Methodology of Application of Diffuse Mathematics to Performance Evaluation

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Abstract: Every day it lends greater attention to the Performance Evaluation (PD) as it allows to improve individual and organizational performance of the companies. Them methods of PE lack in many occasions of two aspects important as the of establish a relationship direct between it planning strategic and them objectives individual and of processes, as well as the high subjectivity in their results, despite its relevance, there is very little research in the topic attending to this problem, is decides to design a procedure of PE supported in technical quantitative using fuzzy mathematics for the reduction of uncertainty.

Keywords: Performance evaluation, Fuzzy Mathematics.

1. INTRODUCTION

Performance evaluation (PE) is an essential tool for companies and enterprises to achieve competitiveness and results, been the use of the Management Excellence Models (MEG) the most extended ([1], [2] and [3]). The MEG model aims at continuously improving the company's performance by applying a number of quality management principles.

Through PE, companies and organizations obtain information for tangible and intangible decision making aspects (sales, production, quality, etc.) (Behavior, attitudes, etc.), and it is of great importance to develop methods (objective and with great certainty) of employee PE, capable of objectively integrating the quantitative and qualitative results of its collaborators, and also contribute to the fulfilment of strategic and organizational goals.

For the treatment of subjectivity and uncertainty, ([4]) developed the Fuzzy Logic Models, which could be applied to take into account subjective factors in the personnel performance evaluation, reducing uncertainty, and facilitating more effective decision making.

The present work has as purpose develop in a model of PE by method of scales graphic using the mathematical diffuse for the treatment of the subjectivity, in which is propose:

(a) A new frame of flexible evaluation: where the evaluators will be able to express their opinions through assessed information in different expression domains (numeric, interval, linguistic) depending on the nature and knowledge of the indicator of the evaluator.

(b) A performance evaluation fuzzy model: capable of treating the non-homogeneous information of the former evaluating frame and manage uncertainty of the provided information by the evaluators.

2. MATERIALS AND METHODS

This section shows an analysis of the trends, methods and fundamental techniques, which are used for the evaluation of performance, applications of fuzzy mathematics and the methodology used for this research.

(a) Performance Evaluation. Current Trends

PE processes may have several purposes: administrative or control [5], development [6], and planning of human resources and personnel selection [7].

Trend analysis will consider three elements, time or evaluation period (for there are many authors that defend continuous and not annual evaluation as other authors propose), the current approaches of PE, and lastly, quantitative and qualitative methods and their analysis and uncertainty at the time of measuring their indicators.

To analyze the evaluation period, the most updated work is shown by the research "Predictions for 2016": A Bold New World of Talent, Learning, Leadership, and HR Technology Ahead of Bersin by Deloitte, where a comparison is established between the annual PE and the model of continuous management and evaluation, that this consulting company promotes as an emerging trend in the ambit of people management.

Current trend reorients to the use of continuous evaluation that could be weekly or monthly, with simple tools, easy to apply, automated and focused continuous improvement of the employee as well as of the organization.

The second element of trend analysis is related to the approaches on performance measurement. According to [8] the current approach of performance measurement concealed in most organizations is based on costs accounting systems, even to evaluate operative output, typically centered on costs and production and ignoring other measurements that could reflect performance better in terms of quality, flexibility and opportunity.

Several autthors ([6], [9], [10]) suggest that employee performance evaluation has been directly carried out by directive teams, who are finally the ones making the decisions. However, more and more, organizations not only consider the opinions of CEOS but those of colleagues, subordinates, collaborators, clients, and even that of the individual abut itself. This PE process is known as 360º Evaluation or integral evaluation ([7], [5]).

The third element in trends analysis are methods and their uncertainty, and here authors show different points of view. Authors like [11] exposes a wide variety of qualitative (critical incidents, forced election, descriptive phrases, field research, etc.) and quantitative methods (Evaluation by results, weighted graphic scales, etc.) according to this author, its use does not depend on uncertainty but on true scenarios and environment of organizations.

Others authors ([12] and [13]) adopt an approach of evaluation by competences based in the capacity of enhance the performance to all them levels of the Organization, for this, defines competencies and modes of performance according to them results expected for each process, this approach however presents a high subjectivity caused by two elements: indicators subjective and periods very long of evaluation Evaluation[14] and [9] emphasize the indistinct use of qualitative and quantitative techniques, provided the indicators to be

evaluated be so in an objective manner, with tangible measuring scales and results that show aggregated value (named valued added¨), [15].

