Competency-based approach to the assessment of specialists using the theory of fuzzy sets

Компетентностный Подход К Оценке Специалистов С Использованием Теории Нечетких Множеств

Enfoque basado en competencias para la evaluación de especialistas utilizando la teoría de conjuntos difusos

Written by:
Lev Isakovitch Ushvitskiy[6]
ORCID ID: 0000-0002-2093-8560
https://elibrary.ru/author_items.asp?authorid=77932
Tat'yana Anatol'evna Kulagovskaya[7]
ORCID ID: 0000-0001-5438-4693
https://elibrary.ru/item.asp?id=37287887
Anna Alexandrovna Ter-Grigor'yants[8]
ORCID ID: 0000-0001-8957-4198
https://elibrary.ru/author_items.asp?authorid=449796
Natalia Vladimirovna Maslennikova[9]
ORCID ID: 0000-0001-7776-2511
https://elibrary.ru/author_items.asp?authorid=379296
Ekaterina Evgenevna Puchkova[10]
ORCID ID: 0000-0001-5080-5518
https://elibrary.ru/author_items.asp?authorid=417029

Abstract

Corporate culture is one of the main factors of the inner environment of an organization that forms prerequisites for the effective use of labor resources. The concept of corporate culture, its significance, composition and properties were studied by many Russian and foreign scientists. However, the methods of modeling the qualification portrait of a specialist in the process of forming the corporate culture of an organization are still to be studied. The article considers such properties of corporate culture as dynamics, systemic character, heterogeneity, structuredness of elements, relativity, commitment and adaptability. In the process of using qualification competency units in the formation of the corporate qualification portrait of a specialist, the authors offer a methodological toolkit that allows receiving detailed assessment data, the apparatus of fuzzy sets in particular. Further, a typical assessment model of

Аннотация

Корпоративная культура является одним из основных факторов внутренней среды организации, которая формирует предпосылки для эффективного использования трудовых ресурсов. Понятие корпоративной культуры, ее значение, состав и свойства изучались многими российскими и зарубежными учеными. Однако методы моделирования квалификационного портрета специалиста в процессе формирования корпоративной культуры организации еще предстоит изучить. В статье рассматриваются такие свойства корпоративной культуры, как динамика, системность, неоднородность, структурированность элементов, относительность, приверженность и адаптивность. В процессе использования единиц квалификационной компетентности при формировании корпоративного квалификационного портрета специалиста

[6] Russian Federation, North Caucasus Federal University (NCFU), 1, Pushkina streel, Stavropol, 355017
[7] Russian Federation, North Caucasus Federal University (NCFU), 1, Pushkina streel, Stavropol, 355017
[8] Russian Federation, North Caucasus Federal University (NCFU), 1, Pushkina streel, Stavropol, 355017
[9] Russian Federation, North Caucasus Federal University (NCFU), 1, Pushkina streel, Stavropol, 355017
[10] Russian Federation, North Caucasus Federal University (NCFU), 1, Pushkina streel, Stavropol, 355017

Ushvitskiy, L., Kulagovskaya, T., Ter-Grigor'yants, A., Maslennikova, N., Puchkova, E. / *Vol. 8 Núm. 22: 31 - 39/*
septiembre - octubre 2019

32

qualification competency units of employees of an economic entity can be specified taking into account the data about the profile of a particular position or the content of an aggregate qualification matrix in the structural parts of an organization.

Keywords: competency units, corporate culture, linguistic variables of a qualification competency unit, a qualification portrait of an employee.

авторы предлагают методический инструментарий, позволяющий получать подробные оценочные данные, в частности аппарат нечетких множеств. Кроме того, типичная модель оценки квалификационных компетенций подразделений работников экономического субъекта может быть задана с учетом данных о профиле конкретной должности или содержании совокупной квалификационной матрицы в структурных подразделениях организации.

Ключевые слова: единицы компетенции, корпоративная культура, лингвистические переменные единицы квалификационной компетентности, квалификационный портрет работника.

