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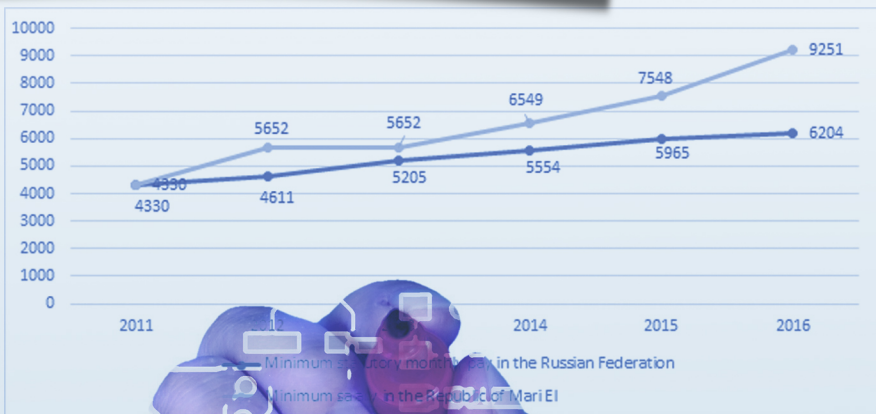
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Artificial neural network in the development of tests to evaluate the psychophysiological state of a human

Delegation of authorities as an effective tool of organisation management

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Innovative enterprise activity analysis

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Labour safety as the element of economic safety of a working person



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## ARTIFICIAL NEURAL NETWORK IN THE DEVELOPMENT OF TESTS TO EVALUATE THE PSYCHOPHYSIOLOGICAL STATE OF A HUMAN

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**Summary:** *In this document, we make an analysis of the possibility of using neural networks in the development of tests to evaluate the psychophysiological state of a human. Also, in this paper, the developed system of psychophysiological diagnostics is presented. This system will automate the execution and processing of results of the express testing methods for evaluation the psychophysiological state.*

*The described model of evaluation the human's psychophysiological state using a neural network has the following advantages: remote diagnostics, stability and accuracy of the results, the ability to self-training by detecting complex dependencies, identification of typical trends for people of a certain profession or in a particular area.*

*It has been proved that the usage of neural networks for processing the results of psychophysiological tests will improve the accuracy of diagnosis.*

**Keywords:** *diagnosis, human physiological state, physiological tests, decision-making support, neural network.*

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## 1 INTRODUCTION

Nowadays, psychophysiology has a lot of methods and tools for evaluation of the human psychophysiological state. This branch of psychology is rapidly developing and adjusting under the ever-changing requirements. The results obtained from psychophysiological diagnostics are used in different fields of human activity, ranging from career counseling up to monitoring the condition of the person prior to admission to work. The tools used for diagnosis have come a long way from the old techniques with paper blanks and patient monitoring to hardware and software systems and mobile applications. One of the ways to improve the quality of diagnosis and the search for new patterns is the use of neural networks.



An analysis of the use of neural networks for medical diagnosis has given the following result: in many cases, neural networks have been able to diagnose the disease two times more accurately than the expert. Using of the neural networks has a few significant advantages, such as:

- The ability to conduct remote diagnostics, which is quite an important criterion for a lot of people who do not have the opportunity to visit a good specialist;
- The stability of the diagnostic results, regardless of the expert mood and interpersonal interaction;
- The ability to find complex dependencies in an input data.

It is proved [4], that the use of neural networks has a number of drawbacks. For example, a neural network can inherit specialist's knowledge gaps if they are into the training sample. Consequently, the high quality of input data is vital. Accordingly, using data obtained from several experts in different (but related) profiles, we can assume that the neural network will diagnose more accurately than the average medical consultant.

The purpose of this paper is an analysis of the existing solutions that use neural networks in medical diagnosis and attempt to use one of the considered models for the evaluation of human psychophysiological state using the data obtained from the developed tests.

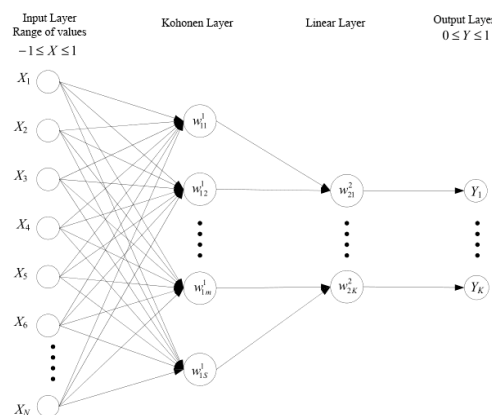
## 2 USING NEURAL NETWORKS FOR SOLVING THE PROBLEMS OF MEDICAL DIAGNOSTICS

### 2.1 An analysis of the applications of neural networks for the diagnosis of myocardial infarction

Neural networks are used for medical diagnosis because each person has a unique, specific set of peculiarities. This makes it difficult to develop a universal method of diagnosis for all people. The approach of using neural networks in this case allows to increase the accuracy of diagnosis, as compared with the results obtained by using amplitude-time methods [3]. In a training sample, the final estimate of psychophysiological state was based on the solutions of several experts, according to the majority decision. Every decision can correspond with two propositions:

- Suspected myocardial infarction;
- Signs of a heart attack are not detected.

