



Research Article

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Staff performance appraisal based on data envelopment analysis (DEA)

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ABSTRACT

Traditional staff performance appraisal methods are lack of quantitative tools and tend to be affected by subjective factors, as a result of which numerous problems arose. This puts forward the method that applies the ideology of production efficiency to staff performance appraisal and uses DEA to create the frontier, which can not only provide quantitative appraising results, but also be convenient for staff to find the gap between him or her and the excellent performance and be urged to improve his or her own performance.

Keywords: Performance Appraisal; DEA (Data Envelopment Analysis); Frontier

INTRODUCTION

Staff performance appraisal is an important task of human resources management. To appraise the performance of staff is to provide an opportunity for the staff to get the feedback information about work, to provide an opportunity for the enterprise to know the relationship between staff's working behavior and outcome, and to provide the enterprise with basis on which to make important decisions and plans. Only adopting scientific and effective appraising method and evaluating subjectively, can the appraisal result provide true and credible information for the enterprise to make subsequent decisions and plans, can be beneficial to the long-term development and the staff vocation career development, can be assurance of realizing corporate objectives and making harmonious atmosphere, high working enthusiasm of the staff and high working efficiency. Therefore, to study the method of appraising staff performance becomes an importance subject of human resources management field, and as a result we should make unceasing progress in improving staff performance appraisal and bringing forth new appraising method.

This puts forward the method that applies the ideology of production efficiency to staff performance appraisal and uses DEA to create the frontier, which can not only provide quantitative appraising results, but also can avoid the influence of subjective factors in appraisal job, be convenient for staff to find the gap between him or her point out direction to improve performance.

Conventional Method of Staff Performance Appraisal

Enterprise always appraises staff performance for one or several reasons as following. First, appraisals provide information upon which promotion and salary decisions can be made. Second, they provide an opportunity for the enterprise and the staff to review the subordinate's work-related behavior, this in turn lets both develop a plan for correcting any deficiencies the appraisal might have unearthed, and reinforce the things being done right; (3) the appraisal is part of the firm's career-planning process, because it provides an opportunity to review the person's career plans in light of his or her exhibited strengths and weaknesses; (4) (and in keeping with reasons 1 through 3 above), appraisals can help to better manage and improve organization's performance.[1]

In practice of enterprises, the several tradition appraisal methods are graphic rating scale method, alternation ranking method, paired comparison method, forced distribution method, critical incident method, narrative forms,

behaviorally anchored rating scales (BARS), the management by objectives method (MBO). The advantages and disadvantages of major appraisal methods are shown in table 1.

Table 1 Advantages and Disadvantages of Major Appraisal Methods

Method	Advantages	Disadvantages
Graphic rating scale	Simple to use; provides a quantitative rating for each employee.	Standards may be unclear; halo effect, central tendency, leniency, bias can also be problem.
Alternation ranking	Simple to use (but not as simple as graphic rating scales). Avoids central tendency and other problems of rating scales.	Can cause disagreements among employees and may be unfair if all employees are, in face, excellent.
Forced distribution method	End up with a predetermined number of people in each group.	Appraisal results depend on the adequacy of your original choice of cutoff point.
Critical incident method	Helps specify what is "right" and "wrong" about the employee's performances; forces supervisor to evaluate subordinates on an ongoing basis.	Difficult to rate or rank employees relative to one another.
BARS	Provides behavioral "anchors". BARS is very accurate.	Difficult to develop.
MBO	Tied to jointly agreed-upon performance objectives.	Time consuming.

Source: Gary Dessler, *Human Resource Management (Eighth Edition)*, Tsinghua University Press, 2001

In practice, most firms combine several appraisal techniques to reflect overall working quality of staff and avoid the problems caused by disadvantages of some single method. However, in the course of appraising staff performance, for the reason that they are lack of quantitative analyzing tools and depend much on subjective judgment, these methods have some adherent problems in use which make the reliability and validity of the appraisal result decline to some extent. The problems are, for example, the unclear work performance criterion, different understanding of evaluators, the result not reflecting the real performance level because of similar standard for different jobs without specialty, and halo effect, tendency, leniency, bias caused by evaluators' opinions and habits, etc.

