer (index layer) related to the top layer (target layer).

Assuming ωx_i ($i = 1, 2, L, n$) is importance weight of i criterion of criterion layer (X_i) to the target layer (X); ωx_{ij} is the single rank weight of the criterion of j criterion layer (X_{ij}) to i criterion layer, while the value of index weight without the control of criteria layer standard is 0, then the value of X_{ij} index to the target layer (X) can be determined, namely, the weight of ω_{ij} is:

$$\omega_{ij} = \omega x_i \cdot \omega x_{ij} \quad (i = 1, 2, L, n; j = 1, 2, L, m) \quad (1)$$

Determining Evaluation Value of Single Index

If there are n criteria in the evaluation criterion, there are m indexes under No. i criterion, and the evaluation index value of the evaluated staff No. l , which can be expressed as:

$$a = (a_{ijk})_{n \times m \times l}$$

Among them: a_{ijk} ($i = 1, 2, L, n; j = 1, 2, L, m; k = 1, 2, L, l$) is the evaluation value of No. j index of the evaluated staff No. k under No. i evaluation criteria.

If the weight of the evaluated staff No. t is ω_t ($t = 1, 2, L, T$; T is the amount of the evaluated staff), as for the evaluated staff No. k , the range of the evaluation of No. j index

under No. i criterion is $[a_{1ijk}^{(t)}, a_{2ijk}^{(t)}]$, then as for the evaluated staff No. k under No. i criterion, the average set value of statistics evaluation value of No. j index is a_{ijk} :

$$a_{ijk} = \frac{\frac{1}{2} \sum_{t=1}^T \omega_t [(a_{2ijk}^{(t)})^2 - (a_{1ijk}^{(t)})^2]}{\sum_{t=1}^T \omega_t [a_{2ijk}^{(t)} - a_{1ijk}^{(t)}]} \quad (2)$$

As for quantitative index, it can be translated into the corresponding scores according to the completion of workload.

3.3 Analysis on Single Index Attribute Measurement

Assuming the evaluated staff No. k , the evaluation value of No. j index under No. i criterion is a_{ijk} , " $a_{ijk} \in C_r$ " ($1 \leq r \leq R$) can represent that " a_{ijk} belongs to C_r of No. r class", whose attribute measurement is $\mu_{ijr}^k = \mu(a_{ijk} \in C_r)$. μ_{ijr}^k needs to satisfy

$$\mu_{ijr}^k \geq 0, \sum_{r=1}^R \mu_{ijr}^k = 1.$$

$C = (C_1, C_2, C_3, C_4)$ is the evaluation set of middle-level cadres evaluation, which is (excellent, competent, basic competent, incompetent). The grade division values of each index are as follows: $C_1 = 100 \sim 90$; $C_2 = 90 \sim 75$; $C_3 = 75 \sim 60$; $C_4 = 60 \sim 50$. The attribute measurement function can be constructed as follows:

$$\mu_{ij1}^k(a_{ijk}) = \begin{cases} 1 & a_{ijk} > 95 \\ \frac{a_{ijk} - 85}{10} & 85 \leq a_{ijk} \leq 95 \\ 0 & a_{ijk} < 85 \end{cases} \quad (3)$$

$$\mu_{ij2}^k(a_{ijk}) = \begin{cases} \frac{95 - a_{ijk}}{10} & 85 \leq a_{ijk} \leq 95 \\ 1 & 82.5 < a_{ijk} < 85 \\ \frac{a_{ijk} - 67.5}{15} & 67.5 \leq a_{ijk} \leq 82.5 \\ 0 & \text{Others} \end{cases} \quad (4)$$

Others

$$\mu_{ij3}^k(a_{ijk}) = \begin{cases} \frac{82.5 - a_{ijk}}{15} & 67.5 \leq a_{ijk} \leq 82.5 \\ 1 & 65 < a_{ijk} < 67.5 \\ \frac{a_{ijk} - 55}{10} & 55 \leq a_{ijk} \leq 65 \\ 0 & \text{Others} \end{cases} \quad (5)$$

$$\mu_{ij4}^k(a_{ijk}) = \begin{cases} 1 & a_{ijk} < 55 \\ \frac{65 - a_{ijk}}{10} & 55 \leq a_{ijk} \leq 65 \\ 0 & a_{ijk} > 65 \end{cases} \quad (6)$$

Analysis on Multi-Index Comprehensive Attribute Measurement

From the index weight ω_{ij} and the single index attribute measurement μ_{ijr}^k , we can get the multi-index comprehensive attribute measurement of the evaluated staff No. k :

$$\mu_r^k = \sum_{i=1}^n \sum_{j=1}^m \omega_{ij} \mu_{ijr}^k \quad (r = 1, 2, \dots, R) \quad (7)$$

The comprehensive attribute measurement μ_r^k adopts the confidence criterion, which can be used to evaluate and sort the evaluating people, setting the reliability is λ (generally the range is between 0.6 and 0.7):

$$r_0 = \min \left\{ r \mid \sum_{l=1}^r \mu_l^k \geq \lambda, 1 \leq r \leq R \right\} \quad (8)$$

It is considered that the evaluated staff No. k belongs to C_{r_0} class.

Examples of Calculation

Among the year -end assessment in a certain university, assessment is carried on A, B and C, who are the leaders of three administrative departments. Evaluating people are from service objects, management objects as well as their leaders, which can carry on the assessment according to the principle that is shown in Fig.2.