Learning Vector Quantization (LVQ) Neural Networks has been used for implementation of this analysis.



**Figure 1 - The structure of the LVQ Neural Networks**

The value of the output signal of the *LVQ* neural network determined by using this formula:

$$Y_k = F_{lin} \left( \sum_{j=1}^S w_{jk}^2 \cdot F_{compe} \left( \sqrt{\sum_{i=1}^N (x_i - w_{im}^1)^2} \right) \right)_j \quad (1)$$

where  $x_i$  –  $i$ -th element of the input vector,  $w_{im}^1$  –  $i$ -th element of the vector of weight  $m$ -th neuron in kohonen layer,  $w_{jm}^1$  –  $j$ -th element of the vector of weight  $k$ -th neuron in linear layer,  $F_{compe}$  – the function of kohonen layer,  $F_{lin}$  – the function of linear layer,  $N$  – the number of elements in input vector,  $S$  – the number of elements in the kohonen layer,  $Y_k$  –  $k$ -th value of the output vector.

## 2.2 An analysis of the applications of neural networks for the recognition and expression of emotions based on physiological parameters

The necessity of using neural networks [2] is due to the complexity of the relationships between physiological and psychological states, which are based on the interaction of the various systems of the body and are characterized by non-linear and multi-layered structure.

To display the relationship between physiological and psychological states, the neural network with backpropagation method of training was used. This neural network is composed of several layers of neurons, wherein each neuron of layer  $i$  is connected to each neuron of layer  $i + 1$ . In this case, three layers have been realized:

- The first layer contains basic physiological parameters;
- Second – physiological functional systems;
- Third, depending on the first two, the cognitive and regulatory abilities.

Twelve factorial estimates calculated from the primary physiological parameters are used as input parameters. The rhythm of the front and lateral cortex of the brain, the reactivity of the nervous system, vascular reactions, changes in blood pressure and other emotional pressure are examples of physiological parameters. Parameters of the emotional competence are the output data. The relationship between physiological parameters and varying functional system was revealed during the analysis of the model of the neural network, that will accordingly formalize the diagnosis of emotional competence, taking into account the physiological characteristics.

Diagnosis of psychological indicators using physiological parameters with help of neural networks promotes the creation of an instrument to consolidate existing psychological and physiological methods of diagnosis psychophysiological state [2]. To date, the problem lies in the fact that the physiological and psychological techniques were developed in isolation from each other without considering the relationship of psychic and physiological systems of a human. The use of neural networks for solving this problem would integrate the existing psychological and physiological methods of diagnosis of psycho-physiological state of a human. In this case, Backpropagation is used for training of neural network. One of the improvements of this model is the method of steepest descent at the training.

## 2.3 Using neural networks for diagnosis of psychophysiological state of a human

Successful using of neural networks in the field of medical diagnosis was the basis of research on the use of neural networks for the classification of psychophysiological states, using data that was obtained from psychological tests.



The system of analysis of a psychophysiological state of a human contains a set of tests of a different kind for identification of psychophysiological characteristics of a human. To date, the system has two psychophysiological tests: the reaction to a moving object and a tapping rate.

Designed reaction to a moving objects test suggests that the subject will respond at the moment when the moving object crosses fixed marks as fast as possible. Initially, the test was used to determine the ratio of excitation and inhibition processes. Prevalence of correct answers indicates a high functional condition of the nervous system, the high number of outrunning errors proves the predominance of excitation processes, and a high number of lag errors shows predominance of inhibitory processes. Realized test also helps to evaluate the functional asymmetry of the human brain.

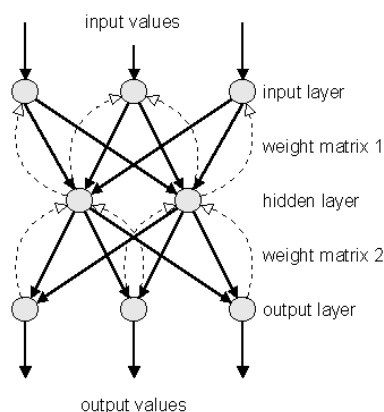
The tapping rate is used to identify the strength of the nervous system of a human by analyzing their psychomotor performance [1]. This test monitors changes of the maximum rate of wrist movements and provides the following data for the analysis: number of errors, the average time of pressing, the duration of the test, the number of taps every five seconds.

To collect statistical data, a sequence of five experiments with pupils from sports school and students has been conducted. A total of 30 people were tested. The age of subjects varied from 14 to 22 years of age. The final decision on the psychophysiological state of a human is based on the assessment of several experts. The resulting experimental data is a training set for the neural network.

