Performance Appraisal with Multiple Linguistic Scales

R. de Andrés
PRESAD Research Group,
University of Valladolid, Valladolid 47011, Spain.
E-mail:rocioac@eco.uva.es

M. Espinilla, R. M. Rodríguez and L. Martínez
Computer Sciences Department, University Jaén, Jaén 23071, Spain.
E-mail:mestevez@ujaen.es, rmrodrig@ujaen.es, martin@ujaen.es

Performance appraisal is a process used by companies, in order to evaluate the employees' efficiency and productivity, for planning their Human Resource policies. Traditionally, this process has just been carried out by the executive staff, although recently it has been developed evaluation processes based on the opinion of different types of appraisers. In such evaluation processes, appraisers can have different degree of knowledge about the criteria used to evaluate employees. Such knowledge is usually vague and subjective, consequently, it seems then suitable to offer a flexible framework in which different appraisers can express their opinions by using linguistic information assessed in different scales according to their knowledge. We propose in this contribution a multiple linguistic scale 360-degree performance appraisal model based on the extended linguistic hierarchies in order to deal in a precise way with such type of information.

Keywords: Performance appraisal, multiple linguistic scales, extended linguistic hierarchies

1. Introduction

Performance appraisal is a common activity in companies whose aim is to evaluate and analyze employees' capacity to accomplish their work. It plays a key role in companies competitiveness. So far, companies have carried out either informal performance appraisal methods or formal ones but just based on the knowledge of one or various supervisors that provide their subjective opinions about different criteria, usually qualitative ones, related to employee capacity. Most of those methods use an evaluation framework with a unique numerical scale.

Recently new models to accomplish performance appraisal has been in-

This contribution has been partially supported by the research project TIN2006-02121, P08-TIC-3548 and Feder Fonds.

troduced that propose different types of appraisers such as supervisors, collaborators, customers, colleagues and employee himself. This type of model is called 360-degree performance appraisal and it tries to obtain a more general, objective and better assessment about the employee.

We focus on the 360-degree performance appraisal because its use might introduce new necessities namely, different groups of appraisers can have different degree of knowledge about the evaluated employees, therefore the use of manifold scales could be useful and necessary to facilitate appraisers their assessment process. Additionally, we have aforementioned that performance appraisal implies vagueness and subjectivity about different criteria. Hence it seems difficult to express precise assessments in such a case, the use of fuzzy linguistic approach has provided good results to manage such type of information.[1,4,7]

In this contribution, we propose a 360-degree performance appraisal model that deals with multiple linguistic scales based on the use of Extended Linguistic Hierarchies[3] that provide a new framework to deal with multiple linguistic scales. Such a model offers a multiple linguistic scales framework in which appraisers can express their opinions in a scale according to their knowledge and obtains linguistic and precise assessments easy to rank in order to plan Human Resources policies in the company.

The contribution is organized as follows. Section 2 reviews some important concepts for our model regarding linguistic information. In Section 3, we present a 360-degree performance appraisal model with multiple linguistic scales information. Finally, the contribution is concluded in Section 4.

2. Linguistic Background

Due to the fact that our model proposal deals with multiple linguistic scales, we introduce some concepts and tools that our evaluation model uses, such as, the Extended Linguistic Hierarchy[3] (ELH) in order to manage multiple linguistic scales in a precise way and the 2-tuple representation model.

2.1. *The 2-Tuple Linguistic Representation Model*

The 2-tuple fuzzy linguistic representation model is based on the concept of *symbolic translation*.[5] This model represents the linguistic information through a 2-tuple (s, α), where s is a linguistic term and α is a numerical value representation of the symbolic translation.[5] So, being $\beta \in [0, g]$ the value which represents the result of a symbolic aggregation operation, we can then assign a 2-tuple (s, α) that expresses the equivalent information of that given by β.

Definition 2.1. Let $S = \{s_0, \ldots, s_g\}$ be a set of linguistic terms. The *2-tuple set associated with* S is defined as $\langle S \rangle = S \times [-0.5, 0.5)$. We define the function $\Delta_S : [0, g] \longrightarrow \langle S \rangle$ given by,

$$\Delta_S(\beta) = (s_i, \alpha), \quad \text{with} \quad \begin{cases} i = \text{ round } (\beta), \\ \alpha = \beta - i, \end{cases}$$

where *round* assigns to β the integer number $i \in \{0, 1, \ldots, g\}$ closest to β.