Resumen

La cultura corporativa es uno de los principales factores del entorno interno de una organización que forma requisitos previos para el uso efectivo de los recursos laborales. El concepto de cultura corporativa, su importancia, composición y propiedades han sido estudiados por muchos científicos rusos y extranjeros. Sin embargo, los métodos para modelar el retrato de calificación de un especialista en el proceso de formación de la cultura corporativa de una organización aún no se han estudiado. El artículo considera propiedades de la cultura corporativa como dinámica, carácter sistémico, heterogeneidad, estructuración de elementos, relatividad, compromiso y adaptabilidad. En el proceso de usar unidades de competencia de calificación en la formación del retrato de calificación corporativa de un especialista, los autores ofrecen un conjunto de herramientas metodológicas que permite recibir datos de evaluación detallados, el aparato de conjuntos difusos en particular. Además, se puede especificar un modelo de evaluación típico de las unidades de competencia de calificación de los empleados de una entidad económica teniendo en cuenta la fecha sobre el perfil de un puesto en particular o el contenido de una matriz de calificación agregada en las partes estructurales de una organización.

Palabras clave: Unidades de competencia, cultura corporativa, variables lingüísticas de una unidad de competencia de calificación, un retrato de calificación de un empleado.

Introduction

In the process of implementing labor functions, any organization's employees are faced with the necessity to arrange interpersonal communication, including through meeting particular spiritual needs. Such communication necessity determines the level of staff unity, the moral climate of an enterprise, workers' readiness for transformations and the specifics of corporate culture. It is precisely corporate culture that is one of the main factors of the inner environment of an organization that forms prerequisites for the effective use of labor resources.

Problem Statement

The concept of corporate culture, its significance, composition and properties were studied by

many Russian and foreign scientists. M. Armstrong (2014), I. Groshev and A. Krasnoslobodtsev (2015), Yu. Yermolov (2012), I. Isachenko, O. Yelizarova, E. Kondrus, I. Mashinskaya (Isachenko, Yelizarova, Kondrus, Mashinskaya, 2013), V. Kozlov and A. Kozlova (2000), M. Makarchenko (2004), Ya. Pirog (2012), V. Tomilov (2003), S. Shapiro (2015), U. Sandler and L. Tsitolovsky (2008), and others made particular contributions to studying the problem of corporate culture.

M. Armstrong considers corporate culture as a combination of beliefs, attitudes, behavioral norms and values that are common to all employees of an enterprise (Armstrong, 2014). Ya.Yu. Pirog understands corporate culture as an implicit, invisible and informal consciousness of

an organization that guides the behavior of individuals and is formed under the influence of their behavior in turn (Pirog, 2012).

Methods

Implementation of the goal and objectives of the study is based on the application of the systematic approach and the theory of self-organization. This is possible due to the use of a combination of the following methods and approaches:

- The target approach is associated with an assessment of the degree of achievement of the planned result, namely, a qualitative and quantitative analysis of the organization of work on the formation of an organization's corporate culture;
- The genetic approach is based on a retrospective analysis and extrapolation method used for the subsequent identification of internal and external factors of the sociocultural and economic nature that influence the formation and development of the corporate culture system of an economic entity;
- The teleological approach should be used when studying the activities of the subjects and objects of the personnel management process based on the targets of specific activities in the context of the ambiguity of professional competences and the degree of approximation of the results to the set goals;
- The functional approach reflects the principles of interdependence and synergy of the processes related to the formation of the corporate culture of an economic agent based on the efficiency of the labor resource use;
- The multiparameter approach is aimed at developing a methodology for assessing a complex qualification portrait of a specialist, considering the peculiarities of mastering professional competencies by specialists.

In the process of the research, it is necessary to use the theory of fuzzy sets, methods of structural and qualitative analysis and synthesis, comparison, extrapolation, expert estimates, statistical indices, technologies of economic and mathematical modeling, as well as software and computational and analytical developments.