Let's determine the number of neural networks. Since each test involves a different dimension of the input vector to the neural network and is used to determine a different number of psychological parameters, it is advisable to use the number of the neural networks that is equal to the number of tests. Also, unique parameters of each individual test should be taken into account during the training.

## 2.4 A generalized description of the neural network to process the results of various psychophysiological tests is offered

The neural network that was discussed in details in [2] was implemented to solve this problem. This neural network is a multilayer backpropagation network. For each of the tests, we established its own neural network, because the dimension of the input and output vectors are different.



**Figure 2** - A multilayer neural network with backpropagation error and one hidden layer

An example of the input and output vectors for neural network used to process results of reaction to a moving objects test is presented here. Six test results are given to neural network. Results contain 2 parameters and 16 discrete values. Here is an example of one of this test results:

- The velocity of the object 100 pixels/sec;
- Direction of the object: from left to right;

- Difference between the position of the label and the fixed object (15 values): -1, -4, -3, -3, -4, 5, -3, -4, -4, -3, 1, -4, 0, -6, -2.

Thus, the dimension of the input vector  $N = 17 * 6 = 102$ .

The neural network is able to identify the following properties of the human nervous system:

- Strength of the nervous system: strong / weak;
- Functional asymmetry of the brain: the left / right / not expressed;
- Ratio of excitation and inhibition: excitation / inhibition / balanced.

The dimension of the output vector  $K$  is defined as a composition of the number of options and the count of values of each of the recognized properties of the nervous system; and is equal to  $K = 2 * 3 * 3 = 18$ .

### 3 CONCLUSIONS

The article shows that neural networks are an effective tool for the study of a stochastic system, such as a person. The usage of neural networks in the psychophysiological diagnostics improves accuracy by identifying the hidden relationships between different human systems. It is worth to remember that the psychophysiological state of a person depends on many factors such as physiological condition, emotional area, behavioral sphere.

This hierarchy corresponds to a multilayer structure of the neural network shown in Fig. 2 and has the following properties:

- The presence of a non-linear relationship between the first and last layers can determine the number of layers and the number of neurons in each layer.
- Each intermediate layer represents one level of the system and is interpreted separately.

The ability to use the neural networks for processing the results of psychophysiological tests was confirmed with the help of a generalized description of the neural network, and examples of input and output vectors for processing results of the reaction to moving objects test. Thus, it justified that the use of neural networks for the processing of the results in the developed tests will improve the accuracy of diagnosis.

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## DELEGATION OF AUTHORITIES AS AN EFFECTIVE TOOL OF ORGANISATION MANAGEMENT

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**Summary:** *The paper describes the features of delegation of authorities in construction industry. Potential capabilities of organizations using decentralization experience in decision-making are described. It is concluded that the process of delegation of authorities in a staff management system of a modern construction organization must take into account the peculiarities of construction industry, its current challenges and global trends in the development of approaches to staff management and delegation of authorities.*

**Keywords:** *staff management, delegation of authorities, effective management, construction industry staffing*

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## 1 INTRODUCTION

One of the trends of modern society transformation is movement to intensive information development. Growth of information sector complicates the procedure of effective administrative decision-making. Thus, the process of delegation of authorities is becoming currently important in decision-making management. Besides, the focus on an effective utilization of scientific and technical, investment and financial resources is necessary for concentration on the structure of the companies which are characterized by reduction in the levels of management, general decrease of the number of top and middle managers with simultaneous improvement of staff quality.

## 2 OBJECTIVE OF THE RESEARCH

consists in disclosing the essence of delegation of authorities in managing a construction organization from the view point of various methodological approaches and formulating an integrally built toolkit in the context of economic theories possible to be applied to the process of solving the problem of a construction organization development.

According to the strategy of social and economic development of Russia till 2020 the basic element of modern economy modernization is an innovative development of the country as well as effective functioning of enterprises based on the development of the mechanisms of self-

regulation and mental potential of organizations. Construction industry which is a constituent and most important part of economic system is intended to solve many problems of social and economic development of the country as a whole. New requirements to competitiveness of construction organizations put forward modern trends of development from the view point of self-regulation. Major factors for quality assurance of production at the enterprise level are as follows: material resources, qualified staff, material and technical facilities and the enterprise management efficiency aimed at the production to meet quality requirements. Each of these factors is necessary, but they can be sufficient for stable functioning of an enterprise only in aggregate.

It turned out that only 15-20 % of quality problems are the fault of the workforce and 80-85 % are caused by top managers of companies. One of the key parameters influencing product quality as a whole is quality of a staff management system. Quality of building production grows out of all previous work done by the company. It concerns, first of all, quality managerial staff, functions of quality and decisions on quality management. Thus, revealing and development of competence of leaders in modern organizations is a problem to be solved, taking into account current requirements to company management efficiency.

