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Assessment of the Influence of Human Factor on the Working Process Effectiveness as a Factor for Improving the Efficiency of Production Management at Industrial Enterprises

Evaluación de la influencia del factor humano en la eficacia del proceso de trabajo como factor para mejorar la eficiencia de la gestión productiva en empresas industriales

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Contents

ABSTRACT:

The purpose of this work is considering the essence of the human factor influence on the efficiency of the working process through the prism of professional competences, as well as carrying out practical diagnostics of employees' competence at medium and small-sized industrial enterprises and giving recommendations on the use of modern methods to analyze the impact of the human factor on the efficiency of the working process. Competences of employees of small and medium-sized industrial enterprises are diagnosed based on identification of the concept of "competences", classification of professional competences, and application of corresponding measurement methods. Conducted research allowed us to reveal the low level of occupational safety caused by inadequate behavior of employees, ignorance or absence of discussions regarding accomplishment of tasks, unnecessary risk-

RESUMEN:

El propósito de este trabajo es considerar la esencia de la influencia del factor humano en la eficiencia del proceso de trabajo a través del prisma de las competencias profesionales, así como realizar diagnósticos prácticos de la competencia de los empleados en empresas industriales medianas y pequeñas y dar recomendaciones. en el uso de métodos modernos para analizar el impacto del factor humano en la eficiencia del proceso de trabajo. Las competencias de los empleados de pequeñas y medianas empresas industriales se diagnostican según la identificación del concepto de "competencias", la clasificación de las competencias profesionales y la aplicación de los métodos de medición correspondientes. La investigación realizada nos permitió revelar el bajo nivel de seguridad laboral causado por el comportamiento inadecuado de los empleados, la ignorancia o la ausencia de discusiones

taking, inefficient relationships and human response, low level of qualification, and insufficient process control. In order to minimize the impact of human error on the efficiency of the working process, it is proposed to use Dekker's method.
Keywords: human potential, competence, labor safety, personnel assessment, types of competences, diagnostics of competences, human error

sobre el cumplimiento de tareas, la toma innecesaria de riesgos, las relaciones ineficientes y la respuesta humana, el bajo nivel de calificación y el control insuficiente de los procesos. Para minimizar el impacto del error humano en la eficiencia del proceso de trabajo, se propone utilizar el método de Dekker.
Palabras clave: potencial humano, competencia, seguridad laboral, evaluación de personal, tipos de competencias, diagnóstico de competencias, error humano

1. Introduction

In the context of "knowledge economy" formation, successful operation of enterprises requires taking into account the fact that the entire economic system is based on a human, who has certain potential. The use of this potential within the enterprise depends primarily on the management and system of methods and means of human resource management at the enterprise (Lukina and Panova 2017, Voronkova 2014), as well as the analysis of the influence of human factor on efficiency of working process.

Studies in the field of identification of influence of human factor on working process efficiency testify to essential discrepancies between theoretical and practical results in assessment of employees' competences. This requires the elimination of gaps between the results of self-diagnostics (which are often unreasonably overstated) and poor job performance that are associated with the human factor in the form of errors which arise not only due to the lack of individual competences, but also under the influence of stochastic negative factors at the workplace.

Therefore, in order to improve the enterprise performance efficiency, an integrated approach is proposed, aimed at improving the production process by combining the procedures for diagnosing the competences of employees with measures aimed at minimizing human error and improving occupational safety at the enterprise. All definitions concerning the employees' competences are sourced mainly from works of D. McClelland, who began his research work in the 70s of the last century. According to McClelland, competences are made up of knowledge, skills, abilities, and personal qualities necessary for the proper implementation of the set tasks (McClelland 1973, Ovchinnikov 2014). Following the theory of R. Boyatzis, a follower of McClelland, who propagated the idea to assess employees through the prism of their behavioral competences (Boyatzis 2008), L.M. Spencer and S.M. Spencer suggested the following definition of competence: "Competence is an intrinsic characteristic of each employee, which establishes a cause consequence with specific criteria based on the exceptional achievements at work or in a given situation" (Spencer and Spencer 2010). The above definition referrers to the ability of the competent performance of work or certain tasks, as well as a set of behavioral qualities that should be inherent to any person to competently perform the tasks and functions associated with the work. Hence, to avoid misunderstanding and complications when considering the above term, we should clearly distinguish the two meanings of competence:

- *competence* as a concept related to people and certain human qualities which form the basis of competent actions;

- *competence* as a notion associated with work and with phases of work, in which the person is competent.

