Correlation between HR-system efficiency and its formation based on the job competency model in the digital world

Elena I. Pozolotina
Director of Corporate University TMK2U
Assistant of Labor Economics and Human Resources
Management Department
Ural State University of Economics
PozolotinaEl@sinara-group.com

Inna A. Kulkova
Doctor of Economic Sciences
Professor of Labor Economics and Human Resources
Management Department
Ural State University of Economics
i.a.koulkova@mail.ru

Abstract – The development of economic relations resulting from formation of the fourth industrial revolution, require a change in approaches to HR-management basic principles. One of these approaches in modern conditions might be a competency-based approach. The article describes an experiment on the formation of HR-management system based on the job competence models of four large metallurgical enterprises and its results by the system efficiency criteria. The system efficiency criteria, methodological basis of the chosen approach, HR-management system generation algorithms based on the job competency models are given in the article. It has the evidence base confirming the existence of a positive correlation between the effectiveness of the HR-management system and the method of its formation based on the job competency models and the competency-based approach. The article examine the relevance of this approach in conditions of the fourth industrial revolution and digital economy.

Keywords – competence, competency, competency-based approach, HR-management based on the competency-based approach, job competency model, employee competency profile, deficit and surplus of competencies, digital economy, fourth industrial revolution.

I. INTRODUCTION

To form an enterprise management system is necessary primarily to ensure its functionality. Enterprise management is built on the interrelated operation of several systems. One of them is HR-management system. There are many theories of management, on which the various approaches to HR-management are formed. The choice of approach to HR-management is a strategically important step that the head of the organization takes. Selected approach becomes the foundation for building the HR-management system. A change in approach leads to a change in the HR-management system. Availability of studies confirming the effectiveness of a particular approach in the formation of HR-management system is important scientific information, which becomes a practical tool in decision-making by the executives and managers of companies and corporations. Furthermore, in the context of the fourth industrial revolution, an important criterion for choosing one or another approach to HR-management becomes the criterion of its adaptability to change, as well as the presence of potential in the approach to ensuring changes in an organization through an HR-management system built on its basis. We have reviewed more than thirty approaches to HR-management, which in varying degrees are used in the formation of an HR-management system. HR subsystems were analyzed in the context of each of the proposed approaches. An analysis of the literature has shown us that existing methods and methodologies for the formation of HR-management subsystems are most often based on different approaches to HR-management and have no common basis. After analyzing the publications of many authors, we came to this conclusion that competency-based approach affects most of subsystems. In Spencer & Spencer, the competency-based approach is applied to three subsystems and five business processes: recruitment and management of employee records, management of employee development, and management of motivation and incentives. E.A. Mitrofanova, V.G. Konovalova, O.L. Belovo, A.Ya. Kibanov in designing the methodology for developing a competency-based model proposed the use of the approach in the formation of similar subsystems, but only for three business processes: recruitment, training and incentives (system elements).

Many authors who conducted research in the direction of developing the application of the competency-based approach focused only on one subsystem – recruitment management in the business process of assessment and recruitment. That includes such authors as D. McClelland, P. Boyacis, Guyon, Carol, E.S. Smirnova, N.F. Talyzina, N.G. Pechenyuk, L.B. Khikhlovsky, and many others in Russia, Europe and America. The effectiveness of this approach was analyzed by...
the authors on performance indicators of subsystem processes of the distribution area.

The purpose of the study was to expand the applicability of the competency-based approach to the level of an integrated HR-management system. It was hypothesized that there is a correlation between the effectiveness of HR-management system and building it based on a single foundation - job competency models. The statement of the problem is due to the fact that in conditions the fourth industrial revolution and digital economy an important characteristic of an organization’s activities becomes the rate of change within it. The rate of change is higher, the simpler the mechanism of change and the faster the communication between the systems of the organization. HR-management system is the connecting system in the organization. Its element - personnel is an element of any other systems. So the faster the rate of change in the HR-management system, the faster the rate of change of the entire organization. It means the methodology at which the maximum rate of change is achieved will be the tool for solving current problems of a market economy.