As a whole, the trends of human resources management are global and are characterized by the search of leading organizations in the sphere of formation of effective systems of implementation of their both creative and productive potential. The theoretical basis of the new concept is considered to be recognition of not only economic utility but social value of human resources which development requires the same investments as in other kinds of economic resources.

For the enterprises using vertically descending organizational structure the majority of innovative decisions are more likely made on the basis of emotions and policy rather than on the basis of the information available and logics. In the situation given, the skills to create unions, to gain support of top-managers, as well as to redirect the process of managerial decision-making to the most convenient direction are becoming most necessary and highly demanded. In this case information becomes supporting for making a necessary political decision. Frequently, top-management considers revealing drawbacks in checking the reliability of information to be the basic task.

The fact that companies pay more attention to the process of functioning and activity rather than to the end result negatively influences the situation. In such realities, the result is in the increase in the time necessary for decision-making at corporate level, decrease in the degree of responsibility for the decision made and promotion of non-risky offers. At present, the situation is unfolding, when the importance of the process of delegating authorities and conditions required for the growth of its efficiency are overlooked. Many top-managers failed in the very moment of their organization growth.

Considering delegation one of the basic elements of organizational structures management creation, it is necessary to find an optimum allowable ratio of principles of centralization and decentralization depending on such factors as the size of the enterprise or the organization, the "know-how" used, and the existing environment. It is necessary to consider the decision-making process at the lowest levels so that it supplemented the system of a higher level management and was a component of the decision-making processes occurring daily.

If the process of delegation of authorities is based on the principle of decentralization, the process of managerial decision-making is downwarded to the managers closely connected with certain problematic situations. In case of denying the stereotypes of centralization, when instructions are delivered from the top level through the system of commands and control, and transition to the collective decision-making and problem-solving, the conditions for integration of functions are created and the basis for adaptation of structures to changing conditions of both external and internal environment is formed.



The experience of decentralization in organization management structures testifies to a lot of advantages of such organizational reconstruction. Implementing flat organizational structure arises more conditions for perfection of professional skills of managers of various levels, significant growth of creative nature of administrative work, and preconditions to bring one's own contribution into the growth and development of the organization.

Nowadays, the system of effective non-formalized communicative channels and procedures of communication with people is acknowledged. The most part of the employees of an organization are ready to work better and more effectively provided that s/he is given an opportunity to take part in solving the problems related to their work.

Accumulation of information and working out advice can be useful when delegating authorities to lower levels of management without allotting corresponding resources to them. A higher degree of decentralization assumes transfer of decision-making to lower levels of management and is based on the condition that various organizational functions are significantly influenced by the decisions made at lower levels. Reduction of an administrative distance between the levels of management is typical of flat organizational structures with maximal decentralization under the condition of professionally trained managers.

It is necessary to take into account, that decentralization is not a synonym of control cancellation. The organizations with smaller number of managerial levels and wider scope of control systems are finally faster and more adaptive than centralized structures. One of the main and basic preconditions of productive delegation is well organized control over the results of the work. Before delegating the responsibility and powers for solving any problem it is necessary to understand the results to be awaited from the subordinates and when exactly those results should be submitted.

Frequently, delegating authorities appears ineffective and unsuccessful due to the difficulties of overcoming such properties embedded in the model of human behavior as fear for the status and position, fear to take risk, lack of self-confidence, lack of ability to entrust somebody to execute certain tasks which you are personally responsible for. In most cases leaders prefer to employ people who seem their own reflection to them. In such a situation there is high probability that the process of delegation the authority 'adhered' to the nature and style of work of the executor and the manager will be inefficient. The process of delegation of authorities depends in most cases on the ability to adequately perceive new ideas, readiness to delegate decision-making on some problems to lower managerial level, as well as the ability to trust workers and aspirations to carry out general control of the tasks being fulfilled.

Increase and growth of a social role of a person along with complication of technical and economic operating conditions of organizations determine the necessity of transformation of personal methods of decision-making to group ones, keeping the principle of hierarchy. Great uncertainty of external and internal environment increases the desire of the organizations using non-routine methods to the process of decentralization and the necessity of delegation of authorities for decision-making.

Before delegating the authorities it is necessary to classify the problems facing the organization, form the list of powers which can be delegated, calculate probable risks and benefits, and define the skills level and moral and psychological qualities of the workers. The primary goal of the leader is not to perform the work himself, rather to organize the working process with the capabilities of the organization staff, take the responsibility upon himself and apply the authority for achieving goals and tasks set. In turn, the process of delegation of authorities allows the employee to use his knowledge and experience effectively showing the leader his competence in view of knowledge and skills. The efficiency of this process will in many respects be defined by the ability of the leader to transfer a part of his powers, which requires corresponding skills, psychological readiness to trust the subordinates decision-making on the tasks delegated.

It is necessary to note, that delegation of authorities possesses some advantages:

- impose a leader with dealing with the problems of a high level;
- allows to reveal the potential of an employee, namely, his abilities, knowledge, skills and qualifications;
- forms synergy effect and additional motivation of employees;
- allows to keep the personnel in the organization;
- subordinates are capable to execute some kinds of work better than their leader.

