

Performance Appraisal System using Multifactorial Evaluation Model

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Abstract—Performance appraisal of employee is important in managing the human resource of an organization. With the change towards knowledge-based capitalism, maintaining talented knowledge workers is critical. However, management classification of “outstanding”, “poor” and “average” performance may not be an easy decision. Besides that, superior might also tend to judge the work performance of their subordinates informally and arbitrarily especially without the existence of a system of appraisal. In this paper, we propose a performance appraisal system using multifactorial evaluation model in dealing with appraisal grades which are often express vaguely in linguistic terms. The proposed model is for evaluating staff performance based on specific performance appraisal criteria. The project was collaboration with one of the Information and Communication Technology company in Malaysia with reference to its performance appraisal process.

Keywords—Multifactorial Evaluation Model, performance appraisal system, decision support system.

I. INTRODUCTION

ACCORDING to Moon, C. *et al.* [1], performance appraisal of candidates in relation to a particular position, is a key task towards managing the human resources of an organization. Supervisors are concerned with performance appraisal judgments and evaluations that they have to make on their subordinates. On the other hand, subordinates are increasingly realizing the importance of performance appraisal since it would very much affect their rewards and future career path. As the world began to shift towards knowledge-based capitalism, it reminds all organizations on the importance of maintaining their talented knowledge workers [1]. Therefore, discovering and promoting the most qualified candidates is essential because valuable human expertise is the main source of competitive advantage for the organizations. Thus, the creation of performance criteria is an important requirement towards performance appraisal [2].

Performance appraisal is usually conducted periodically within an organization to examine and discuss the work performance of subordinate so as to identify the strengths and weaknesses as well as opportunities for improvement among employees. Following this, most of the employers use the performance appraisal result to determine if a particular staff should be terminated or reinforced; as an employee development and coaching tool; to give a practical evaluation of an employee's readiness for promotion; and to serve as the foundation for giving merit bonus.

Following the awareness and understanding of the concept of fuzzy sets, some researchers have applied the fuzzy sets theory to the performance appraisal process. However,

Khairul, A. R and Qiang, S. [3] mentioned that, there has been an argument regarding one of the most suitable ways of managing multiple variables that have imprecise data to apply fuzzy concept reasoning which reflects the way of human-thinking. Various studies were conducted to improve the application of fuzzy sets theory and fuzzy logic in areas of performance appraisal. In this paper, we aimed to develop a performance appraisal system that applies the fuzzy set theory in dealing with appraisal grades which are often express vaguely in linguistic terms. Therefore, we proposed to use multifactorial evaluation model, an application of fuzzy set theory to decision making process, in the performance appraisal system.

II. RELATED WORK

A. Performance Appraisal System

Performance appraisal is a formal management system that provides for the evaluation of the quality of an individual's performance in an organization [4]. As mentioned by Dessler, G [5], performance appraisal has the means to evaluate an employee's current and past performance relative to the employee's performance standards. It is a process which involves creating work standards; evaluate employee's actual performance relative to those work standards; and giving feedback to employee so as to motivate him or her to improve the job performance or to eliminate performance deficiency. In addition to that, Terrence, H. M and Joyce, M. [6] stated that, some potential aims of performance appraisal might include identifying particular behavior or job.

Various techniques or methods have been used by human resource management experts to evaluate the performance of an employee. As outlined by Vicky G. [7], some of the appraisal methods include ranking; trait scales; critical incident; narrative; and criteria-based. Terrence, H. M. and Joyce, M. [6] mentioned few other methods including management-by-objectives (MBO), work planning and review, 360° appraisal and peer review. With all the available techniques, it is essential to understand that different organization might use different technique in assessing staff performance. Since all the techniques mentioned above has their own advantages and disadvantages, most organizations might mix and match different techniques for their own performance appraisal system that can fulfill their organizational needs.

Performance appraisal system has become one of the most valuable management tool in which organization members use to achieve collective goals. In order to ensure that the results of the performance appraisals are useful and reasonable to the superior when evaluating their subordinates, it is important for the performance appraisal system to consistently produce

reliable and valid results for the management of an organization.