Sun, (2010) and Varela (2013) emphasize the indistinct use of qualitative and quantitative techniques, provided the indicators to be evaluated be so in an objective manner, with tangible measuring scales and results that show aggregated value (named valued added¨), (Rockwell, E. 2015).

(b) Fuzzy Logic Methodology

In the field of human resources, the fuzzy logic has been applied to the selection of personnel by Afshari (2013). Kelemenis et. al., (2010) developed the principles of the TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) applied to decision-making as it is the case of the present work. TOPSIS is a compensatory multi-criteria decision method, whose objective is the management of a finite set of alternatives. He principle basic is that the alternative selected should have the lower distance to it solution ideal positive and the greater distance to the solution ideal negative. An ideal solution is defined as a collection of scores or values in all the attributes considered in the decision, and can happen that such a solution is unattainable. The vector composed of the best values of the jth attribute with respect to all possible actions is called the "positive ideal solution"; likewise, the "negative ideal solution" will be one whose vector contains the worst values in all attributes. In order to achieve order, a similarity (or relative proximity) index is defined with respect to the ideal solution by combining the proximity to the positive ideal solution and the distance from the ideal negative solution. It is selected that alternative that is located as far as possible to the maximum similarity with respect to the ideal negative solution, that is to say one whose index of similarity is closer to 1.

3. RESULTS

This section establishes the methodology of performance evaluation and the procedure to incorporate the diffuse mathematics to this.

(a) Performance Evaluation Methodology

PE is a process of great importance in Human Resources Management. Its execution is complex, mainly because of its intrinsic subjective component, whether due to the evaluators' criteria or the subjective nature of the indicator used [9].

On the basis of the methodological procedure defined by [18] it is designed a system of performance evaluation that responds to the demands of the management of human resources, especially at the levels of quality and efficiency required by the development of organizations.

The procedure consists of eight stages, as shown in Figure 1.

The first three stages of the procedure are the result of an internal analysis of each organization where they apply a performance evaluation diagnosis, define the objectives of the evaluation and the requirements of the process.

The method is based in the weighted graphic scales. As a starting point, it analyzes the proposed indicators for each process or job, and their respective importance weights as well as the qualitative form (levels) that each indicator will take. The number of levels or qualitative evaluation is defined by the organization and the mathematical model assumes it.

These indicators are used as performance goals, according to the needs of the company, the operational processes; balanced with the individual needs of the workers.