In an employee-oriented approach, competences are characteristic (inherent) to the human; he is the basis of his effective performance and conduct in the course of work. These functions can be grouped into categories that typically include knowledge, skills, abilities, and relationships. In an employee-oriented approach, where the initial emphasis is placed on the human, the focus on work is also present. According to this approach, the first phase is formulating a list of steps necessary to perform the work. Then, in accordance with the necessary stages, employees are selected depending on required personal attributes. In this sense, the term "competence" is used to define actions or roles that a person can competently and successfully perform (Flowers 2005).

In this context, according to C. Woodroof, the term "competence" refers to one of the behavior sets that a person must possess to competently perform the task (Woodruffe 2007). Therefore, the competences are related to the performance of a specific job. It is clear that competences should be understood in both senses as action-oriented and employee-oriented.

Thus, competences are understood as dispositions in the field of knowledge, skills, and abilities that allow carrying out professional tasks at a certain level. So, professional competence includes three components:

– knowledge acquired in the course of studying at school and out of school;

– skills that make it possible to apply knowledge in practice;

– preferences that reflect the attitude of employees to the performance of professional tasks.

Knowledge and skills reveal the level of ability to perform tasks in the field of development, whereas the preference displays the attitude of employees to set tasks, which may vary within the range from negative to positive, crossing through neutral attitude (Vetrenko et al. 2017).

There are different types of competence classification. These classifications can be supplemented with the powers necessary to fulfill the specific tasks in development sphere. The types of competences and their scopes are presented in Table 1.

Table 1
Types of competences and their scopes

Types of competences	Scopes of competences
Social competences	Identification with the company, building relationships, communications, collaboration, cooperation both within the company and with third parties, the ability to resolve conflicts, negotiation skills, ability to listen, self-confidence, written communication, and customer-oriented approach.
Personal competences	Motivation to action, striving for results, innovation, independence, flexibility, imagination, ability to overcome stress, self-control skills, ability to analytical and synthetic thinking, decision-making, and problem solving.
Professional competences	Professional knowledge, information management, project management, process management, office skills, business orientations, knowledge application procedures, and readiness for training and advanced training.
Managerial competences	Ability creating effective organization, planning abilities, goal management, team building, change management, delegation, motivation, coaching, commitment, strategic thinking, management control, and leadership skills.

Key competences are considered in three categories: conceptual, social, and technical ones. Therefore, for example, different level management requires certain skills in different proportions (Desfontaines and Semenova 2017). So, the lowest level managers should have a significant degree of technical competences and to lesser degree conceptual and social competence (in equal proportions). Mid-level managers should have all three above skills in equal proportions. Senior managers should be characterized by an equally high level of conceptual and social competences, while may have slightly lower technical level of competences.

Competence can be measured in many ways. The methods of competence measuring include:

– studying the scope of selected competences using indicators that determine the level of

productivity;

– using competence cards, which represent the title of competence and describe the requirements for the implementation of the particular task. The competence card can be used to check the level of competence mastery by the employee;

– carrying out competence diagnostics through a questionnaire-based survey, which contains a number of statements relating to one of the competence indicators and assessed on a proposed scale. Using a survey, one can get data about employee self-appraisal and the behavior of other employees;

– carrying out qualification tests, which represent a set of statements describing possible ways of action in various situations; during the test the employee describes the optimal behavior in a particular situation;

– conducting conversations and interviews regarding the identification of employee behavior in the workplace;

– monitoring the behavior of the employee in the workplace.