B. Application of Fuzzy based Method

Fuzzy based method has been applied into several performance appraisal systems. Moon, C. *et al* [1] proposed a methodology utilizing fuzzy set theory and electronic nominal group technology for multi-criteria assessment in the group decision-making of promotion screening. The study suggested that the methodology is a good method for a transparent and fair multi-criteria performance evaluation in military organizations.

Researchers have demonstrated that fuzzy set theory could be successfully used to solve multiple criteria problems [8]. This is because, in many circumstances, appraiser tends to use vaguely defined qualitative criteria in evaluating the performance of their subordinates. Therefore, it creates difficulty for appraiser to precisely quantifying the score of each candidate. Jing, R.C *et al* [8] worked on applying fuzzy set theory on computer-based fuzzy group decision support system (FGDSS). Based on the findings of their work, the application of fuzzy set theory in FGDSS is said to be able to assist decision maker to make better decisions under different circumstances and alternatives [1].

A good example of the application of the fuzzy-set theory to decision-making process is multifactorial evaluation model [9]. For example, Tutmez *et. al.* [10] had used multifactorial fuzzy approach to evaluate the sawability and select a suitable diamond saw for a new building stone. This study has suggested that information can reasonably obtain and sawability classification is reasonable and acceptable.

The literatures that have been reviewed supported that the fuzzy set theory would be a good concept to be used in the development of the performance appraisal system. This is because fuzzy set theory allows the performance appraisal system to be developed by using some fuzzy variables and relationships. Therefore, the idea of incorporating this model in the performance appraisal system can be a promising approach.

III. METHODOLOGY

In this study, we have collaborated with one of the Information and Communication Technology based company in Malaysia to understand their performance appraisal process. Interview has been conducted with their Human Resource Section. A semi-structured interview was adopted. The semi-structured interview in this study is most appropriate because it provides a great deal of flexibility to interviewees on how to reply the questions. At the same time, interviewers were able to pick up appropriate information by the interviewee [11]. Prior to actual implementation of the system, questionnaires were distributed to the human resource section to evaluate the usability and effectiveness of the system. In order to demonstrate the application of multifactorial evaluation model in the performance appraisal system, a performance appraisal system that applied multifactorial evaluation model was developed. This performance appraisal system used the performance appraisal criteria provided by the company. The

following section will described the performance appraisal model of the company.

IV. PERFORMANCE APPRAISAL MODEL

A. Performance Appraisal Process

Performance appraisal is used by an organization to reward and develop the human resource of the organization to ensure that the organization runs smoothly and grow. Every year, staffs are required to fill up Yearly Work Plan to report on the progress of the tasks assigned as agreed early of the year. This is done at the beginning and at the middle of the year. At year end, the Yearly Work Plan is used to evaluate the performance of the staff throughout the whole year. The process of performance appraisal is shown in Fig. 1 below.

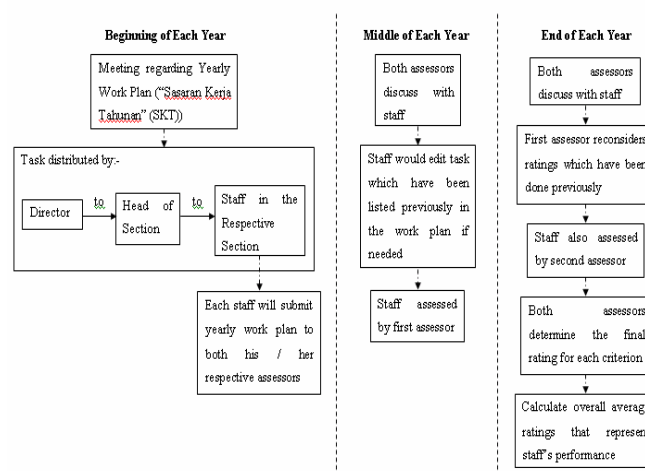


Fig. 1 Performance Appraisal Process

B. Staff Evaluation

Four aspects will be taken into consideration when evaluating staff performance and each aspect will index into its subcriteria, as follows:

- Working output (Aspect 1): This aspect evaluates the quantity, quality and effectiveness of the staff's working output as well as staff's punctuality.
- Knowledge and skills (Aspect 2): This aspect evaluates the staff's knowledge and skills in the working field as well as their effectiveness in communication and realization of rules.
- Personal quality (Aspect 3): This aspect evaluates the personal quality appreciated by the organization such as discipline, proactive, innovative, cooperativeness and independence.
- Informal Event(s) and Contribution(s) (Aspect 4): Staff's contribution to the organization, community, state, country and international.

When evaluating staff's performance, appraiser will use a scale of 1 to 10 to rate each subcriteria for each aspect mentioned above. 1 indicates that the staff was rated poorly in that particular subcriteria and 10 indicates that the staff was rated

highly in a particular subcriteria. The verbal grade for the scale is shown in Table I:

TABLE I
VERBAL GRADES AND SCALE FOR EACH ASPECT

VERBAL GRADES	SCALE
Very high	9 or 10
High	7 or 8
Moderate	5 or 6
Low	3 or 4
Very Low	1 or 2

V. PERFORMANCE APPRAISAL SYSTEM

The proposed application of Multifactorial Evaluation Model in the performance appraisal system is a combination of four multifactorial evaluation models.

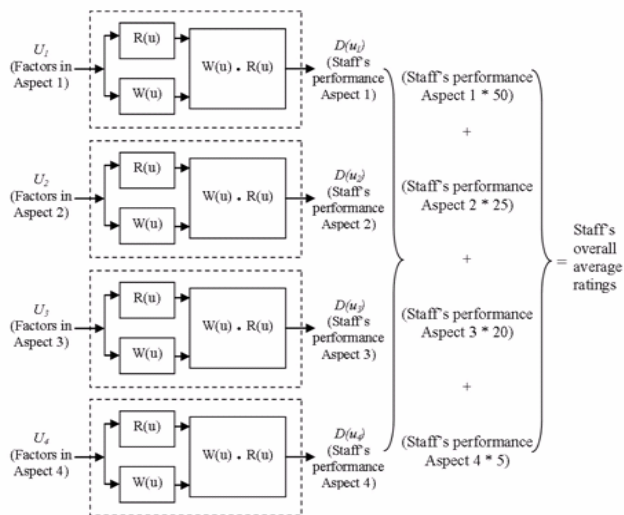


Fig. 2 Proposed Application of Multifactorial Evaluation Model in Performance Appraisal System

As shown in Fig. 2, each of the models represents aspect to be evaluated in the performance appraisal. After getting the staff's performance on each aspect from their superior, the staff's overall average ratings can be calculated by following the equation shown in Fig. 2 above. In Fig. 2, U is the factors to be evaluated in each aspect whereas $D(u)$ is the result of staff's performance in a particular aspect.

The first evaluation model in Fig. 2 uses U_1 , that is, the factors in Aspect 1 (Working Output) as its input. The subcriteria for this aspect will be used as the basic factors under this aspect which are:

- f_1 = Quantity of Working Output,
- f_2 = Quality of Working Output,
- f_3 = Punctuality, and
- f_4 = Effectiveness of Working Output.

Therefore, $F = \{f_1, f_2, f_3, f_4\}$.

The verbal grades used for the appraisal are:

- e_1 = Very High,
- e_2 = High,
- e_3 = Moderate,
- e_4 = Low, and
- e_5 = Very Low

Therefore, $E = \{e_1, e_2, e_3, e_4, e_5\}$.