Consequently, we have developed a methodology for forming a job competency model for a large organization, detailed in other publications, and proposed algorithms for the formation of all major subsystems of HR-management on its base. We have conducted a study to determine the correlation between the effectiveness of an HR-management system and the approach to its formation based on the job competency model. The results of the study will be presented in this article.

The article describes the experiment on the formation of HR-management system on the basis of the job competency model of four large metallurgical enterprises and its results by the criterion of system efficiency. This article also presents a number of indicators to determine the criteria for system effectiveness. As a result, this article will provide the evidence base confirming positive correlation between the effectiveness of an HR-management system and the approach to its formation based on the job competency model and the competency-based approach as primary.

II. LITERATURE REVIEW

The formation of the author's approach to the HR-management system’s creation on the basis of job position’s competence model is based on the analysis and development of the scientific approach, proposed by Spencer & Spencer, as well as A. Kibanov in collaboration with E. Mitrofanova, V. Konovalova and O. Belova in terms of the management of recruitment and employee records and talent management.

Regarding business process, there were approaches, described in modern scientific studies by such authors as: E. Bayeva, V. Baydenko, A. Bey, V. Bogdanova, Z. Gantemirova, L. Gashkova, I. Zimnyaya, O. Korneeva, A. Korneeva and other authors who conduct research in the field of pedagogy.

Proposed approaches are expanded through the application of the competence model in the subsystems, which were not previously described by authors, such as organizational development, personnel planning; subsystems, which are different in content, such as: motivation and stimulation, extended subsystems: training and career management. The model is presented in Figure 1.

Algorithms of processes of HR-management subsystems, which were not previously described in scientific researches through the application of competence-based approach on the basis of job competence model, are shown below in Figures 2.3.

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1 Created by the author
Vacant positions in staff schedule

Vacancy analysis job competence model. Organization of demands in the number of personnel of a particular set of competences

Recognition of recruitment’s sources and methods

Labour market analysis on required competencies

Internal database analysis on available competencies

Analysis of the reasons for contradictions and exclusion possibilities.

Analysis of the inconsistency of the employee’s competence profile and job competence model. Organization of demands in substitute personnel with a particular set of competences.

Analysis of staff turnover. Organization of demands in substitute of personnel with a particular set of competences.

Analysis of the reason of duplication. Elimination possibilities.

The comparison of competence models’ chains concerning the duplication of competences between chains. Control of duplicate competencies.

Staff optimization, positions’ utilization.

Analysis of job competence models for substitute personnel. Check of the possibility of expanding and combining functions within the proposed competencies.

Competence shortage

Competence shortage

Positions division according to narrow competencies, change in business processes.

Change in organizational structure, duplicate elimination, change in business processes.

Analysis of job competence models for substitute personnel. Check of the possibility of eliminating, splitting or expanding, improving professional profiles in the labor market.

Fig. 2. The integrated algorithm of application of job competence model in a planning and HR marketing subsystem

Fig. 3. The integrated algorithm of the competence-based approach application in the subsystem “Organizational structure management”

To repeat the experiment and obtain a similar result, it is important to apply the algorithms in accordance with the proposed ones. The systematic implementation of job competence model into management subsystems is an important criteria that determines relationship. A complete description of the algorithms is given in other articles of the authors.

To determine the criteria for the effectiveness of the HR-management system, the following approach was chosen. The criteria for the processes effectiveness of various subsystems, which existed in the scientific literature, were analyzed. Cross-cutting things, which characterize the effectiveness of more than one process, were determined. In addition, from the set of criteria were selected those criteria that, in the author’s opinion, are significant in the context of ongoing business changes caused by the fourth industrial revolution and digitalization, that is, reflecting the organization’s ability to change faster and to function effectively. The result of the analysis is presented in table 1. Criteria that are most significant in the digital economy and the influence on them is the aim in selecting methods and techniques into any management system.
### TABLE 1. DISTRIBUTION OF PERFORMANCE INDICATORS OF THE IMPLEMENTATION OF THE METHODOLOGY FOR HR-MANAGEMENT SUBSYSTEMS3