Competence development is an element of the employee's professional development. Professional development of the employee occurs mainly in the workplace during the performance of professional tasks (70%), under the influence of information and recommendations received from others (20%), and through training (10%) (Baber and Stanton 2004). It is important to develop all the above mentioned qualities through team-work training (a), and development of competences necessary for the proper performance of their duties (b).

Thus, human and his activities play an important role in the work process, and at the same time human is the weakest link of the process. Dekker S. has proposed a method that allows accurately determining the cause of the error and analyzing it in detail that can become one of the elements of continuous improvement, enhancing communication and understanding by employees and managers of the key elements of set tasks (Dekker 2002). This technique makes it possible eliminating human errors, avoiding serious failures and downtimes, thereby increasing the enterprise performance efficiency. Accidents or emergencies potentially adversely affect not only the company image, but also the involvement of employees in the workflow. The guarantee of safety during work improves the well-being and comfort of employees.

Dekker's method is one of the elements of the broader concept of WCM (World Class Manufacturing). The main goal of WCM is improving production processes through quality upgrading, reducing costs, enhancing efficiency, and minimizing waste (Midor 2012). Like other systems of best practices, WCM proceeds from the assumption that selected areas are becoming the objects of measures to improve their current state, which determines the basis for improving the company's processes (Hendry 2008).

Dekker's method is one of the methods associated with the personnel development principles, which are closely correlated with the occupational safety principles. Personnel management is becoming increasingly popular, essentially influencing decision-making processes (selection of employees based on their abilities and interests). Employees of the Human Resources (HR) Department together with the employer make an inventory of works to determine the scope of activity for the employees, taking into account the standards approved by the Ministry of Health. The HR Department assigns competencies based on the principle which consists in "creating a unique integration between human factors and the technological process, the combination of which is difficult to reproduce, that creates the competitive advantage of the enterprise" (Kennedy and Kirwan 2011). One of the main success factors in human capital management is the analysis of the causes of errors made by employees.

The purpose of the present study consists in diagnosing competence on the example of medium and small-sized industrial enterprises, comparing the results of self-diagnostics with the results of job performance, identifying problem areas, and exploring opportunities to minimize the negative impact of human error on the efficiency of the working process. This will be done on the basis of advanced identification of the concept of "competence",

classification of professional competences of the employee of an industrial enterprise, and the identification of methods for measuring competences.

The research hypothesis consists in the following assumption: comparing the results of self-diagnostics with the results of job performance will reveal the problem areas and let exploring the possibility to minimize the negative impact of human error on the efficiency of the working process using the Dekker's method.

2. Methods

The authors investigated the personnel of medium and small-sized industrial enterprises of the Leningrad Region (50 employees). The study was carried out during workshops on automotive mechanics. Employees, in particular, motor mechanics, were interviewed by experts of diagnostic centers.

The object of the analysis included the following areas:

– testing professional competences – 30 test questions;

– self-diagnostics of the respondent's professional competence;

– 30-minute monitoring in the workplace to identify professional skills and abilities in practice.

Experts (32 persons) in the field of industrial enterprises management, executives of small and medium-sized industrial enterprises, as well as representatives of the middle management of small and medium-sized industrial enterprises participated in the discussion of the results of the conducted study.

3. Results

The questionnaire of professional competences diagnostics contained 30 questions concerning conditions and technology of production process and workplace safety. The result obtained among the testees was quite high: 75% of respondents reached the level of over 70%. The unsatisfactory result (less than half of the correct answers) was received by 7.4% of employees who passed the test. Over the past two years, more than half of respondents out of all employees attended advanced training courses (theoretical courses). It should be especially noted that 10 questions among the 30 questions in the questionnaire concerned the occupational safety.

The analysis of competence self-diagnostics was conducted with respect to professional competences in the following categories: job knowledge, knowledge and mastery of specific skills, professional development, job arrangement, professional ethics, and skills in the IT field. The results were assessed on a scale from 1 to 12 points. According to the results obtained, the self-assessment of employees in the areas related to workplace safety turned out to be very high (Table 2).