For a staff's performance in terms of working output, the single-factor evaluation for each aspect has been determined by the executives in the Administration Section of the company. As an example, the weightage of the "Quantity of Working Output" factor f_1 are, 10% for Very High, 40% for High, 30% for Moderate, 10% for Low, and 10% for Very Low, thus, the single-factor evaluation vector $R_1(u)$ is:

$$R_1(u) = \{0.1, 0.4, 0.3, 0.1, 0.1\}$$

In the same way, the single-factor evaluation vectors for f_2 , f_3 , and f_4 which have been gained are as shown as below:-

$$R_2(u) = \{0.2, 0.5, 0.2, 0.1, 0.0\}$$

$$R_3(u) = \{0.5, 0.3, 0.1, 0.1, 0.0\}$$

$$R_4(u) = \{0.2, 0.5, 0.2, 0.1, 0.0\}$$

As a result, by referring to the single-factor evaluations vectors stated above, the following evaluation matrix can be built:-

$$R(u) = \begin{bmatrix} R_1(u) \\ R_2(u) \\ R_3(u) \\ R_4(u) \end{bmatrix} = \begin{bmatrix} 0.1 & 0.4 & 0.3 & 0.1 & 0.1 \\ 0.2 & 0.5 & 0.2 & 0.1 & 0.0 \\ 0.5 & 0.3 & 0.1 & 0.1 & 0.0 \\ 0.2 & 0.5 & 0.2 & 0.1 & 0.0 \end{bmatrix}$$

$W(u)$ is the weighting factors. Therefore, it is the appraiser's rating towards a staff for all the subcriteria in a particular aspect. As an example, assume that the appraiser's rating for weight vector corresponding to the four factors in all aspects are:

$$W_1(u) = \{0.2, 0.3, 0.3, 0.2\}$$

$$W_2(u) = \{0.3, 0.4, 0.3\}$$

$$W_3(u) = \{0.2, 0.3, 0.2, 0.3\}$$

$$W_4(u) = \{0.1\}$$

Multiplication of matrices $W(u)$ and $R(u)$ is based on the min-max composition of fuzzy relations, where the resulting evaluation is in the form of a fuzzy set $D(u) = [d_1, d_2, d_3, d_4]$ [9]. Since the aspect of Working Output has five verbal grades, that is, $E = \{e_1, e_2, e_3, e_4, e_5\}$ which would be involved in the performance appraisal system, thus, the resulting evaluation is in the form of a fuzzy set $D(u) = [d_1, d_2, d_3, d_4, d_5]$ as shown below:-

$$D(u) = W_1(u) \cdot R(u)$$

$$= [0.2 \quad 0.3 \quad 0.3 \quad 0.2] \cdot \begin{bmatrix} 0.1 & 0.4 & 0.3 & 0.1 & 0.1 \\ 0.2 & 0.5 & 0.2 & 0.1 & 0.0 \\ 0.5 & 0.3 & 0.1 & 0.1 & 0.0 \\ 0.2 & 0.5 & 0.2 & 0.1 & 0.0 \end{bmatrix}$$

$$= [0.3 \quad 0.3 \quad 0.2 \quad 0.1 \quad 0.1]$$

They are calculated through the following steps as shown below whereby \wedge represent the operations min and \vee represent the operation max.

$$\begin{aligned} d_1 &= (w_1 \wedge r_{11}) \vee (w_2 \wedge r_{21}) \vee (w_3 \wedge r_{31}) \vee (w_4 \wedge r_{41}) \\ &= (0.2 \wedge 0.1) \vee (0.3 \wedge 0.2) \vee (0.3 \wedge 0.5) \vee (0.2 \wedge 0.2) \\ &= 0.1 \vee 0.2 \vee 0.3 \vee 0.2 \\ &= 0.3 \end{aligned}$$

$$\begin{aligned} d_2 &= (w_1 \wedge r_{12}) \vee (w_2 \wedge r_{22}) \vee (w_3 \wedge r_{32}) \vee (w_4 \wedge r_{42}) \\ &= (0.2 \wedge 0.4) \vee (0.3 \wedge 0.5) \vee (0.3 \wedge 0.3) \vee (0.2 \wedge 0.5) \\ &= 0.2 \vee 0.3 \vee 0.3 \vee 0.2 \\ &= 0.3 \end{aligned}$$