We note that Δ_S is bijective[5] and $\Delta_S^{-1} : \langle S \rangle \longrightarrow [0, g]$ is defined by $\Delta_S^{-1}(s_i, \alpha) = i + \alpha$. We can consider the injective mapping $S \longrightarrow \langle S \rangle$ that allows us to transform a linguistic term s_i into a 2-tuple: $(s_i, 0)$. On the other hand, $\Delta_S(i) = (s_i, 0)$ and $\Delta_S^{-1}(s_i, 0) = i$, for every $i \in \{0, 1, \ldots, g\}$. The 2-tuple fuzzy linguistic representation model has a linguistic computational associated model in which different aggregation operators.[5] This computational model demonstrated that the operations with symmetrical and triangular-shaped labels are carried out without loss of information.

2.2. *Extended Linguistic Hierarchies*

Our proposal deals with multiple linguistic scales, therefore we have reviewed in the literature different methods to manage and accomplish the processes of Computing with Words (CW) with this information. There exist different methods[2,4,6,7] to deal with linguistic information assessed in multiple linguistic scales but we propose the use of the ELH because it offers a greater flexibility regarding the scales and its computations are accurate.

The ELH are based on the Linguistic Hierarchies,[6] but the extension defines a new way to build a multi-granular evaluation framework with more flexibility. Let $\langle S^{n(q)} \rangle, q = \{1, ..., m\}$, a set of linguistic term sets, being $n(q)$ the granularity of each one. The ELH assumes that $\langle S^{n(q)} \rangle = \{s_0^{n(q)}, ..., s_{n(q)-1}^{n(q)}\}$, are linguistic terms whose membership functions are triangular-shaped and symmetrical and uniformly distributed with an odd number of terms. An ELH satisfies the following rules:[3]

- *Extended Rule 1:* to include a finite number of the levels (terms sets) $q = 1, ..., m$ that defines the context with multiple linguistic scales.
- *Extended Rule 2:* to add a new level $q' = m + 1$ where $\langle S^{n(q')} \rangle$, whose granularity is $n(q') = (LCM(\delta_1, ..., \delta_m)) + 1, q = 1, ..., m$, being LCM the *Least Common Multiple* in order to keep all the former modal points[6] of all the previous levels $q = 1, ..., m$ within this new level.

Therefore, an extended linguistic hierarchy $ELH = \bigcup_{q=1}^{q=m+1} \langle S^{n(q)} \rangle$ is a set of linguistic term sets where $\langle S^{n(q')} \rangle$ keeps all the former points of the other term sets. A graphical example of an ELH is showed in Fig. 1, the context is defined by two scales of 5 and 7 labels, the granularity of the last level in the ELH is 13 according to *Extended Rule 2*.

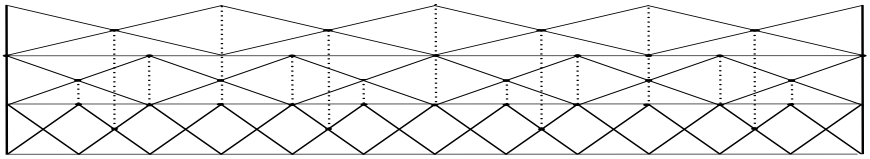

Figure 1. Extended linguistic hierarchy

To carry out the process of CW in an ELH, the multi-granular linguistic information must be unified into one term set. Due to the fact that $\langle S^{n(q')} \rangle$ is the only term set that keeps all the former points and it is the key to obtain accurate results,[6] the information should be transformed into terms in $\langle S^{n(q')} \rangle$ by means of the transformation function defined in:[6] $F_{q'}^{q}(s_j^{n(q)}, \alpha_j) = (s_k^{n(q')}, \alpha_k)$.

At this moment, the processes of CW can be carried out by using the 2-tuple computational model and the results might be transformed into the initial term sets by means of the transformation function: $F_q^{q'}(s_f^{n(q')}, \alpha_f) = (s_h^{n(q)}, \alpha_h)$.

3. Performance Appraisal with Multiple Linguistic Scales

Here, we present our proposal for a 360-degree performance appraisal model dealing with multiple linguistic scales based on the model presented in[1] that consists of fixing the evaluation framework and rank the employees.