Table 2
Assessment of employees' professional competences

Category of assessment	Average score
Job knowledge	9.27
Knowledge and mastery of specific skills	10.6
Professional development	8.88
Job arrangement	6.2
Professional ethics	8.4

Skills in the IT field	7.2

The results of the self-assessment generally concur with the results of the preliminary tests for the professional knowledge assessment. Categories such as "knowledge and application of procedures" and "job arrangement" have also received high estimate.

However, based on the results of the analysis of actions taken in the production environment, (Table 3) it can be concluded that from the viewpoint of workplace safety, the actions of employees do not always meet the requirements. According to the analysis results, it is obvious that the practical sphere requires corrective measures.

Table 3
Assessment of professional competences of employees (by selected categories)

Selected actions	Actions are performed correctly, %	Actions are performed incorrectly, %
Taking gloves and goggles	4.44	95.56
Switching on ventilation during welding	6.67	93.33
Maintaining order in the workplace	11.11	88.89
Total	22.22	77.78

4. Discussion

The purpose of each method or tool designed to improve safety is increasing the predictability of processes at the enterprise in order to avoid errors caused by a human. Systemic approach to management allows achieving much better results in terms of ensuring health and safe working conditions. With the implementation of organizational solutions, it is possible to strengthen the interaction of employees and business efficiency by minimizing errors of employees (Voronkova et al. 2017). It is worth noting that a human with his skills and qualifications is an important element of the management system and forms its basis. The use of any methods and means does not guarantee success if the people who use them do not have adequate training and do not possess the necessary competences (Sanders and McCormick 2003). Therefore, here methods and tools for analyzing employee errors are very important.

According to experts, from the standpoint of the professional competences formation, the work cycle can be divided into 4 stages:

The 1st stage: Formation of the necessary set of competences for each type of work;

diagnostics of employees ' competences.

The 2nd stage: Production process.

The 3rd stage: Detection of errors; analysis of errors caused by the human factor.

The 4th stage: Identification of problem areas and implementation of corrective measures.

Exploring the impact of the human factor on the efficiency of the working process, experts note that achieving perfection at each stage of the working cycle is impossible, and here the slightest positive changes are very important. According to the experts, errors should not be considered inadmissible. The aim should consist in ensuring that there is sustainable improvement caused by eliminating errors. According to experts, in the system of "human–machine–environment", where a human is the weakest link because of his errors (Semenova 2017), it should be remembered that:

– errors are mostly predictable;

– organization can influence human behavior;

– the employee’s behavior is stipulated by organization;

– errors can be avoided.

Workers should be informed that admission of the same mistake is not a threat. The problem occurs when the error is not analyzed and preventive measures are not taken.

According to experts, very often human errors arise as a result of reasons such as lack of competence, lack of attention, forgetfulness, unforeseen situation, lack of instructions, poor behavior, and making wrong decisions.

It should be noted that human behavior can significantly affect the safety and efficiency of labor; therefore it is advisable to take measures that will help reduce human errors.

The proposed Dekker’s method is a systemic method for the analysis of human error. It should be applied to identify the causes of the error (such as employment injury) and to take appropriate measures preventing the same error from happening again. The Dekker’s method is used to analyze errors made by a human, and it is an example of active involvement methods which are used to eliminate errors and create a favorable situation preventing them in future (Morgan et al. 2014). Methods of active involvement are used in case of human errors. Analysis based on Dekker’s method is carried out as soon as possible right after identifying the cause of the error or identifying problems caused by a human.

The first stage of the method is conditioned by the ways of employees’ training. This is a method that is used to identify the problem, but it can also be useful in the learning process. According to the Dekker’s method, the first stage consists of four questions listed on the Dekker sheet. An employee can select just one answer per question. In the case, where it is difficult to determine the correct answer, the employee can get additional questions for a more detailed analysis of the situation. Sample questions are given in the Table 4. The answer to each question gives an opportunity to take a broader look at the problem and make accurate diagnostics. The more responses are accumulated, the larger is the database, and the better are the results of the analysis.