Research results

It is possible to agree with the point of view according to which, corporate culture is a manifestation of basic values in the organizational structure of an economic entity, the management system and personnel policy (Shapiro, 2015). However, in our opinion, the interpretation of the corporate culture of an enterprise offered by V. Kozlov and A. Kozlova is the most complete. They believe that corporate culture is a system of formal and informal rules and norms of activity, customs and traditions, individual and group interests, behavioral specifics of the employees of a given organizational structure, a leadership style, employees' working conditions satisfaction indicators, the level of mutual cooperation, employees' readiness for organization's development (Kozlov and Kozlova, 2000). At the same time, the main properties of corporate culture include dynamics, systemic character, dynamics, systemic character, heterogeneity, structuredness of elements, relativity, commitment and adaptability (Figure 1) (Isachenko, Yelizarova, Kondrus, Mashinskaya, 2013).

It is worth noting that the corporate culture of an organization is formed as a result of a manifestation of such types of corporate culture as culture of authority, role culture, culture of achievements, culture of trust and support in pure or mixed forms (Isachenko, Yelizarova, Kondrus, Mashinskaya, 2013). The particular goals of an economic entity are achieved on the basis of collective or individual victories of its employees as part of implementing the corporate culture of achievements. Employees identify themselves with the enterprise, perceiving its success as their own, which enhances their internal motivation and professional return. Apart from the culture of achievement, the corporate culture of trust and support involves the development of favorable moral and psychological motivation allowing organization's staff to work using various principles of teamwork, the targeted information exchange and the collective development of progressive ideas.
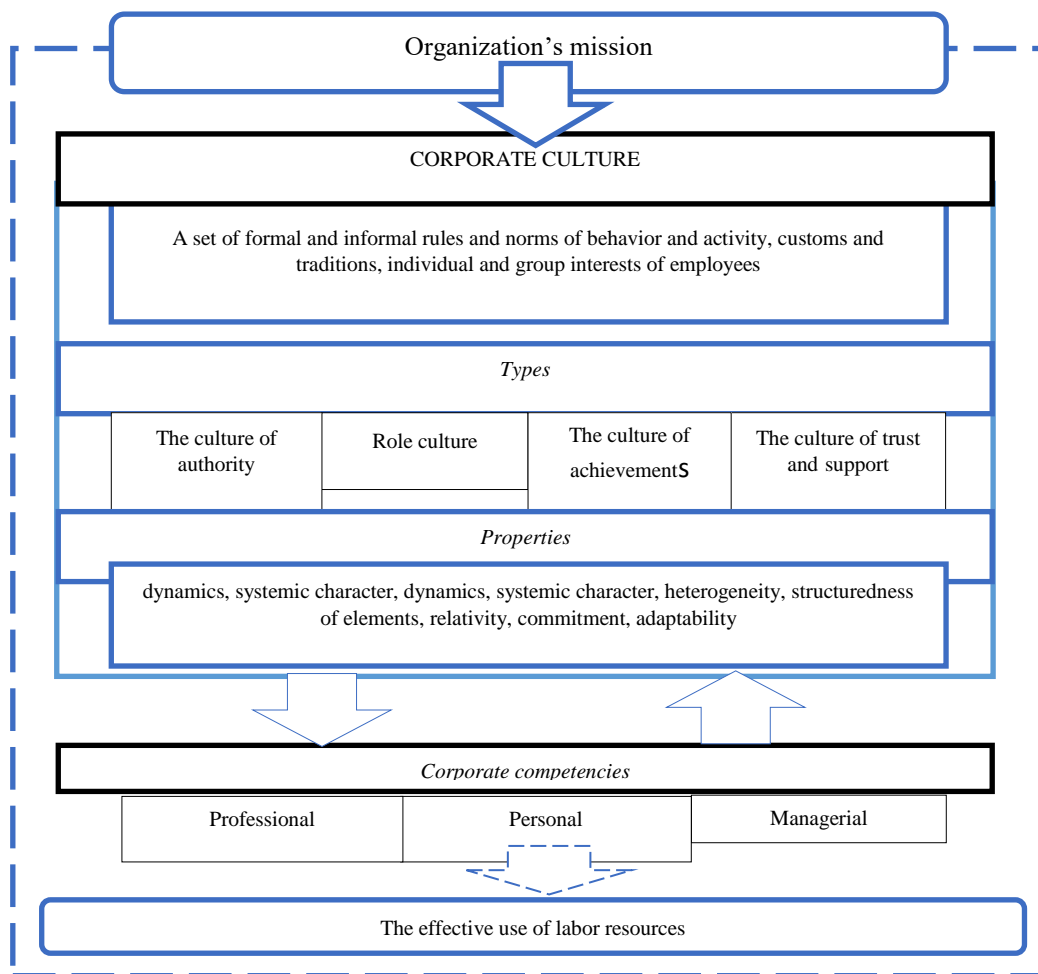
Figure 1 – The formation of the corporate culture of an organization