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Performance indicators of the implementation of the methodology in the subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and marketing</td>
<td>– Staff turnover.</td>
</tr>
<tr>
<td></td>
<td>– Payroll costs.</td>
</tr>
<tr>
<td></td>
<td>– The rate of change.</td>
</tr>
<tr>
<td></td>
<td>– Productivity.</td>
</tr>
<tr>
<td>Recruitment and accounting staff</td>
<td>– Staff turnover.</td>
</tr>
<tr>
<td>management</td>
<td>– Staff turnover in the first year of work.</td>
</tr>
<tr>
<td></td>
<td>– Time of staffing vacancies.</td>
</tr>
<tr>
<td></td>
<td>– Recruitment costs.</td>
</tr>
<tr>
<td></td>
<td>– Qualification training time.</td>
</tr>
<tr>
<td></td>
<td>– The rate of change.</td>
</tr>
<tr>
<td></td>
<td>– Productivity.</td>
</tr>
<tr>
<td></td>
<td>– Share of reclaims for unqualified employees.</td>
</tr>
<tr>
<td></td>
<td>– Staff satisfaction by various groups of factors</td>
</tr>
<tr>
<td>Labor relationship management</td>
<td>– Staff turnover.</td>
</tr>
<tr>
<td></td>
<td>– Staff turnover in the first year of work.</td>
</tr>
<tr>
<td>HR-development management</td>
<td>– Staff turnover.</td>
</tr>
<tr>
<td></td>
<td>– Staff turnover in the first year of work.</td>
</tr>
<tr>
<td></td>
<td>– Realization of a management reserve potential (appointment from a reserve).</td>
</tr>
<tr>
<td></td>
<td>– Employees participation in the processes of HR-management subsystems on the conditions of self-promotion.</td>
</tr>
<tr>
<td></td>
<td>– Training efficiency.</td>
</tr>
<tr>
<td></td>
<td>– Training and development, recruitment and assessment costs.</td>
</tr>
<tr>
<td></td>
<td>– Qualification training time.</td>
</tr>
<tr>
<td></td>
<td>– The rate of change.</td>
</tr>
<tr>
<td></td>
<td>– Productivity.</td>
</tr>
<tr>
<td></td>
<td>– Share of reclaims for unqualified employees.</td>
</tr>
<tr>
<td></td>
<td>– Staff satisfaction by various groups of factors.</td>
</tr>
<tr>
<td>Motivation and incentives management</td>
<td>– Payroll costs.</td>
</tr>
<tr>
<td></td>
<td>– Productivity.</td>
</tr>
<tr>
<td></td>
<td>– Staff satisfaction by various groups of factors.</td>
</tr>
<tr>
<td>Organizational development</td>
<td>– Regulated processes of HR-management subsystems.</td>
</tr>
<tr>
<td>Information management of the HR</td>
<td>– Employees information awareness on the processes of HR-management subsystems.</td>
</tr>
<tr>
<td>management system</td>
<td>– Regulated processes of HR-management subsystems.</td>
</tr>
<tr>
<td></td>
<td>– The rate of change.</td>
</tr>
<tr>
<td></td>
<td>– Staff satisfaction by various groups of factors.</td>
</tr>
</tbody>
</table>

Formulas for selected performance criteria are described below:

– Staff turnover or staff turnover factor:
\[
F_T = \frac{N_T}{N_{EM}} \times 100
\]  
(1)

where \(F_T\) – staff turnover or staff turnover factor, \%; \(N_T\) – number of employees who left the organization, because of staff turnovers (voluntarily, for absenteeism, for violation of safety, and for other reasons not caused by production or national need) during the period; \(N_{EM}\) – average number of employees over the same period;

