Advances in Economics, Business and Management Research, volume 128
International Scientific Conference "Far East Con" (ISCFEC 2020)

Employee Performance Assessment in a Large Enterprise

I Tarasova[1], N Asanova[1], O Avdeyuk[1]

[1]Department of applied mathematics, Volgograd State Technical University, Avenue them. V. I. Lenin 28, Volgograd 400005, Russia

E-mail: tarasova.irina.aleks@gmail.com, natali_as@mail.ru, oxal2@mail.ru

Abstract. Employee performance assessment is a complex process which aims to identify the effectiveness of the staff's daily activity and to provide information that will help in decision-making. In this article, employee performance is viewed as a complex structure which is comprised of four criteria groups (qualification, staff morale, productivity, discipline). In its turn, each criterion is comprised of sub-criteria. We have developed an adaptable assessment structure that can be easily adjusted to the specific nature of any enterprise. We have used a convolution method to combine criteria into a generalized parameter. We suggest a methodology for employee performance assessment as well as an automated program. The suggested convolution of the staff performance criteria can be used in the systems for optimization and decision-making.

1. Introduction

Regular employee performance assessment is the basis of effective managerial decision making which is crucial for increasing the productivity of an enterprise.

Usually, the performance is represented through numbers: the relation of the profit of some production element to the cost of its implementation [1], [2], [3]. This approach cannot really be used to assess employee performance since it does not reflect many significant factors (the stage in the life cycle of the enterprise, the employee's unit type, etc.).

Nowadays, there is a shift of approach to the employee performance evaluation in Russian companies. A distinct characteristic of this process is the implementation of various methods which are aimed at assessing the conformity with multiple indicators and criteria. However, evaluation techniques, which are widely used abroad, have been implemented in Russia only recently. Neither in Russia, nor abroad is there a unified system for solving any occurring problem.

Various authors address the issue of employee performance assessment in their works [4], [5], [6], [7], [8], [9], [10], [11]. Some works deal with employee performance evaluation in narrow specializations; for example, in health care system [12], construction industry [13], processing industry [14], and even in football [15].

In this work, we suggest a methodology for employee performance assessment at a random enterprise. We address employee performance as a complex structure which consists of four criteria groups (qualification, staff morale, productivity, discipline), where each criterion is comprised of sub-criteria. We have used a convolution method in order to compile criteria into a generalized parameter. We suggest a methodology employee performance assessment based on criteria convolution with the help of the Kolmogorov-Nagumo average. We have also developed a related automated programhese guidelines, written in the style of a submission to J. Phys.: Conf. Ser., show the best layout for your

paper using Microsoft Word. If you don't wish to use the Word template provided, please use the following page setup measurements.

2. Methods

As we have already mentioned, the employee performance assessment is comprised of several groups of criteria that can also be divided into a number of indicators for the individual assessment. It is difficult to analyze a great amount of different data. Thus, all the criteria are joined into a single rating with a convolution method.

Convolution of several criteria into a generalized parameter is used to assess complex hierarchical structures. Traditionally, these convolutions are linear (additive) and multiplier. Both methods have substantial disadvantages. Linear convolution compensates for a decreased assessment of a particular criterion through an increased assessment of another criterion (or several criteria). Consequently, if a criterion evaluation amounts to zero, a unified assessment can be significant provided that other criteria are good enough. Multiplier convolution makes zero of unified quality if one of criteria has low estimates, independently of the good estimates of other criteria. In order to avoid these problems, we can use functional averages as a convolution.

Let $X(x_1, x_2, \ldots x_n)$ be the set of the quantitative criteria. The qualitative criteria should be converted into the quantitative through the previously developed scales. Then, the unified assessment criterion C_g can be represented through the following formula:

$$C_g = F(x_1, x_2, \ldots x_n),$$

where F is a function that satisfies the following conditions:

$$\begin{cases} F(0,0,\ldots 0) = 0 \\ \text{for any } x_i \quad \forall i \in \{1,2,\ldots,n\} \quad 0 < x_i < 1 \quad \Rightarrow \quad \forall j \ \dfrac{\partial F}{\partial x_i} > 0 \ \sum\limits_{j=1}^{n} \dfrac{\partial F}{\partial x_j} = 1 \end{cases}$$

We suggest normalized average Kolmogorov-Nagumo functions as averaging:

$$C_g = F^{-1}\left(\sum_{i=1}^{n} \frac{F(x_i)}{n} \right),$$

where $F(x)$ is a random monotonous function ($ln(x)$, e^x, and $arctg(x)$ are most frequently used). The choice of the former two is justified by the fact that they are less sensitive to the change of system's individual quality. Thus, in case with $F(x) = e^x$, a substantial increase of one quality does not lead to significant changes in system's individual quality. Use of a logarithmic function helps avoid a sharp decline of a system's unified quality in terms of a substantial decrease in one of the individual qualities.