Regardless of the type and individual characteristics of an organization's corporate culture, its effectiveness can largely be determined by the knowledge and skills of employees that are necessary to perform a certain type of work, that is, by the level of the formation of corporate competencies. It is a set of professional, personal and managerial competencies that determines a professional, qualification portrait of an employee in the form of his/her personal characteristics, abilities to perform particular labor functions, types of behavior and social roles.

It should be noted that the approaches to understanding and interpreting a qualification portrait of an employee are rather numerous and can be considered differently depending on targeted objectives. Due to this fact, the problem of the formalization and assessment of corporate competencies is rather complex. To solve the problems of analyzing the qualification portraits of the employees of an organization, we introduce the concept of a qualification competency unit that should be understood as the entirety of employee's qualities, characterizing his/her ability to perform a particular professional function and having a quantitative assessment. A qualification unit may be a characteristic of one or several corporate competencies at the same time.

The requirements for the composition of qualification competency units, the criteria and assessment scales are formed by entities interested in performing particular labor functions by the organization's employees. It should be noted that in the process of using qualification competency units, methodological tools that allow obtaining detailed assessment values should be used.

Presently, the methods based on the achievements of modern mathematics are quite relevant; they give an opportunity to take into account both the incompleteness and distortion of information in drawing up an employee's qualification portrait and the probabilistic nature of the formulated conclusions. Such formalized approaches include fuzzy sets and the logical-probabilistic methods that allow assessing solutions to problems in which a subjective judgment plays a significant role in analyzing ambiguity and uncertainty.

The theory of fuzzy logic offered by L. Zadeh (Zadeh, 1976) is one of the first to deal with imprecise and even unclear concepts. Since that time a great number of works on fuzzy logic have been published.

The fact that the analytical description of a process may not be carried out in describing control systems can be considered an advantage of the fuzzy logic approach over the classical one. In many situations, it is sufficient to professionally describe how the process is controlled by a subject, while with the classical approach it is necessary to analytically describe both the process itself and its control systems.

Fuzzy logic, as can be seen from its name, provides inaccurate, approximate assessments. In most cases, situations are estimated roughly. The necessity to use such an approach is due to the fact that, as a system grows more complex, the ability of a subject to draw accurate and significant conclusions regarding its behavior gradually decreases until a threshold is reached, beyond which accuracy and significance become almost mutually exclusive characteristics. As a result, it was offered to introduce special notations (labels), defining more or less fuzzy concepts, and to use these labels in subsequent studies (Sandler, Tsitolovsky, 2008).