– Staff turnover in the first year of work or staff turnover factor in the first year of work:
\[
F_{T1} = \frac{N_{T1}}{N_{EP}} \times 100
\]  
(2)

where \(F_{T1}\) – staff turnover in the first year of work or staff turnover factor in the first year of work, \%; \(N_{T1}\) – number of employees who left the organization, because of staff turnovers (voluntarily, for absenteeism, for violation of safety, and for other reasons not caused by production or national need) during the period; \(N_{EP}\) – number of hired employees during the period;

– Time of staffing vacancies:
\[
T = \sum_{i=1}^{n} T_i
\]  
(1)

where \(T\) – the average time needed to staff the vacancies; \(T_i\) – the time needed to staff each vacancy; \(n\) – number of vacancy during the period.

– Share of reclaims for unqualified employees:
\[
R = \frac{\sum_{i=1}^{n} R_i}{n} \times 100,
\]  
(2)

where \(R\) – number of reclaims for unqualified employees, \%; \(R_i\) – reclaims for unqualified staff, 1 unit.; \(n\) – number of claims reclaims during certain time;

– Staff satisfaction by various groups of factors:
\[
S = \frac{1}{n_1} \sum_{i=1}^{n_1} S_i = \frac{1}{n_2} \sum_{i=1}^{n_2} S_i
\]  
(3)

where \(S\) – staff satisfaction by average groups of factors; \(S_i\) – staff satisfaction by one factor; \(n_1\) – number of factors; \(n_2\) – number of respondents;

– Rate of change. This indicator is analyzed by a sociological survey method. During the implementation of change, which is significant in the system, a sociological survey is formed. The survey measures staff readiness to accept or not accept changes. A similar sociological survey is organized 3 months after the implementation of changes, where, in addition to the measurements described, time that spent on new methods of work is analyzed. Such analysis should be carried out before and after the implementation of the competence-based approach. The reduction of time required to the system restructure, the increase of staff who accept changes in two surveys give the possibility to evaluate the dynamics of the rate of change implementation;

– Productivity:
\[
P = \frac{V_{final}}{NEM_{ps}}
\]  
(4)

Where \(P\) - labor productivity, \(V\) tonn - volume of production (tonnage) for a certain type of work; \(NEM_{ps}\) - number of employees (production staff);

– Payroll, training and development, recruitment and assessment costs;

– Qualification training time, (man-hours):
\[
T = \sum_{i=1}^{n} T_i \times S_i
\]  
(7)

where \(T\) – time needed to train staff, (man-hours); \(T_i\) – time of a certain type of training, (hours); \(S_i\) – number of staff in a certain type of training, (number of people); \(n\) – number of training during a certain period of time;

– Training efficiency (average score based on the results of feedback questionnaires of the informative part of training);

– Regulated processes of HR management subsystems (the presence or absence of regulations on the basic processes of subsystems);

– Employees information awareness on the processes of HR-management subsystems. It is evaluated by methods of
sociological survey, questionnaires, interviews. Dynamics of criteria is observed. The increase in staff informational awareness due to the use of the competence-based approach, which influence staff involvement and career;

Employees participation in the processes of HR-management subsystems on the conditions of self-promotion. Evaluated by dynamic observation of the growth rate in absolute terms over periods;

...Filling the potential of management reserve (index number of people who is appointed to the position from a management reserve):

$$F_a = \frac{N_{\text{ann}}}{P_{\text{ann}}} \times 100\%$$

where $F_a$ – assignment factor of people who is appointed to the position from a management reserve; $N_{\text{ann}}$ – number of people who is appointed to the position from a management reserve, (people); $P_{\text{ann}}$ – total number of appointed managers, (people).

III. METHODS AND MATERIALS

The experiment was conducted on the basis of 4 large metallurgical enterprises, with a total of 28,000 people, located in three regions of the Russian Federation. All the enterprises have gone through a global technological modernization; they are subjects of the digital economy, on the path of transformation mechanisms dictated by the influence of the fourth industrial revolution.

At first, the HR-management system of enterprises were measured by selected key performance indicators. The study analyzed the dynamics of the selected indicators for 3 years, during which there were no system changes in the approaches to the formation of a HR-management system.