3.1. *Evaluation Framework*

In a 360-degree performance appraisal model, employees are evaluated according to the opinions of different collectives related to them including the opinion of evaluated employees themselves. Let us suppose there is a set of employees $X = \{x_1, \ldots, x_n\}$ to be evaluated by the following collectives:

- A set of supervisors (executive staff): $A = \{a_1, \ldots, a_r\}$.
- A set of collaborators (fellows): $B = \{b_1, \ldots, b_s\}$.
- A set of customers: $C = \{c_1, \ldots, c_t\}$.
- Furthermore, the opinion of employees about themselves.

The evaluation gathers information about different criteria $Y = \{Y_1, \ldots, Y_p\}$. The assessments provided by appraisers $a_i \in A$, $b_i \in B$ and $c_i \in C$, on the employee x_j according to the criterion Y_k are denoted

by a_j^{ik}, b_j^{ik} and c_j^{ik}, respectively. Moreover, x_j^{jk} is the assessment of x_j on himself with respect to Y_k. Therefore, there are $(r+s+t+1)\,p$ assessments for each employee provided by the different collectives.

The selection of the linguistic term sets utilized to assess each criterion Y^k, $k = 1, \ldots, p$ will depend on the knowledge about the evaluated employees. Therefore, we propose a framework with multiple linguistic scales where appraisers fix m scales. After, this it is built the ELH that manages the information of the evaluation process.

3.2. *Rating Process*

3.2.1. *Unification Information Phase*

To operate with information assessed in different linguistic scales first of all, we have to conduct the information provided by the appraisers into a unique linguistic scale by means of the *transformation function* $F_{q'}^{q}$, being $q \in \{1, ..., m\}$ and $q' = m + 1$. In this way, the information obtained in the evaluated process will be expressed into a unique linguistic scale $\langle S^{n(q')} \rangle = \left\{ s_0^{n(q')}, s_1^{n(q')}, \ldots, s_{n(q')-1}^{n(q')} \right\}$ with $q' = m + 1$.

3.2.2. *Aggregation Phase*

The aim of this phase is to obtain an assessment about performance of the evaluated employee according to the different criteria and reviewers' collectives. This assessment is computed in 3 stages presented in.[1]

(1) *Computing appraisers' collective criteria values*, $v_{-}^{k}(x_j)$: For each appraisers' collective, their assessments about a given criterion Y_k are aggregated by means of an aggregation operator, G^{-}, that might be different for each appraisers' collective.

$$
\begin{aligned}
&Supervisors: \; v_A^k(x_j) = G_{-}^{Ak}(a_j^{1k}, ..., a_j^{rk}).\\
&Collaborators: \; v_B^k(x_j) = G_{-}^{Bk}(b_j^{1k}, ..., b_j^{sk}).\\
&Customers: \; v_C^k(x_j) = G_{-}^{Ck}(c_j^{1k}, ..., c_j^{tk}).\\
&Employees: \; v_X^k(x_j) = G_{-}^{Xk}(x_j^{jk}).
\end{aligned}
$$

(2) *Computing global criteria values*, $v^k(x_j)$: The previous collective assessments $v_{-}^{k}(x_j)$ are aggregated by means of an aggregation operator, G^k, obtaining a global criteria value for each criterion Y_k.

$$v^k(x_j) = G^k\big(v_A^k(x_j), v_B^k(x_j), v_C^k(x_j), v_X^k(x_j)\big).$$

(3) *Computing a final value*, $v(x_j)$: It is obtained by aggregating the global criteria values related to the employee x_j.

$$v(x_j) = G\big(v^1(x_j), \ldots, v^p(x_j)\big).$$

3.2.3. *Rating Phase*

The final outcomes obtained in each step of the aggregation process, $v_A^k(x_j)$, $v_B^k(x_j)$, $v_C^k(x_j)$, $v^k(x_j)$ and $v(x_j)$, are used either for sorting and ranking the employees or to establish the companies' Human Resource policy.

4. Concluding Remarks

Performance appraisal is a process to determine efficiency and effectiveness of employees. In this contribution we have presented a linguistic 360-degree performance appraisal model based on ELH where appraisers could express their assessments in different linguistic scales according to their knowledge about employees, defining a multi-granular linguistic evaluation framework. Consequently, this model offers an increment of flexibility in performance appraisal.

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