The methods of the formation of an employee's corporate qualification portrait with the use of qualification competency units offered by the authors is based on the theory of fuzzy sets and implies the realization of the following stages (Figure 2).
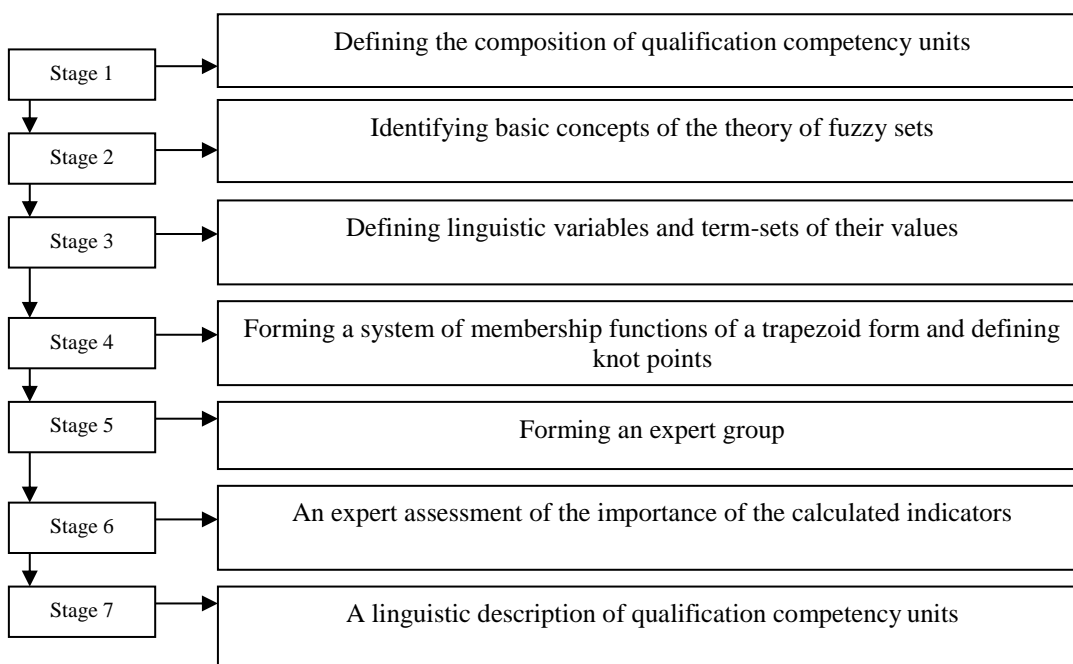

Figure 2 – The algorithm for the assessment of qualification competency units for the formation of a corporate qualification portrait of a specialist

At the first stage, a set of assessed qualification competency units is developed, which may include the following types:

– General professional competencies that include knowledge and skills common to a particular number of professions and positions and that are explicitly used in professional activity;

- Special competencies that include knowledge, skills and experience specific for particular positions;
- Personal and professional propensities that are formed during training process in an educational organization and determine the choice of a future job;
- The opportunities for communication characterizing the ability to work effectively in a team;
- Independent cognitive activity manifested by the employee's abilities to gain new knowledge;
- Instrumental competencies in the form of technical skills that characterize the employee's ability to use various technical means, hardware and software in solving practical problems.

In realizing the second stage, the basic concepts of the theory of fuzzy sets are introduced:

1) *A*-set that includes all observation results within the assessed statistics. The consequences of implementing each alternative are not clear enough and depend on external factors or conditions that are beyond control;

2) A fuzzy set *O* is a set of values of support, where each value of support corresponds to the degree of membership of this value to a set *O*;

3) A membership function $\mu_O(A)$ is a function which domain is support *A* and codomain is a unit interval [0,1]. The higher $\mu_O(A)$ is, the higher the degree of membership of a support element to a fuzzy set *O* is.

The third stage introduces linguistic variables. A linguistic variable is a variable that is given on a certain quantitative scale and that is manifested in words and word combinations of a natural language. Linguistic variable values are described by fuzzy variables. Linguistic variables and their values are used for a qualitative verbal description of a certain quantitative value. Any linguistic variable and all its values are associated with a specific quantitative scale.

In terms of the formation of an employee's corporate qualification portrait, it is advisable to introduce an appropriate linguistic variable "a corporate qualification portrait of an employee" and fuzzy subsets that form a full set of values of the variables introduced. It is important to establish a one-to-one correspondence between the variables introduced (table 1). The indicator of an employee's level of competence takes a value from 0 to 1.

Table 1: The composition of linguistic variables for the formation of an employee's corporate qualification portrait

A domain of a linguistic variable	A linguistic assessment of competencies
A_1	-
A_2	A very low level
A_3	A low level
A_4	An average level
A_5	A high level
A_6	A very high level

Constituent factors at the level of basic factors can be aggregated on the basis of a matrix scheme. For this purpose a "term-set of values" is formed, which is a set of linguistic values of some linguistic variable.