$$\begin{aligned} d_3 &= (w_1 \wedge r_{13}) \vee (w_2 \wedge r_{23}) \vee (w_3 \wedge r_{33}) \vee (w_4 \wedge r_{43}) \\ &= (0.2 \wedge 0.3) \vee (0.3 \wedge 0.2) \vee (0.3 \wedge 0.1) \vee (0.2 \wedge 0.2) \\ &= 0.2 \vee 0.2 \vee 0.1 \vee 0.2 \\ &= 0.2 \end{aligned}$$

$$\begin{aligned} d_4 &= (w_1 \wedge r_{14}) \vee (w_2 \wedge r_{24}) \vee (w_3 \wedge r_{34}) \vee (w_4 \wedge r_{44}) \\ &= (0.2 \wedge 0.1) \vee (0.3 \wedge 0.1) \vee (0.3 \wedge 0.1) \vee (0.2 \wedge 0.1) \\ &= 0.1 \vee 0.1 \vee 0.1 \vee 0.1 \\ &= 0.1 \end{aligned}$$

$$\begin{aligned} d_5 &= (w_1 \wedge r_{15}) \vee (w_2 \wedge r_{25}) \vee (w_3 \wedge r_{35}) \vee (w_4 \wedge r_{45}) \\ &= (0.2 \wedge 0.1) \vee (0.3 \wedge 0.0) \vee (0.3 \wedge 0.0) \vee (0.2 \wedge 0.0) \\ &= 0.1 \vee 0.0 \vee 0.0 \vee 0.0 \\ &= 0.1 \end{aligned}$$

Since the largest components of $D(u)$ are $d_1 = 0.3$, and $d_2 = 0.3$ at the same time. Referring to the verbal grades, $E = \{\text{Very High, High, Moderate, Low, very Low}\}$, the analyzed staff's performance in terms of working output obtained a rating somewhere between "Very High" and "High". However, by applying the principle of the biggest subsection degree as mentioned by Guifeng, G. *et. al.* [12], the staff's performance in terms of working output is "Very High".

TABLE II
VERBAL GRADES AND WEIGHTING FOR EACH ASPECT

Aspect	Verbal Grades	Weighting for Each Aspect
Aspect 1	Very High	1.0
	High	0.8
	Moderate	0.6
	Low	0.4
	Very Low	0.2
Aspect 2 and 3	Excellent	1.0
	Good	0.8
	Moderate	0.6
	Weak	0.4
	Very Weak	0.2
Aspect 4	Very Active	1.0
	Active	0.8
	Moderately Active	0.6
	Less Active	0.4
	Not Active	0.2

The same method of calculation can be applied to U_2 , U_3 , and U_4 , which are, the aspect of Knowledge and Skills, the

aspect of Personal Quality, and the aspect of Informal Event(s) and Contribution(s), respectively. Following this, the verbal grades and weighting for each aspect as shown in Table II is being referred when calculating a staff's overall average ratings:-

The staff's overall average rating (AR) is:-

$$AR = (\text{Aspect 1} * 50) + (\text{Aspect 2} * 25) + (\text{Aspect 3} * 20) + (\text{Aspect 4} * 5)$$

Based on Table II, the analyzed staff's performance in terms of working output obtained a rating of "Very High". As a result, 1.0 would be the weighting for Aspect 1. Meanwhile, according to what have been computed by using the multifactorial evaluation model, the staff has been rated as "Moderate" or the weighting of 0.6 in terms of Knowledge and Skill. As for the aspect of Personal Quality, the staff's performance is "Excellent" or the weighting of 1.0 would be selected. As for the Informal Event(s) and Contribution(s), the staff has gained an "Active" performance or the weighting of 0.8 for this aspect. Thus, the rating and weighting for each aspect is as summarized below:-

TABLE III
SUMMARIZED RATING AND WEIGHTAGE OF THE 4 ASPECTS

Aspect	Rating	Weighting
Aspect 1	Very High	1.0
Aspect 2	Moderate	0.6
Aspect 3	Excellent	1.0
Aspect 4	Active	0.8

Therefore, the staff's overall average rating (AR) is:-

$$AR = (1.0 * 50) + (0.6 * 25) + (1.0 * 20) + (0.8 * 5) = 89$$

As a result, according to the calculation above and by referring to Table IV below, the staff would be categorized in the "High Performer(s)" group.