At the second stage, we introduced the method of forming the job competency model. Description of the methodology is given in the article “Methods of forming a competency model for a large enterprise” by Pozolotina E.I. Competency models have been developed for all positions in the company.

At the third stage, the business processes of the main HR-management subsystems were reengineered. Examples of algorithms for forming business processes of subsystems are given in the next section.

At the conclusion after the first year of work, a re-measurement was carried out on selected key indicators characterizing the performance of the HR-management system after the implementation of the competence approach when forming a personnel management system based on job competence models.

The result of the experiment was a statistical comparison of the measurement results before and after the changes. The establishment of a positive relationship was confirmed by the growth of all key performance indicators of the personnel management system of the enterprise, which made it possible to conclude that the result of the experiment was positive. An important development, in terms of transformational mechanisms, was that by using the described system, staff readiness to change increased and it is the key criteria to the transformation of the economy in general and the organization as its subject in particular. And this means the proposed methodology is one of the possible tools for the adaptation and transformation of any enterprise to the current economic conditions.

Research findings

As a result of the study, the positive dynamics of the selected performance indicators of the HR-management system for four enterprises was determined. The results of measurements before and after the implementation of the competence approach in building an HR-management system are shown in Table 2 below.

Table 2. Dynamics of Changes in Indicators before the Start of the Experiment and on the Results of Implementation

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Enterprise 1</th>
<th>Enterprise 2</th>
<th>Enterprise 3</th>
<th>Enterprise 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013</td>
<td>2017</td>
<td>2013</td>
<td>2017</td>
</tr>
<tr>
<td>Staff turnover, %</td>
<td>6.9</td>
<td>6.0</td>
<td>6.5</td>
<td>7.0</td>
</tr>
</tbody>
</table>
| Time of 
staffing vacancies (on average), months |
> 1 < 1 > 1 < 1 > 1 < 1 > 1 < 1 |
| Share of 
reclamations for unqualified employees, % | 56 19 58 25 | 45 12 48 25 |
| Staff satisfaction by 
various groups of factors 
(remuneration, development, career 
growth), average score | 5.6 7.0 6.7 7.0 | Not conducted | 7.9 | 5.9 | 7.8 |
| Acceptance level | Increased, integral estimate based on the number of changes implemented per year; results of sociological studies conducted simultaneously with changes and assessing the readiness and level of acceptance of changes | | |
| Productivity (in tons), t/p.       | 117 122 92 103 | 95 99 102 110 |
| Payroll expenditures, mln.rub.     | 2,543 2,857 2,583 2,923 | 4,291 4,908 2,450 2,665 |
| Training and 
development costs, mln.rub. | 16 17 20 13 | 23 24 18 11 |
| Recruitment costs (direct), 
assessment, mln.rub. | Not conducted | 1,5 | Not conducted | 2,7 | Not conducted | 3,0 | Not conducted | 1,1 |
| Training time, per. h             | 198 672 141 72 141 72 141 72 | 541 008 412 4 00 | 292 800 | 187 1 60 | 379 7 6 246 5 20 |
| Training efficiency               | 4.4 4.1 4.7 4.1 | 4.1 4.4 4.7 | Not conducted | 4.7 |
| Regulated processes of 
HR-management subsystems, %      | 30 70 45 70 | 32 70 48 70 |

4 Compiled by the author based on the study
Participation of employees in the processes of HR-management subsystems on the conditions of self-promotion

<table>
<thead>
<tr>
<th>Appointment from reserve, %</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55</td>
<td>70.6</td>
</tr>
</tbody>
</table>

As you can see from the given data, more than 90% of the criteria showed a positive trend. Thus, the cumulative efficiency of the HR-management system has grown after the implementation of the proposed approach. System efficiency is the ratio between the estimates and the resources used.

The calculation of the economic effect illustrated in the calculations in table 3 below.