Staff performance appraisal method based on DEA

In view of the limitations of conventional appraisal method mentioned above, in the work of appraising staff performance some more objective and quantitative method should be introduced to make the appraisal course scientific and objective and the appraisal result be less influenced by subjective factors, which in turn improves the reliability and validity of appraisal.

Introduction of DEA

Data Envelopment Analysis (DEA) was an important non-parameter method evaluating relative efficiency, put forward by Charnes, Cooper and Rhodes[2] in 1978 based on the study on evaluation of private enterprises by Farrell. Originally, DEA was used to construct production frontier to evaluate the production efficiency.

Until Koopmans [3] and Debreu [4] introduced the concept of "production possibility set" in 1951, production efficiency has exact economic definition, that is, to maximize the output by input as little as possible. Production possibility set is such input-output set: $T = \{(X, Y): \text{output } Y \text{ can be produced by input } X\}$. The set is composed of two parts: one is boundary of the set (production frontier), the other is inside the set. Based on that, relative efficiency of the decision making unit (DMU) is defined: the points on the boundary are efficient, and the points inside set are inefficient; or assess the relative efficiency by the distance between DMU and the set boundary: if there is strict positive distance, the DMU is inefficient, if the distance is zero, the DMU is efficient. [5] Thus efficient production and inefficient production are distinguished.

In 1957, Farrell [6] expanded the study of Koopmans and Debreu and defined production frontier. Production frontier means an efficient external plane which envelopes all the production-behavior samples observed. That is to say, production frontier stands for the optimal production behaviors. It can be used to evaluate the efficiency of one production unit, by comparing output acquired in it with the maximal possible output by given input, or comparing the actual input in it with the minimal possible input to acquire given output. And production efficiency of one production unit's actual behavior is reflected by deviation from the production frontier, so production frontier can evaluate production efficiency and became an important concept in economy and management.

As to the construction of production frontier, there are parameter methods and non-parameter methods. Parameter methods consider that the relation between production input and output can be expressed as production function, while non-parameter methods do not need construct production function. When it comes to non-parameter methods, an important representative is Data Envelopment Analysis (DEA). DEA do not need construct the relation function between input and output, but use linear programming technique to constitute the actual observation data of each unit observed and construct the piecewise hyperplane "floating" on all the points of observation samples, called

production frontier, thereby evaluate the efficiency of each unit. The production frontier constructed by DEA envelops all the points of observation data: the optimal ones construct the production frontier, other points are enveloped inside. It reflects the optimal relation between input and output of production system. On the other hand, it provides a method to calculate the distance from the DMU to production frontier and opens up a new way to evaluate relative efficiency.

The method and procedures of applying DEA in staff performance appraisal

Staff performance appraisal can also borrow ideas from the concept of production efficiency and idea of evaluating production efficiency. Suppose that all the employees are working under the same limited enterprise resources input, however, because each employee makes different effective efforts to the work (note that here “effective efforts” means not only the ostensibly working time, but also implies the potential requirements, e.g. definite and accurate working objectives, high efficiency and appropriately correct working method etc.), the output of each employee will be different too. And then, the production frontier can be used to evaluate the relative efficiency of each employee’s performance.

The appraisal method can be represented by figure 1, which gives simple geometric explanation. Suppose there are three DMUs (Decision-Making-Unit, representing three employees’ performance), given the input and output factors, which are $A(X_1, Y_1)$, $B(X_2, Y_2)$, $C(X_3, Y_3)$. Take input as the abscissa and output as the ordinate, if $X_1 < X_2 < X_3$, and the magnitudes of ordinates are shown as figure 1. If B is lower than the straight line determined by A and B, the evaluation can be made that performance of B is less efficient than A and C, and the straight line determined by A and B can be looked as the management frontier of these three units. If $B'(X_2, Y_2')$ is the projection of B on the frontier and make $\eta = Y_2 / Y_2'$, η will reflect effective subjective efforts. And if there are many DMUs, the performance frontier can be constructed by DEA.