Since employee performance assessment is a complex multi-level structure, we will use a multi-level convolution proposed in the work [16].

3. Methodology of employee perfomance assessment bulding

Let us represent employee performance evaluation as the following chart figure 1.

Where C_g is a generalized performance parameter. It is comprised of the following criteria:

- C_1 – qualification criterion;
- C_2 – psychological criterion;
- C_3 – productivity criterion;
- C_4 – disciplinary criterion.

Similar criteria were used in their works [17], [18], [19], [20].

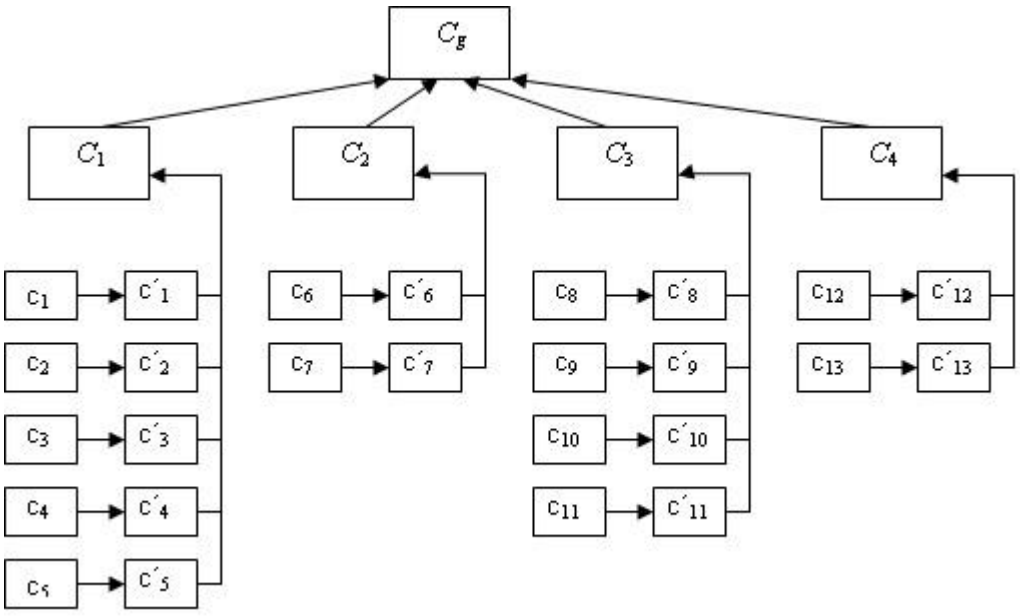

Figure 1. Employee performance structure.

Each of the four criteria is comprised of sub-criteria which help holistically and precisely determine the level of staff performance.

Qualification criterion consists of:

- Average experience;
- Average age;
- Higher education degree;
- Skills development in recent 5 years;
- Experience of having similar job.

Staff morale criterion consists of:

- Average score in automated tests;
- Employees' estimation of internal climate;

Productivity criterion is comprised of:

- Output;
- Client satisfaction;
- Delays;
- Number of errors.

Discipline criterion consists of:

- Time and attendance application data;
- Degree of discipline (expert evaluation).

The head of production unit and HR-manager play the roles of experts.

In greater detail, the criteria are represented in Table 1 with precise units of measure and range of possible values.

Table 1. Units of measure and range of possible values.

Criteria	Sub-criteria	Units of measure	Range
Qualification criterion	Average experience	Year	0-50
	Average age	Year	18-70
	Higher education degree	Percent	0-100
	Skills development in recent 5 years	Percent	0-100
	Experience of having similar job	Score	0-100
Staff morale criterion	Average score in automated tests	Score	0-10
	Employees' estimation of internal climate	Score	0-3
Productivity criterion	Output	Percent	0-100
	Client satisfaction	Percent	0-100
	Delays	Unit	0- >20
	Number of errors	Unit	0- >20
Discipline criterion	Time and attendance application data	Percent	0-100
	Degree of discipline (expert evaluation)	Score	0-5

A generalized performance indicator is calculated according to the formula:

$$C_g = -\ln\left(1/4 \sum_{i=1}^{4} e^{-C_i} \right)$$

C_i criterion assessment is defined by a convolution of normalized values of sub-criteria:

$$C_i = C_i(c'_k, c'_{k+1}, c'_{k+2}, ...)$$

where c'_i is a normalized value of c_i sub-criterion.