It is necessary to take into account that not all problems can be delegated to employees easily. There are a number of specific tasks which can and must be carried out by a highly skilled manager only (Tab. 1).

**Table 1 - Authorities delegated and tasks for independent decision-making**

Subject to be delegated	Not subject to be delegated
Everyday routine work	Making important decisions on the development of the organization policy
All types of preparatory works	The control of results performance
Small side issues	Problems of strictly confidential nature
Highly specialized activity requiring certain qualification	Staff management and motivation
Urgent but not important work (see Eisenhower matrix)	Highly important tasks
	Highly risky tasks
	Unique, exclusive, unusual cases
	Urgent current cases which do not leave time for explanation and control

Utilizing Eisenhower matrix (Fig.1) in the practice of management and delegation of authorities allows top- and medium-level managers to efficiently plan the time and determine the tasks that could be successfully delegated to subordinates to be solved. This requires distributing of all the tasks for the time line to come, either a day or a week, among four cells of the matrix. This given, to improve the efficiency of work, all the tasks and works in the cell “urgent / not important” should be delegated to the subordinates of the organization.

**Figure 1. Eisenhower matrix**

	URGENT	NOT URGENT
IMPORTANT	Urgent / important Urgent current cases which do not leave time for explanation and control	Not urgent / important Strategic cases Need pre-planning
NOT IMPORTANT	Urgent / not important You are a manager – it is necessary to delegate these authorities to your subordinates	Not urgent / not important You may forget about these cases Nothing serious will happen if you do not do them

### 3 CONCLUSION

It is necessary to understand distinctly that delegation of authorities is not the tool of avoiding one’s own responsibility. For the delegation of authorities to be effective it is necessary to analyze the authorities delegated and the responsibility laid. Leaders should

delegate such powers to the employees of the organization which are sufficient for performing all works and tasks they made themselves responsible for. In turn, this does deprive the supreme official of the responsibility for the actions of all the subordinates. The given form of division of labor of a top-manager facilitates considerably the work of a leader, but leaves him a duty to make the final decision.

If the process of delegation of authorities is carried out in full correlation with the results expected and unequivocal distribution of all powers and personal responsibility among the bottom levels of management, this will be the best way to increase the efficiency of managerial decision-making by the heads of various departments of the organization. Unfortunately, in practice the given principle of conformity is broken frequently, resulting in refusal of workers to accept additional powers. In this case initiatives which are connected with the efforts on 'erection' of mutual relations, pointing out the main task, clear comprehension of the essence of division of powers, duties and responsibility will act as the guarantor of correct decision-making.

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## DETERMINANTS OF INTERREGIONAL DIFFERENTIATION IN RUSSIA

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**Summary:** *The main factors of spatial disparity in Russia have been generalized and systematized, the correlation analysis-based evaluation of their impact on the territorial disparities between the regions of Russia having been conducted.*

**Keywords:** *interregional differentiation, spatial disparity, factors of spatial disparity, spatial development theories.*

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## 1 INTRODUCTION

The economic development of countries and regions features different rates of economic growth. Uneven economic growth is the source of inter-country and interregional disparity. A certain level of interregional disparity can be viewed to be quite admissible as long as it does not hamper the country's economic growth as a whole. We observe an unprecedented level of interregional disparities in average gross regional product (GRP) in Russia: this level for the developed countries is exceeded 1.5-2 times and the one for China 1.2 times [1, 2]. Such interregional disparity is becoming a hindrance for sustainable economic growth and a severe challenge for Russia. The Concept of Long-Term Socio-Economic Development of the Russian Federation for the period till 2020 says that the solution to the interregional disparity problem is a strategic priority of the state regional policy [3]. Investigation of the factors and causes of spatial inequality and its interrelation with economic growth is an essential element of the main courses of spatial development of Russia.

The aim of the study is to analyse, identify and summarise the factors governing the spatial disparities in Russia and to evaluate their course impact and effect on interregional disparity.

## 2 DATA AND RESEARCH METHODS

Inequality in Russia is assessed with the statistical data on 83 subjects of the Russian Federation (except the Republic of Crimea and the city of Sevastopol). The total interregional disparity was calculated using the first Theil index, assumed according to per capita gross regional product. The component of Theil index is the characteristic of disparity for each region separately, the contribution of each region in the overall disparity being highlighted (1, 2).

$$I_T = \sum_{i=1}^N \frac{y_i}{y} \ln \left( \frac{y_i/y}{\bar{y}_i/p} \right) = \sum_{i=1}^N R_i, \quad (1)$$



$$R_i = \frac{y_i}{y} \ln \left( \frac{y_i/y}{p_i/p} \right), \quad (2)$$

where  $I_T$  is the first Theil index;  $R_i$  is a component of Theil index for the  $i^{\text{st}}$  region;  $N$  is the number of regions;  $y_i$  is Gross Regional Product of the  $i^{\text{st}}$  region;  $y$  is the country's GDP;  $p_i$  is the population size of the  $i^{\text{st}}$  region;  $p$  is the population size of the country.