For each linguistic variable, for a qualification competency unit (X_i, i= 1-6) in particular, a linguistic variable C_{ij} is introduced:

C_{i1} – a subset "lack of competency X_i"
C_{i2} – a subset "a very low level of competency X_i"
C_{i3} – a subset "a low level of competency X_i"
C_{i4} – a subset "an average level of competency X_i"
C_{i5} – a subset "a high level of competency X_i"
C_{i6} – a subset "a very high level of competency X_i"

The fourth stage introduces a system of six correspondent membership functions $\mu_1(x) \ldots \mu_6(x)$ of a trapezoid form for the given linguistic variable:

$$\mu_1(x) = \begin{cases} 1, 0 \leq \tilde{o} \prec 0,2 \\ 5(0,4 - \tilde{o}), 0,2 \leq \tilde{o} \prec 0,4 \\ 1, 0,4 \leq \tilde{o} \leq 1 \end{cases}$$

$$\mu_2(\tilde{o}) = \begin{cases} 0, 0 \leq \tilde{o} \prec 0,2 \\ 5(\tilde{o} - 0,2), 0,2 \leq \tilde{o} \leq 0,4 \\ 1, 0,4 \leq \tilde{o} \prec 0,6 \\ 5(0,8 - \tilde{o}), 0,6 \leq \tilde{o} \prec 0,8 \\ 0, 0,8 \leq \tilde{o} \leq 1 \end{cases} \quad (1)$$

$$\mu_3(\tilde{o}) = \begin{cases} 0, 0 \leq \tilde{o} \prec 0,6 \\ 5(\tilde{o} - 0,6), 0,6 \leq \tilde{o} \prec 0,8 \\ 1, 0,8 \leq \tilde{o} \leq 1 \end{cases}$$

,

An interval of real axis [0,1] acts as support Xi of a linguistic variable. Any finite-dimensional intervals of real axis can be reduced to [0,1] by means of a simple linear transformation; as a result, the intercepted interval of a unit length is universal and called 01-support. Therefore, it is possible to compare the results of probabilistic research of a competency level with an assessment of a competency level on the basis of fuzzy sets and knowledge.

Besides, at the given stage a set of so-called knot points $\alpha j = (0,2; 0,4; 0,6; 0,8)$ is introduced. On the one hand, they are abscissas of maximums of correspondent membership functions on 01-support, and, on the other hand, they are evenly related to each other on 01-support and symmetrical relative to a 0,5 knot. Hence, a linguistic variable given on 0,1-support (Figure 3) in conjunction with a set of knot points icalled a triangular fuzzy 01-classifier.
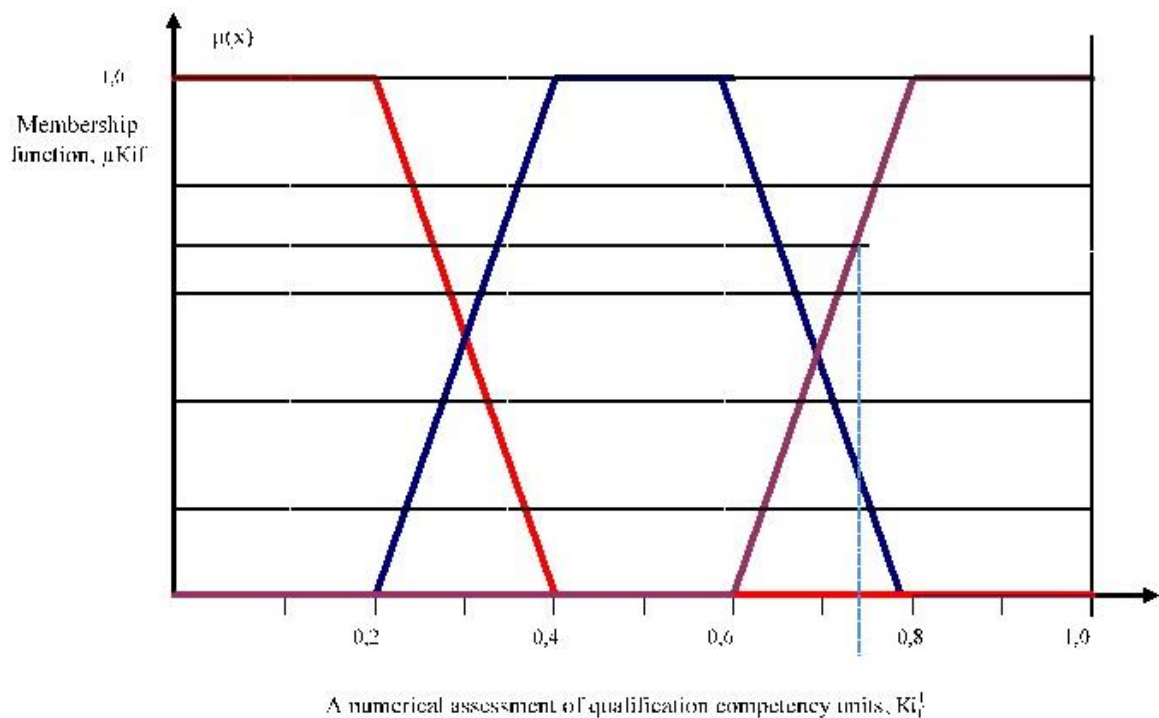