Table 4
Indicative questions of the first stage of the Dekker’s method

1. How to carry out your work effectively?	2. What are the signs that you are doing your job correctly?
Are there instructions that describe standard operating procedures? Are you familiar with the instructions and are they clear to you? Are the instructions updated periodically? *Check whether the employee has been trained and by whom.* Are there causes of errors other than the lack of skills, incorrect behavior, or inappropriate method? If the instructions are clear, would it be possible that the reason for the lack of knowledge is their insufficiency?	Are there any tools that you can use to test your performance efficiency? Are you aware of the most important safety and quality issues? Do the job-related instructions include a formalized validation method to determine that the job has been performed correctly? How long have you been doing this job? How do you update your knowledge? Do you know that there have been changes in standards?
3. What are the signs of obtaining successful results?	4. What do you do when a problem occurs?
Can you describe the verification process, and whether it is clear to you? Is testing foreseen for the proper execution of	Do you know what to do in a problematic situation? Are there clear instructions for behavior in

the work? Do you follow the procedures described? Do you understand when you do something wrong? Is there a clear informing system?	problematic situations? Who can help you, and who should you inform about the problem? Have you used any tools to solve the problem? What decisions did you make on your own?

Source: developed by the authors.

At the second stage of the Dekker's method, certain categories of errors are determined, and preventive and corrective measures are undertaken. This phase should be carried out as soon as possible right after the completion of the first phase. The analysis should result from the work of all employees involved in the diagnostics by Dekker's method based on the results obtained during the first stage.

The third stage of the method is used as a supplement to the information obtained during the first and second stages (at this stage, the information is compared with the indicators of similar areas of working practice). The purpose of this stage is testing the knowledge, skills, and qualifications of employees that are needed to perform a certain job.

The fourth stage is intended to monitor employees or track errors. In order to preserve new knowledge and make successful decisions, it is necessary to monitor the behavior of employees, eliminating old inefficient habits and consolidating new ones.

The application of Dekker's method makes it possible to analyze and investigate the impact of the human factor on the efficiency of the workflow, revealing whether the negative incident depends on the human and therefore whether it can occur again (Voronkova et al. 2016).

Each human error is cost-related, because it can lead to a production fault, failure or breakage of the means of production. In the worst case, an employee can be even excluded from the production process. All this leads to a decrease in the efficiency and performance of the company. Dekker's method can be an excellent means of correction and prevention, effectively eliminating the causes of human errors. An important aspect of the implementation of Dekker's method is the motivation of all employees. The desired success cannot be achieved without motivation and commitment of employees.

The application of Dekker's method also has positive impact on the awareness of both parties, i.e. workers and management, concerning the causes of errors. Employees, who are aware of the impact of errors on the result, and not just measures to prevent errors, are motivated to work effectively in order to improve the safety and efficiency of the company operation. This brings mutual benefit to both the company and the employee. Knowledge and experience of the employee in ensuring safe working conditions guarantee high quality of production. Reducing risks in the work environment (in particular by Dekker's method) increases the feeling of safety of all employees.

4. Conclusion

In the present work competences of employees of small and medium-sized industrial enterprises are diagnosed based on identification of the concept of competence, classification of professional competences, and identification of competences' measurement methods.

The obtained results indicate the gap among the results of professional competence testing, the level of self-diagnostics, and unsatisfactory practical results of labor activity. The reason was the influence of the human factor in the form of errors that occur not only because of the lack of individual competences of employees, but also due to interaction with stochastic factors at the workplace.

In order to minimize the impact of human error on the efficiency of the working process, it is proposed to use Dekker's method. The application of Dekker's method is substantiated,

especially when obtained data show that the analyzed error appeared due to the fault of the human. The application of this method is useful for determining the exact causes of errors and the exact choice of corrective or preventive measures. As a consequence, it is possible to reduce the number of errors of the employees. This will increase the efficiency of business and level of occupational safety. Dekker's method also can be used in complex human-centered systems, where human performs several roles simultaneously.

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