Determining Weight by Means of AHP

Determining Weights of Various Evaluating People

According to the pr executive leaders, management objects and service objects as well as the practical relation of the evaluated middle-level management staff, using AHP to determine

evaluation weight ω_i of the assessment object given by evaluating people:supervisor leader is

$\omega_1 = 21.14\%$, management object is $\omega_2 = 31.19\%$, service object is $\omega_3 = 47.67\%$.

Weight of Evaluation Index

The weight ωx_i of the criterion layer to the target layer can be determined by using AHP, the weight B of the index layer to the criterion layer is ωx_{ij} , while weight ω_{ij} of the index layer to the target layer can be calculated by Formula (1). The results are shown in Table 1.

Table 1 Weight of Each Index

Weight	Virtue (X_1)		Ability (X_2)		Diligence (X_3)		Performance (X_4)		Integrity (X_5)	
	X_{11}	X_{12}	X_{21}	X_{22}	X_{31}	X_{32}	X_{41}	X_{42}	X_{51}	X_{52}
ωx_{ij} (%)	57.82	42.18	52.37	47.63	48.44	51.56	51.14	48.86	46.24	53.76
ωx_i (%)	22.41		18.82		19.32		16.31		23.14	
ω_{ij} (%)	12.96	9.45	9.85	8.96	9.36	9.96	8.34	7.97	10.70	12.45

Determining Evaluation Value of Single Index

Evaluating people choose three people A, B and C as the evaluated objects, having evaluation on ten evaluation indicators (shown in Fig.1). Defining the evaluation value range of the given qualitative index, combined with the evaluation weights, using set value statistics method Formula (2) calculating the evaluation value a_{ijk} of the evaluated object, as for the quantitative index X_{42} (completing an important work), according to the amount of completion, according to the previous appointment to calculate the evaluation value a_{ijk} with the percentage conversion, shown in Table 2.

Table 2 Evaluation Value a_{ijk} of Single Index

k	X_{ij}									
	X_{11}	X_{12}	X_{21}	X_{22}	X_{31}	X_{32}	X_{41}	X_{42}	X_{51}	X_{52}
A	93	89	89	78	87	85	91	83	92	95
B	89	90	88	87	89	91	81	84	88	91
C	83	91	87	78	89	87	81	84	90	91

Attribute Measurement Analysis on Single Index

The single attribute measurement μ_{ijr}^k of each evaluation object is calculated by the attribute measurement function in Formula (3) ~ (6), the results can be shown in Table 3.

Table 3 Attribute Measurement of Single Index μ_{ijr}^k

k	μ_{ijr}^k	X_{ij}									
		X_{11}	X_{12}	X_{21}	X_{22}	X_{31}	X_{32}	X_{41}	X_{42}	X_{51}	X_{52}
A	$\mu_{ij1}^{\text{甲}}$	0.8	0.4	0.4	0	0.2	0	0.6	0	0.7	1
	$\mu_{ij2}^{\text{甲}}$	0.2	0.6	0.6	0.7	0.8	1	0.4	1	0.3	0
	$\mu_{ij3}^{\text{甲}}$	0	0	0	0.3	0	0	0	0	0	0
	$\mu_{ij4}^{\text{甲}}$	0	0	0	0	0	0	0	0	0	0
B	$\mu_{ij1}^{\text{乙}}$	0.4	0.5	0.3	0.2	0.4	0.6	0	0	0.3	0.6
	$\mu_{ij2}^{\text{乙}}$	0.6	0.5	0.7	0.8	0.6	0.4	0.9	1	0.7	0.4
	$\mu_{ij3}^{\text{乙}}$	0	0	0	0	0	0	0.1	0	0	0
	$\mu_{ij4}^{\text{乙}}$	0	0	0	0	0	0	0	0	0	0
C	$\mu_{ij1}^{\text{丙}}$	0	0.6	0.2	0	0.4	0.2	0	0	0.5	0.6
	$\mu_{ij2}^{\text{丙}}$	1	0.4	0.8	0.7	0.6	0.8	0.9	1	0.5	0.4
	$\mu_{ij3}^{\text{丙}}$	0	0	0	0.3	0	0	0.1	0	0	0
	$\mu_{ij4}^{\text{丙}}$	0	0	0	0	0	0	0	0	0	0

Comprehensive Attribute Measurement Analysis on Multi-Index

The comprehensive attribute measurement μ_r^k of each assessment object is calculated by the multi-index comprehensive attribute measurement in Formula (7), the confidence criterion Formula (8) can be adopted to obtain the reliability $\lambda = 0.6$, therefore, the evaluation result and the order of each object can be obtained, shown in Table 4. The comprehensive evaluation results of these three evaluation objects of A, B and C are both satisfactory, compared with the others, B is the best one.

Table 4 Comprehensive Evaluation Results and Ranking

k	μ_r^k				Evaluation result	Ranking
	μ_1^k	μ_2^k	μ_3^k	μ_4^k		
A	0.449	0.524	0.027	0	Competent	2
B	0.351	0.641	0.008	0	Competent	1
C	0.262	0.703	0.035	0	Competent	3

Conclusion

Assessment on management staff is a complex personnel evaluation activities, we should consider many aspects such as "virtue, ability, diligence, performance, integrity". Multi-objective attribute model of middle-level management staff in universities and colleges can use set value statistics method to determine the scores of the qualitative evaluation index value in the range of scores, which can avoid the difficulty of scoring according to a single value. Analytic hierarchy process can be used to take the weights of the influence of the various evaluating people and evaluation indicators into account on the results, which can make the evaluation results more scientific and reasonable, so as to improve the accuracy of evaluation. By means of attribute measurement analysis and recognition, it can the comprehensive quantitative assessment and ranking of middle-level management staff in universities and colleges.

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