Figure 3 – The system of trapezoid membership functions on 01-support

During the next stage of an assessment of employees' qualification competency units, expert groups are formed. Before assessing the competence of experts (a qualitative aspect), it is necessary to consider a quantitative side, in other words, to determine the number of experts. It is quite difficult to establish an optimal size of an expert group. However, a number of formalized approaches to this issue have been developed. One of them is based on the establishment of a maximum and minimum group size. It is known that, in order to minimize the cost of a particular study, a minimum number of experts is sought, provided that the result of a research is not more than E $(0 < E < 1)$. Therefore, a recommended number of experts can be defined by the formula:

$$. N_{MIN} = 2{,}5 + {1{,}5}/{\mathring{A}} \qquad (2),$$

where N $_{MIN}$ is a minimum number of experts;
A is a total number of potential experts.
Substituting maximum values E it is possible to define that:

$$N_{MAX} \to \infty \text{ with } E = 0; \ N_{MIN} \to 4 \text{ with } E = 1.$$

The significance of a calculated competency level can be assessed by means of scores which scale covers n intervals, i.e. $l = 1,2...n,$ where n is a number of formed corporate qualification portraits.
Each level is given a significance level for analyzing λ_l. To assess this level it is necessary to put all indicators in descending order so that the rule

$$. \lambda_1 \geq \lambda_2 \geq ... \lambda_n \qquad (3)$$

is observed.

Further, with the use a membership function reflecting experts' assessment judgments, an aggregate function $\mu(Ki^t)$ can be drawn that characterizes correspondence between a level of qualification competency units achieved by a student and the established requirements.

Let a numerical assessment be given by value Ki_f (Figure 2). Then, the degree of its correspondence to requirements we define with the use of an aggregate function of $\mu(Ki^t)$ type:

$$\mu(Ki_f^t) = \\ \eta(Ki_3^t)\mu_{norm}3(\ Ki_f) + \eta\ (\ Ki_4^t\ )\ \mu_{norm}4\ (Ki_f) \qquad (4)$$

In a similar way, a membership function can be defined at any other value of a variable $Ki_t^t \in [Ki_0^t; Ki_T^t]$ which enables to define a function $\mu(Ki^t)$ on the whole interval of valid values. At the same time, depending on the degree of assessment interval details, the number of points in which the function values are calculated can be changed (it is continuous within limits). The general view of a function drawn in such a way is presented in Figure 4.
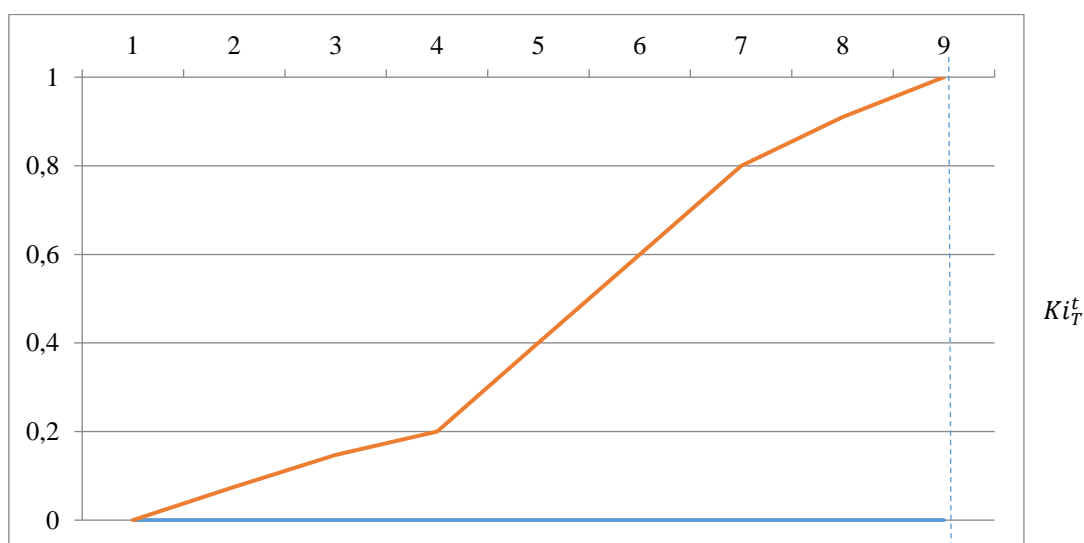