### 3 RESEARCH RESULTS INTERPRETATION AND ITS ANALYSIS

The analysis of the factors of spatial development is paid much attention to in the regional researches. Those factors accelerate or slow down the economic growth in the certain local areas, thereby initiating the process of convergence or divergence of regional economies.

The neoclassical growth theory accentuates the role of labour, capital and technological progress. The cumulative growth theories address the process of growth centers formation, the rise of agglomerations and central places, the phenomenon of innovations diffusion, the center-periphery development and their impact on the regional development. Myrdal's concepts, Perroux's, Boudeville's concept of growth poles, Friedman's center-periphery theory, Richardson's urban agglomeration theory, Hägerstrand's model of diffusion of innovations should be noted among the cumulative growth theories.

Krugman - the founder of the new economic geography [4] - distinguishes two groups of factors. Factors of the first nature are a geographical position and availability of natural resources. Factors of the second nature are human capital, institutions, the level of infrastructure development.

The report of the World Bank of 2009 dedicated to the new view of economic geography, emphasises the 3D Theory: Density, Distance, Division [5]. The factors of the spatial development are density of economic activity, reduction in the distance between economic agents and markets and differentiation between countries and within countries due to natural, cultural and political barriers. All these factors are considerably influenced by the market forces: agglomeration, migration, specialisation and trade.

Fujita, Krugman and Venables note that globalisation and trade can speed up or slow down the spatial development [6]. The impact of globalisation on the spatial development is similar to the influence of domestic trade. Some regions may receive more revenue from foreign trade, therefore, international trade can accelerate spatial development. Foreign trade stimulates spatial development. Regions and cities rich in natural resources for export or natural advantages due to the vicinity to rivers, coastal areas and transportation networks benefit from foreign trade while the remote regions do not derive any benefit.

Rodrik divides the factors of spatial development into the 'direct' and 'deep' ones [7]. The factors of production (physical and human capital) and productivity are referred to the 'direct' factors. The 'deep' factors include foreign trade, institutions and geography.

Institutions affect the economic growth. Regional differences in the quality of institutions can also significantly affect the economic development of the region within the country. Economic institutions establishing the rules in a society influence the level of transaction costs, which economic activities are related to, determine the degree of risk and uncertainty. In addition, the political institutions that determine the distribution of power and financial resources between the federal, regional and local authorities can play an important role in the regulation of spatial disparity [6].

Spatial development is affected by the political institutions in developing countries. Property rights are easier to establish and protect in the cities, where the courts and the legal system are accessible. In addition, political corruption and instability may impede the urban development, when taking bribes for providing access to resources, information and communications the city

authorities, cannot stop the crime. The benefits of the political status will be higher under dictatorship rather than under democracy. Federalism or political power balance between the federal, regional and local authorities is also of importance for spatial development. A nation in the United States was formed with a weak federal government and significant political power was exercised by the states and local authorities till the second half of the 20<sup>th</sup> century. As a result, the American style of federalism accelerated the spatial development [8]. On the other hand, many Latin American countries were established having a strong federal government but weak local authorities. The Latin American style of federalism has exerted considerable influence on spatial development.

The Russian scientists - the participants of The Consortium for Economic Policy Research and Advice - have identified the following determinants of spatial development [9]: the climate of the region, the presence of seaports in the region, the agglomeration effect, population migration, raw materials specialisation of the region, human capital, transportation and communications infrastructure.

The analysis of the approaches to type the spatial disparity determinants helped to systematise the factors combining them into four groups given in Table 1.

**Table 1 - The grouping of the factors influencing the spatial disparity**

<b>Geographical factors</b>	Location Climatic conditions Natural resources
<b>Economic factors</b>	Economic activity concentration Urbanization Industry specialisation Investments Innovations Trade Labour mobility Physical infrastructure Current level of economic development
<b>Social and cultural factors</b>	Human capital Standards of living Demographics Ethnic factors Religious factors
<b>Political and administrative factors</b>	Governance model Institutional environment factors Foreign-policy factors

The factors under examination include:

- The initial level of regional development measured by per capita GRP attained in the previous period by the year 2000.
- The level of urbanisation in the region determined by the proportion of urban population in the region's one.
- The size of the cities which is taken into account when the region possesses the cities with the population over 500 thousand people or does not have such cities. The factorial characteristic is a dummy variable (equal to 1 if a large city (or cities) is/are found in the region; the factorial characteristic is equal to 0 if there are no large cities there).