To design them indicators general, specific and their degrees, is uses a technical of work in group (Method Delphy) and packages statistical to define the weight specific that has each indicator depending on the importance that is attributed to the same, using for this the technical of comparison paired or nesting [11].
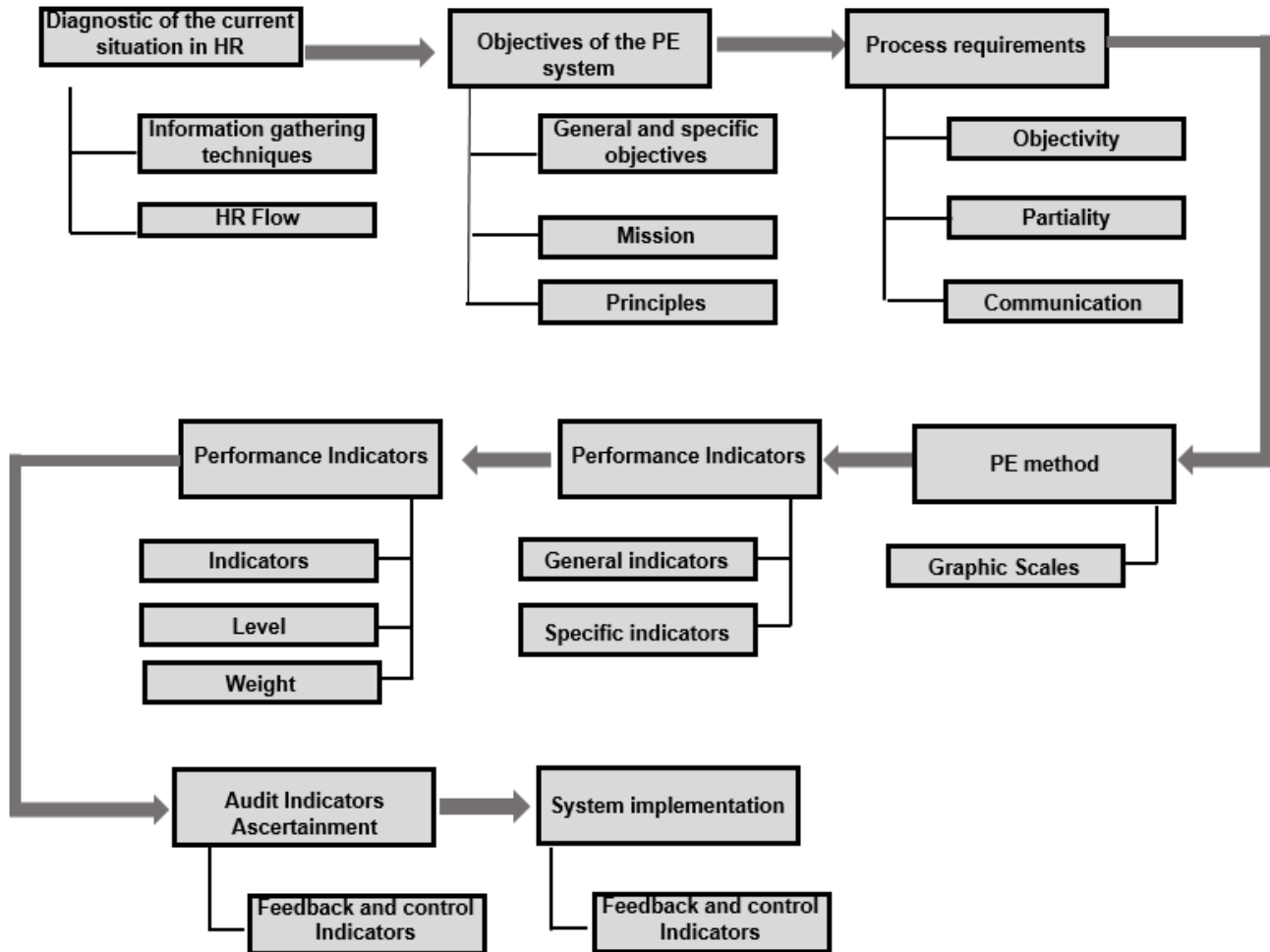
Figure 1: PE procedure stages. Source: [18]

The procedure for applying the Delphy method consists of three stages [19]. A preparatory phase, where the experts are selected, the instrument is prepared and a decision is made about the consultation route. A consultation phase, where the rounds are carried out, the statistical processing and its feedback are done, and a consensus phase, where the results are reported.

(b) Fuzzy Mathematics Application Methodology for Performance Assessment

The application of the fuzzy PE model allows to find the numerical performance indicators for each employee in any area of the organization, as well as the graphs and analysis of historical behavior, both for individual and organizational areas or processes.

Figure 2 shows a block diagram with the steps of applying the procedure.

After defined the model, are designed graphic scales for jobs that include the general indicators, specific, and the establishment of levels of importance of each indicator and its processes. The Delphy method by rounds, determining experts in the organization who had competition expert ¨K¨ coefficient above 0.8 (as [20]) defining the specific weight and importance of each indicator for each process. Later was developed into mathematical model on the basis of fuzzy logic (Zadeh, 1965) for the processing of the data and the results (see Figure 3).
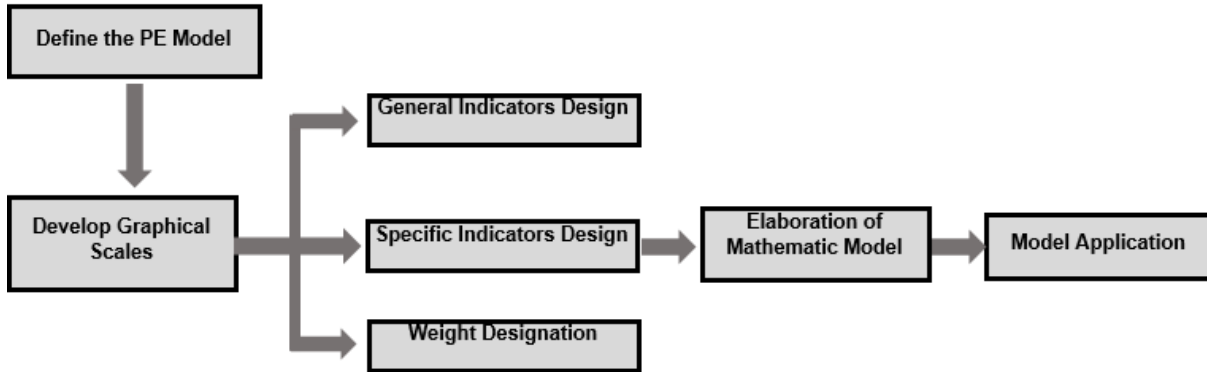
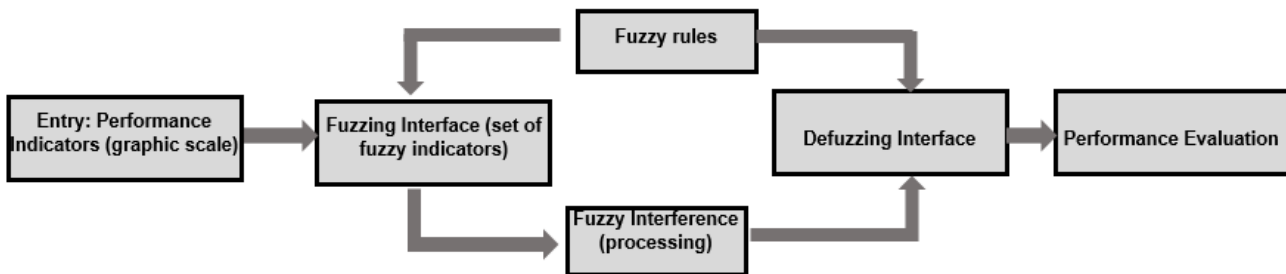**Figure 2: Model implementation flowchart**