Criteria are calculated according to the formulae:

$$C_1 = -\ln\left(1/5\left(e^{-c'_1} + e^{-c'_2} + e^{-c'_3} + e^{-c'_4} + e^{-c'_5}\right)\right)$$

$$C_2 = -\ln\left(1/2\left(e^{-c'_6} + e^{-c'_7}\right)\right)$$

$$C_3 = -\ln\left(1/4\left(e^{-c'_8} + e^{-c'_9} + e^{-c'_{10}} + e^{-c'_{11}}\right)\right)$$

$$C_4 = -\ln\left(1/2\left(e^{-c'_{12}} + e^{-c'_{13}}\right)\right)$$

where c_1 is average experience; c_2 is average age; c_3 is an average number of workers with a higher education degree; c_4 is an average number of employees who have developed their skills in recent 5 years; c_5 is an average number of staff who have had similar job; c_6 is an average score in automated personality test; c_7 is an average evaluation of internal climate (by employees); c_8 - average output; c_9 is average client satisfaction; c_{10} is an average number of delays; c_{11} is an average number of errors; c_{12} is average assessment of time and attendance application data; c_{13} is average assessment of discipline level (carried out by experts).

Normalization was carried out by experts according to actual impact of criteria on total performance. The range of possible normalized criteria values is [-1,1]. Where c^-_i is the low limit related to unacceptable values, and c^+_i is the upper limit of acceptable values. Values from -1 to 0 are considered to be unacceptable, and values from 0 to 1 are acceptable.

4. Development of automated program for employee performance assessment

The stated methodology was tested in a program. The main objectives of the functional module of the program are: normalization of sub-criteria according to the set linear functions in [-1;1] range at the first stage; calculation of four criteria from normalized values of sub-criteria at the second stage;

total performance is calculated from previously calculated four criteria at the third stage; performance criteria diagrams and overall performance diagram are built at the fourth stage. Visual Studio 2008 was used to develop user interface.

Figures 2, 3 show screenshots of the main parts of the program.

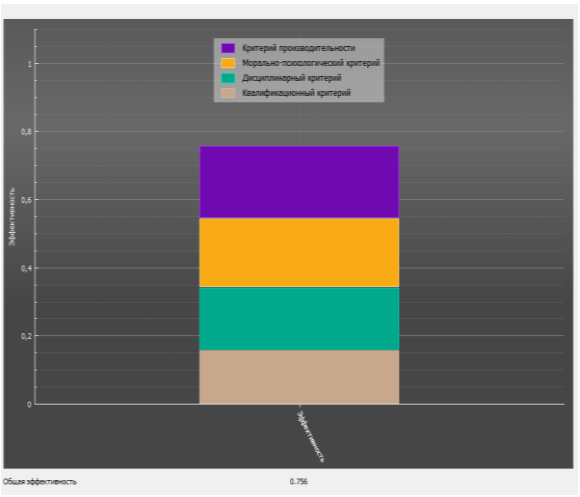

Figure 2. Criteria share in overall performance and their numerical value.

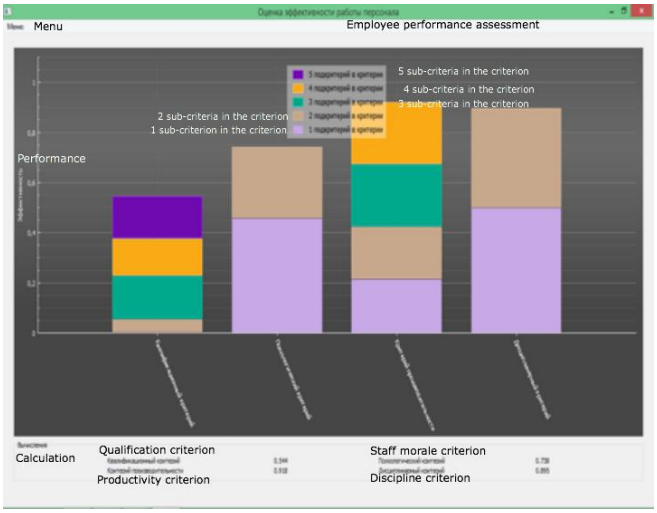

Figure 3. Sub-criteria share in each criterion and their numerical value.

Thus, obtained automated program calculates values of overall staff performance as well as values of each criterion, and represents results.

5. Result and conclusions

The suggested methodology and the automated program, which was developed on the basis of the stated methodology, help quickly conduct employee performance evaluation according to a number of indicators. It can be easily updated or changed by input or deletion of criteria or sub-criteria.

It can be used to assess staff performance at various enterprises in order to compare results. However, in our opinion, it will be more useful to monitor the dynamics of employee performance in a particular company under changing management. The program helps track staff performance and define weaknesses of the personnel.