- The population density determined by the number of people per 1 km<sup>2</sup> on the territory of the region.
- Regional specialisation of the economy, represented by the three parameters: the volume of mineral production per capita, the volume of manufacturing activities per capita, the volume of agricultural output per capita.
- Trade measured by three indicators: the regional retail trade turnover per capita, the volume of exports per capita in the region, the volume of imports per capita of the region's population.
- Economic infrastructure, represented by the integral indicator developed by L.V. Dorofeeva<sup>1</sup> [10, p. 65-72, 185-187] and taking into account 20 indicators of four types of infrastructure: transportation, communications, trade, innovations.
- The mobility of the population measured by an increase (decrease) in the population of the region in the period of 2000-2014.
- Investments represented by the investments in fixed capital per capita of the population in the region.
- Human capital measured by the Human Development Index.
- Institutional environment evaluated by the indicator of management efficiency in Russia's regions. The indicator is calculated by the Agency for Political and Economic Communications (APEC) and the Laboratory of Regional Political Studies of National Research University Higher School of Economics for 2014 [11].

The results of correlation analysis of influence of the factors under consideration on the spatial disparity for 2014 are given in Table 2.

**Table 2 - Influence of factors on spatial disparity in Russia**

<b>Factors</b>	<b>Indicators</b>	<b>Correlation coefficients between the regional disparity component and the indicator</b>
Initial level of regional development	GRP per capita in 2000, thous. rubles	0.7
Urbanisation	Share of urban population in the region's population, %	0.3
City size	Presence or absence of cities in the region with population over 500 thous. people	0.15*
Population density	Population size of the region per 1 km <sup>2</sup> of its territory	0.71
Specialisation of the regional economy	Volume of mineral production per capita, rubles	0.29
	Volume of manufacturing activities per capita, rubles	0.27
	Volume of agricultural production per capita, rubles	-0.22

Trade	Retail trade turnover per capita, rubles	0.58
	Volume of exports per capita, dollars	0.51
	Volume of imports per capita, dollars	0.40
Infrastructure	Integral indicator having regard to the development of the four types of infrastructure: transportation, communications, trade and innovation	0.51
Mobility of population	Increase (decrease) in the population of the region for 2000-2014, thous. people	0.81
Investments	Investments in fixed capital per capita, rubles	0.41
Human capital	Human Development Index of the region	0.52
Institutions	Regional management efficiency indicator	0.27

\* the factor is statistically insignificant under 5% significance point

Such factors as population mobility, population density and the initial level of regional development (correlation coefficient being 0.7) have the highest positive correlation with spatial disparity value. Trade, human capital, economic infrastructure and investments (correlation coefficient being 0.4-0.58) have moderate positive correlation with spatial disparity. The influence of urbanisation and institutions on the interregional inequality is less pronounced (the correlation coefficient being below 0.3). Spatial disparity is affected by the specialisation of the regional economy: specialisation in mineral production or manufacturing industries adds to disparity and developed agriculture, on the contrary, restrains inequality (the correlation coefficient is negative between the volume of agricultural production per capita and evaluation of interregional disparity).

## 4 CONCLUSION

In general, higher levels of the factors under consideration, except for the volumes of agricultural products per capita, will conduce deepening of interregional disparity. In the future, the ongoing economic crisis will cause reduction in the level of some factors such as investments or turnover due to the falling consumer demand. This will entail a reduction of regional disparity. Continued growth in agriculture will also level out the interregional gap.

Currently, Russia is at that stage of economic development, when rapid economic growth simultaneously causes the growth of spatial disparity and the factors which have traditionally been viewed as growth drivers (high population mobility, high intellectual capital, advanced institutions, high level of urbanisation, etc.) enhance spatial disparities.

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## INNOVATIVE ENTERPRISE ACTIVITY ANALYSIS

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**Summary:** *Innovative business development applying new technologies is considered. Historical analysis over recent years in the field under study is conducted. The results of small innovative enterprises development in Russia are analyzed. The ways of persuading the consumer to buy the innovative product are demonstrated.*

**Key words:** *small innovative enterprise, innovative devices, commercialisation of research and development, business*

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## 1 INTRODUCTION

Several years ago we could not even imagine that there will be such a concept as innovative business. For the moment, development of new technologies has reached such heights that it is difficult to surprise somebody with a new invention in any field of activity. Herewith we shall consider an innovation to be an implemented novelty which leads to qualitative growth in efficiency of sales and processes demanded on the market and which is a result of intellectual activity of a person, his/her imagination, discoveries, and rational reflections as well. Both devices, ways, methods and marketing decisions can be innovative. Today, for the business to be successful it should be based on an innovative product. So, small innovative enterprises (SIE) based on creation of his/her own innovative device are considered by young businessmen a new qualitative round of business development.

## 2 RESEARCH METHODS

Within the framework of research the analysis of definitions, the method of analogies and a number of statistical methods were applied.