Figure 3: Fuzzy mathematics model flowchart

The fuzzy inference systems according to ([4], [21]) are expert systems with approximate reasoning that map an input vector to a single (scalar) output. They are based on fuzzy logic to carry out this mapping and consists of several stages:

(a) **Fuzzing:** The fuzzing aims to become diffuse values actual values. In the fuzzing membership grades are assigned to each of the input variables in relation to fuzzy sets previously defined using property functions associated with fuzzy sets.

(b) **Fuzzy Inference:** The inference relates them joint fuzzy of input and output to represent the rules that will define the system. In the inference is used the information of the base of knowledge to generate rules through the use of conditions.

The definition of the fuzzy rules for the mathematical model is a very important aspect for the processing and analysis of the results. Authors such as [21], [16], [22] put forward that the diffuse linguistic sets (levels) may vary depending on the variables to be measured and their meaning. For this project, we defined as rules the establishment of 4 levels and their respective fuzzy triangular numbers, as shown in Figure 4.
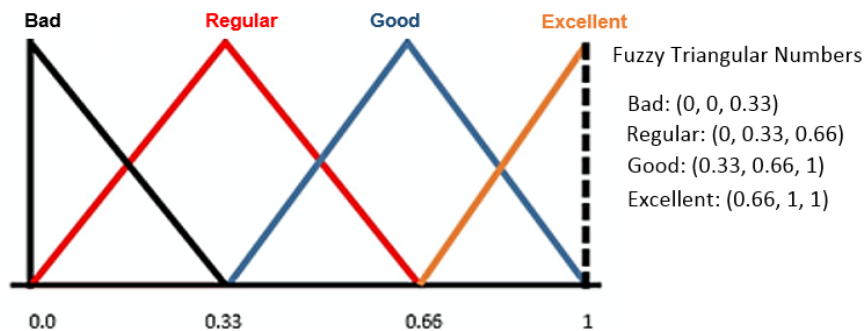

Figure 4: Fuzzy rules for the model developed

(c) Defuzzing

Defuzzing is the process of adapting the fuzzy values generated in the inference to real values, which are then used in the control process. In Defuzzing, is used simple mathematical methods, such as the maximum method, centroid method and height method (Zadeh, 1965).

- Maximum method: It chooses as the output value the one for which the characteristic function of the fuzzy set is maximum. This not an optimal method, as the value can be reached by several outputs.

- Centroid method: It uses as output the center of gravity of the output characteristic function. With this method a unique output is obtained (This is the method applied in this work.)

- Height method: It calculates the centers of gravity for each rule of the fuzzy output set and then the weighted mean.

4. CONCLUSION

The model developed represents a relevant tool for performance evaluation, since it allows the evaluator a clear alternative in the definition of criteria, in the weighting of each one and in the analysis of each result.

The modeling of indicators using fuzzy logic should not be seen as a way of contrasting results with classical logic, since the former is an extension of the latter and there should be no contradiction between the results. The difference lies in the fact that the fuzzy logic allows an extension of the information obtained and an increase in the capacity to represent vague or uncertain phenomena.

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