Figure 4 – The change in a membership function for different values of variable qualification competency units

The drawn membership function can be used in assessing a relevant level of qualification competency units of an employee. It allows defining the degree of correspondence between an actual level of competency and the established requirements for any value $Ki_t^t \in [Ki_0^t; Ki_T^t]$ that was acquired during the formation of an employee's corporate qualification portrait.

Conclusions

In the future, it is possible to specify a typical model of assessing qualification competency units of employees, taking into account the information about the profile of a particular position or the content of a consolidated qualification matrix in an organization's structural unit. At the same time, the composition of corporate qualification competency units may also be reflected in workplace responsibilities and characteristics, in a corporate code of ethics and in various normative acts on a staff assessment. The data obtained as a result of the development of an employee's corporate qualification portrait can be clearly represented in the form of a petal diagram, where it is necessary to depict the employee's levels of mastery of the relevant types of qualification competency units, which will reveal the "problem areas" and make an employee's individual development plan. In this case, it is also necessary to take into account the individual indicators of qualification competency units, since they reveal the image of a "perfect employee", whose progressive knowledge, skills and abilities will significantly improve work efficiency.

The purposeful impact of correspondent management entities on the indicators of qualification competency units of an employee will not only improve his/her abilities to fulfill necessary labor functions professionally but also contribute to the development of creativity, which is crucial for an organization's favorable corporate culture.

Conflict of interest

The authors confirm that the data do not contain any conflict of interest.

References

Armstrong M., Taylor S. (2014). *Handbook of Human Resource Management Practice* 13th ed. Kogan Page. 880 p.

Groshev, I.V. Krasnoslobodtsev, A.A. (2015). *Organizational culture: textbook for students of management and economics*. M.: UNITY-DANA, 2015, 535.

Isachenko, I.I., Yelizarova, O.I., Kondrus, Ye.A., Mashinskaya, I.S. (2013). Managing human resources. Available at: http://hi-edu.ru/e-books/xbook962/01/part-008.htm

Kozlov, V.V., Kozlova, A.A. (2000). *Corporate culture: costume of successful business. Personnel management*. Moscow: Focus, 514 p.

Makarchenko, M.A. (2004). *Methodology and methodology of designing the company's culture in the process of creating flexible organizational structures*. SPb., 215 p.

Pirog, Ya. Yu. (2012). *Corporate culture: sources, traditions, modern condition, development tendencies.* M.: Laboratoriya knigi, 105.

Sandler, U., Tsitolovsky, L. (2008). Neural cell behavior and fuzzy logic. Springer, 478. ISBN 978-0-387-09542-4.

Shapiro, S.A. (2015). *The concepts of managing human resources: textbook.* Moscow-Berlin: Direct-Media, 342.

Tomilov, V.V. (2003). Management Moscow: Yurayt-Izdat, 591 p.

Yermolov, Yu.A. (2012). Subject-content relationship definitions of "organizational culture" and "corporate culture". *Tambov University Review. Series Humanities,* 9 (113), 78-85.

Zadeh, L.A. (1976). *The concept of a linguistic variable and its application to approximate reasoning*. M.: Mir, 166.