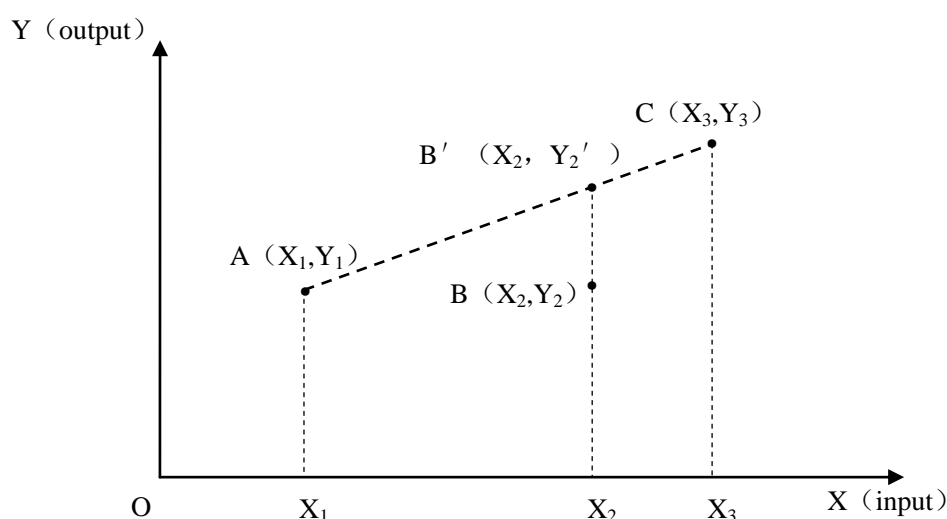


Figure 1. the geometric explanation of DEA

The procedures applying DEA to staff performance appraisal can take the following as reference.

(1) Analyze the factors influencing staff performance. Group the staff behavioral factors to be appraised into input and output. If the case is to appraise the salesmen performance in sales department, and the factors influencing working performance are sales input, sales revenue, we should take sales input as input, sales revenue as output.

(2) Use DEA to construct performance frontier.

(3) Calculate the relative evaluating result. Utilize the method of analyzing whether the production is efficient or not, in which the points on the frontier are efficient and others are inefficient or low efficient, i.e. use the comparison of current value and the projection point on the frontier to represent the level of efficiency. Thus, not only the relative appraisal result is got, but also can be got the outstanding and excellent staff performances which are worth of learning from and popularizing (the points on the frontier).

Advantages of Staff Performance Appraisal Based on DEA

The method of staff performance appraisal based on DEA has distinct advantages that conventional performance appraisal methods lack. First, the method can eliminate the evaluators' subjective factors effectively which avoids the disadvantages of conventional appraisal methods and improve the reliability of appraisal results. Second, the method don't need to represent the complicated relation between input and output which sometimes are impossible to represent, and just construct a performance frontier enveloping all the possible performance points to find the efficient points(excellent staff performances) among the staff to be evaluated. Last, through the calculation of efficiency, make the relative efficiency quantitative and be convenient for the staff to find the gap to the excellent performance according to the feedback information, and then analyze the reason and point out the direction to performance improvement and staff carrier development.

CONCLUSION

To appraise the staff performance is a significant work in human resources management, which is the base of control on the work of staff, and an important step of ensuring that performance of the whole enterprise conform to the overall planning objectives. For the reason of lack of quantitative tools, the conventional performance appraisal methods tend to be affected by subjective factors and bring various problems, even combine several methods still can't solve the problems well. Applying DEA to staff performance appraisal can avoid the influence of subjective factors in appraisal job, improve the objectivity and quantitative level of appraisal, provide feedback information to staff and point out direction to improve performance, therefore it is a scientific, effective method worthy of trial.

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