**Table 3. Calculation of the economic effect of the introduction of the competence approach in the HR-management system.**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Ent.1</th>
<th>Ent.3</th>
<th>Ent.2</th>
<th>Ent.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculating the annual economic effect in terms of staff turnover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnover deviation, %</td>
<td>0.9%</td>
<td>0.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of vacancies to reduce</td>
<td>51</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The cost of staffing one vacancy, rub.</td>
<td>5 500</td>
<td>5 500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll size for the recruitment period, rub./month.</td>
<td>42 000</td>
<td>40 600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Savings on recruitment, rub.</td>
<td>280</td>
<td>385</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll savings, rub.</td>
<td>3 211</td>
<td>4 262</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reducing the number of replacement staff</td>
<td>10</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payroll savings of replacement staff, rub.</td>
<td>642</td>
<td>852</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General economic effect, rub.</td>
<td>4 275</td>
<td>5 692</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The economic effect in terms of recruitment time

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Ent.1</th>
<th>Ent.3</th>
<th>Ent.2</th>
<th>Ent.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payroll savings (surcharges), rub.</td>
<td>7 119</td>
<td>11 225</td>
<td>9 904</td>
<td>9 546</td>
</tr>
<tr>
<td>Reducing the number of replacement staff</td>
<td>7</td>
<td>9</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Payroll savings of replacement staff, rub.</td>
<td>3 528</td>
<td>4 384</td>
<td>3 528</td>
<td>3 996</td>
</tr>
<tr>
<td>General economic effect, rub.</td>
<td>10 647</td>
<td>15 609</td>
<td>12 432</td>
<td>13 542</td>
</tr>
</tbody>
</table>

The economic effect in terms of training time

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Ent.1</th>
<th>Ent.3</th>
<th>Ent.2</th>
<th>Ent.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saving hours</td>
<td>56 952</td>
<td>105 640</td>
<td>128 608</td>
<td>133 256</td>
</tr>
<tr>
<td>Reducing the number of replacement staff</td>
<td>28</td>
<td>53</td>
<td>65</td>
<td>67</td>
</tr>
</tbody>
</table>

5 Compiled by the author on the basis of research, calculations.

The total economic effect:
– in kind – 338 pcs. number optimization;
– in the received economic benefit – 212 mln.rub. annually, or 1.5% cost.

Considering that the personnel management system built on the principles of the competence approach applied to the formation of all subsystems through the post competency model, functions for one year, we expect the system to increase in efficiency over the next three years, when all processes of the main subsystems will work at the maximum level of efficiency.

Conclusions
The results of the experiment allow us to draw some conclusions:

The change or choice of approach in the formation of the HR-management system affects the efficiency of the system.

The application of one key approach in building HR-management systems creates the foundations of integrity and improves the efficiency of the system.

The dependence of the system efficiency on the chosen approach is determined empirically.

The effectiveness of using the competency-based approach and the formation of HR-management systems based on the proposed competency model of the position and algorithms for building business processes of the main subsystems has been proven for large enterprises in a stable market using the example of 4 enterprises located in different regions of the Russian Federation.

The study creates prerequisites for the hypothesis of the possible distribution of the results to other large enterprises, as well as medium-sized enterprises, where there is a reasonable need for standardization of management systems, and therefore its universality.

The study proves the effectiveness of the proposed tools and methods for building HR-management subsystems in the conditions of digital economy and business transformations resulting from the fourth industrial revolution.

It is important to note that the results of research correlate with other studies that have used a similar approach. For example, the effectiveness of the selection system with the
The practice of competence management was proved by Spencer and Spencer, Kibanov. The practical implications of this study are that the proposed approach can be used by HR-services, heads of any large enterprise - the metallurgical industry without modifications, other industries with minor modifications of the competence directory. In addition, the proposed methodology and approach can be used in training programs in the direction - labor economics, HR-management as a practical tool that has proven its effectiveness on a large sample. The considered approach, as shown in the study, is the basis for revising approaches to HR-management. It allows to achieve a significant acceleration of labor processes, which is one of the key factors for the transition to the fourth industrial revolution.

References