References

[1] Lee H-W 2019 Performance-Based Human Resource Management and Federal Employee's Motivation: Moderating Roles of Goal-Clarifying Intervention, Appraisal Fairness, and Feedback Satisfaction *Review of Public Personnel Administration* **39(3)** pp 323-348

[2] Skousen C, Sun L 2019 Do employee dimension ratings reflect employee performance? Evidence from MSCI's ESG databas *Applied Economics Letters* **26(14)** pp 1182-1185

[3] Sophia G, Sarno R 2019 AHP-TOPSIS for analyzing job performance with factor evaluation system and process mining *Telkomnika (Telecommunication Computing Electronics and Control)* **17(3)** pp 1344-1351

[4] Coutinho V, Domingues A R, Caeiro S, Painho M, Antunes P, Santos R, Videira N, Walker R M, Huisingh D and Ramos T B 2017 Employee-Driven Sustainability Performance Assessment in Public Organisations *Corporate Social Responsibility and Environmental Management* **25(1)** pp 29-46

[5] Knies E, Leisink P, van de Schoot R 2017 People management: developing and testing a measurement scale *International Journal of Human Resource Management* pp 1-33

[6] Parnell A M, Lorah E R, Karnes A, Schaefer-Whitby P 2017 Effectiveness of Job Aids and Post

Performance Review on Staff Implementation of Discrete Trial Instruction *Journal of Organizational Behavior Management* **37(2)** pp 207-220
[7] Nguyen T N Q, Ngo L V 2019 When do-good meets empathy and mindfulness *Journal of Retailing and Consumer Services* **50** pp 22-29
[8] Bruning P F, Campion M A 2019 Exploring job crafting: Diagnosing and responding to the ways employees adjust their jobs *Business Horizons* **62(5)** pp 625-635
[9] Ali M, Lei S, Freeman S 2019 Implemented and perceived high-performance work system and its effect on branch performance: A 2-1-2 mediational multilevel approach *Employee Relations* **41(4)** pp 793-810
[10] Shin Y, Hur W-M, Moon T W, Lee S 2019 A Motivational Perspective on Job Insecurity: Relationships Between Job Insecurity, Intrinsic Motivation, and Performance and Behavioral Outcomes *International Journal of Environmental Research and Public Health* 16(10):1812
[11] Oktavianti E, Komala N and Nugrahani F 2019 Simple multi attribute rating technique (SMART) method on employee promotions *J. Phys.: Conf. Ser*. 012028
[12] Valerie T, Choy K L, Siu P K Y, Lam H Y, Ho G T S, Cheng S W Y 2017 An intelligent performance assessment system for enhancing the service quality of home care nursing staff in the healthcare industry *PICMET 2016 - Portland International Conference on Management of Engineering and Technology: Technology Management For Social Innovation, Proceedings* 7806657 pp 576-584
[13] Isichei E E, Ayandele I A 2017 Operational work system design and staff performance in the Nigerian construction industry *Entrepreneurial Business and Economics Review* **5(1)** pp 187-200
[14] Dinis-Carvalho J, Ratnayake R M C, Stadnicka D, Sousa R M, Isoherranen J V and Kumar M Performance enhancing in the manufacturing industry: An improvement KATA application *IEEE International Conference on Industrial Engineering and Engineering Management* 2016-December 7798078 pp 1250-1254
[15] Kröckel P 2017 Decision support enhancement for player substitution in football: A design science approach *Lecture Notes in Business Information Processing* pp 357-366
[16] Godenko A, Tarasova I, Volchkov V, Styazhin V 2017 Systematic Approach to Quality Assessment of Hierarchy Structure in Education for Management Decision Making Creativity in Intelligent Technologies and Data Science Second Conference, CIT&DS 2017 (Volgograd, Russia) Proceedings ed. by A Kravets, M Shcherbakov, M Kultsova, Peter Groumpos Volgograd State Technical University *Springer International Publishing AG* pp 375-385
[17] Humam M, Somantri O, Boni Abdillah, Arif Romadhon S et all 2019 The application of particle swarm optimization using neural network to optimize classification of employee performance assessment *J. Phys.: Conf. Ser*. 1175 012067
[18] Pujotomo D, Budi Puspitasari N, Arasyandi M 2019 Performance Appraisal Based on Employees Competence in Procurement Services Unit (Case of Area Semarang) *J. Phys.: Conf. Ser*. 1175 012194
[19] Villajos E, Tordera N, Peiró J M, van Veldhoven M 2019 Refinement and validation of a comprehensive scale for measuring HR practices aimed at performance-enhancement and employee-support *European Management Journal* **37(3)** pp 387-397
[20] Robledo E, Zappalà S, Topa G 2019 Job Crafting as a Mediator between Work Engagement and Wellbeing Outcomes: A Time-Lagged Study *International Journal of Environmental Research and Public Health* **16(8)** 1376