TABLE IV
BENCHMARK / STANDARD USED IN DETERMINING STAFF'S PERFORMANCE

Overall Average Ratings	Group	Remarks
Above 80%	High Performer(s)	<ul style="list-style-type: none"> Entitled for "Best Service Award". An incentive of RM 1000. A certificate of appreciation.
Less than 80% but more than 50 %	Average Performer(s)	<ul style="list-style-type: none"> Advised to improve their performance in the coming year.
Less than 50%	Low Performer(s)	<ul style="list-style-type: none"> Disciplinary action <i>might be</i> taken towards the staff. Should constantly report his / her work progress to his / her assessors in a stated period.

V. CONCLUSION

In this study, we intended to give an illustrative example that encourages the application of one of the fuzzy set theory in the multi-criteria performance appraisal system. Following this, we have developed a performance appraisal system utilizing the performance appraisal criteria from an Information and Communication Technology based company in Malaysia. This system uses multifactorial evaluation model in assisting high-level management, particularly in the aforementioned company, to appraise their employees. Utilizing the concept of using four multifactorial evaluation model in the performance appraisal system could ease the changes need to be made in this system whenever it is necessary. This model follows a systematic step in determining a staff's performance, and therefore, it creates a system of appraisal which is able to consistently produce reliable and valid results for the appraisal process. In order to allow other companies to use this system, the aspect to be evaluated and the weightage for each of these aspects need to be define in the system before hand.

REFERENCES

- [1] Moon, C., Lee, J., Jeong, C., Lee, J., Park, S. and Lim, S. (2007), "An Implementation Case for the Performance Appraisal and Promotion Ranking", in IEEE International Conference on System, Man and Cybernetics, 2007.
- [2] Adnan, S. and Minwir, A. (1998), "Fuzzy Logic Modeling for Performance Appraisal Systems – A Framework for Empirical Evaluation", Expert Systems with Applications, Vol. 14, No. 3, p. 323-328.
- [3] Khairul, A. R and Qiang, S. (2006), "Data-Driven Fuzzy Rule Generation and Its Application for Student Academic Performance Evaluation", Applied Intelligence, Vol. 25, Issue. 3. p. 305-319.
- [4] Ab. Aziz Yusof. (2003), Performance Appraisal Issues, Challenges & Prospects, Pearson.
- [5] Dessler, G. (2000), Human Resource Management (8th Edition), New Jersey, Pearson Education, Inc.
- [6] Terrence, H. M. and Joyce, M. (2004), Performance Appraisals, ABA Labor and Employment Law Section, Equal Employment Opportunity Committee.
- [7] Vicky, G. (2002), Performance Appraisals, Loss Control Services, Texas Association of Counties.
- [8] Jing, R.C, Cheng, C. H. and Chen, L. S. (2007), "A Fuzzy-Based Military Officer Performance Appraisal System", Applied Soft Computing, Vol. 7, Issue. 3, p. 936-945.
- [9] Mehmed, K. (2003), Data Mining Concepts, Models, Methods, and Algorithms, Wiley-Interscience.
- [10] Tutmez, B., Kahraman, S. and Gunaydin, O. (2006), "Multifactorial Fuzzy Approach to the Sawability Classification of Building Stones", Construction and Building Materials, Vol.21, Issue 8, p. 1672-1679.
- [11] Emma, B. and Bryman, A. (2003), Business Research Methods. US: Oxford University Press.
- [12] Guifeng, G., Luo, Y. and Yan, B. (2006), "Fuzzy Evaluation System of Traffic Safety in Highway Tunnel" http://lib.hpu.edu.cn/comp_meeting/PROGRESS%20IN%20SAFETY%20SCIENCE%20AND%20TECHNOLOGY%20VOL.V1/1989.doc [Accessed on 23th December 2008]