## 3 DISCUSSION

Recently the development of innovative technologies has been paid special attention to. Various funds have been created to support young talents who can help scientists implement their ideas and then receive a grant for a SIE development. Small innovative enterprises are an

important component of a national innovative system as they operate as a link between the science and the manufacture. Creation of small innovative enterprises is regulated by the Federal law of the Russian Federation N 217-Φ3 of 2 August 2009 about small innovative enterprises at higher schools.

This law was adopted approximately 10 years ago, but market transformations taking place in the Russian Federation at present managed to commercialize only about 10 % of all scientific research results. According to experts, Russia is lagging 40-50 years behind the advanced countries in this sphere. Moreover, statistical data of the all-Russia non-governmental organization of small and medium-sized business “Opora Rossii” (Support of Russia) consider that the amount of innovative enterprises abroad reaches approximately 57 % while in Russia this figure does not exceed 2 %. In such a situation the government tries to put into practice state reforms and offers various ways of coping with the challenge of innovative development of Russia, first of all, using scientific potential of higher educational institutions. Taking into account the problems facing industrial enterprises under the hard burden of reforms and sanctions from the European countries and the USA, the task of association of efforts of the science and the industry comes to the fore. This was the aim of creation SIEs at higher schools the activity of which consists in practical application (adoption) of the results of intellectual activity exclusive rights on which belong to scientific institutions. [1]

The law has been operating for several years and has contributed to the trend of development and statistics of innovative activity shown in Table 1.

**Table 1 - Basic parameters of innovative activity**

№		Unit of meas.	2010	2011	2012	2013	2014	2015
1.	Innovative activity of organizations (proportion of the organizations which implemented technological, organizational, marketing innovations in accounting year in the total number of the organizations surveyed)	per cent	9.5	10.4	10.3	10.1	9.9	9.3
2.	Proportion of the organizations which implemented technological innovations in the total number of the organizations surveyed	per cent	7.9	8.9	9.1	8.9	8.8	8.3
3.	Goods manufactured and shipped, works done and services rendered by the organization using its own forces	mln rbs	25 794 618.1	33 407 033.4	35 944 433.7	38 334 530.2	41 233 490.9	45 525 133.8
	Including innovative products, works, services		1 243 712.5	2 106 740.7	2 872 905.1	3 507 866.0	3 579 923.8	3 843 428.7
4.	Proportion of innovative products, works, services in the total amount of the goods shipped, works done, services rendered	per cent	4.8	6.3	8.0	9.2	8.7	8.4
5.	Expenses for technological innovations	mln rbs						
	In actual prices		400 803.8	733 815.9	904 560.8	1 112 429.2	1 211 897.1	1 200 363.8
	In fixed prices in 2000		101 124.6	159 745.5	183 347.5	214 641.4	218 128.3	186 263.5
6.	Proportion of expenses for technological innovations in the total amount of the goods shipped, works done, services rendered	per cent	1.6	2.2	2.5	2.9	2.9	2.6
7.	Proportion of the organizations which implemented organizational innovations in accounting year in the total number of the organizations surveyed	per cent	3.2	3.3	3.0	2.9	2.8	2.7
8.	Proportion of the organizations which implemented marketing innovations in accounting year in the total number of the organizations surveyed	per cent	2.2	2.3	1.9	1.9	1.7	1.8

№		Unit of meas.	2010	2011	2012	2013	2014	2015
9.	Proportion of the organizations which implemented ecology innovations in accounting year in the total number of the organizations surveyed	per cent	4.7	5.7	2.7	1.5	1.6	1.6

The progressive tendency of development can be observed during the whole period of research in all spheres of innovative activity. Innovations fall into four categories: technological innovations (process, product), marketing innovations, organizational innovations and ecological innovations. The proportion of the first three types of innovations grew constantly in 2010-2013. However there was a small recession after 2013 connected with global economic crisis and the beginning of imposing sanctions against Russia, but still this level did not fall below 9 %. All in all, it should be noted that the rate of speeding up the innovative processes in the economy of Russia remains low. The share of the innovatively active industrial enterprises (7.9 %) is 5-6 times lower here than in the advanced countries of Europe [4]. Nevertheless the results of the accounting year show positive tendencies, the proportion of the organizations which implemented technological innovations in the total number of the organizations surveyed increased up to 8.3 % (Tab. 1).

As to the expenses on technological innovations, significant growth is observed on the results of accounting year since 2010. The figures have increased in actual prices from RUB 400 803.8 up to RUB 1 200 363.8, almost 3 times. According to the table, the index for own-produced goods shipped nearly doubled in the period under consideration and reached the figure of RUB 45 525 133.8. We can observe the same tendency on the example of a certain area, comparing parameters not only for Russia. Let us consider the figures for the Russian Federation as a whole, for Privolzhsky Federal District and for the Republic of Mari El. Table 2 contains figures for the period of 2010-2015. The volume of innovative goods, works and services of the constituent units of the Russian Federation grows both in general and in view of the goods manufactured and shipped, works done and services rendered by the organization using its own forces.

**Table 2 - Volume of innovative products, works and services per a constituent unit of the Russian Federation**

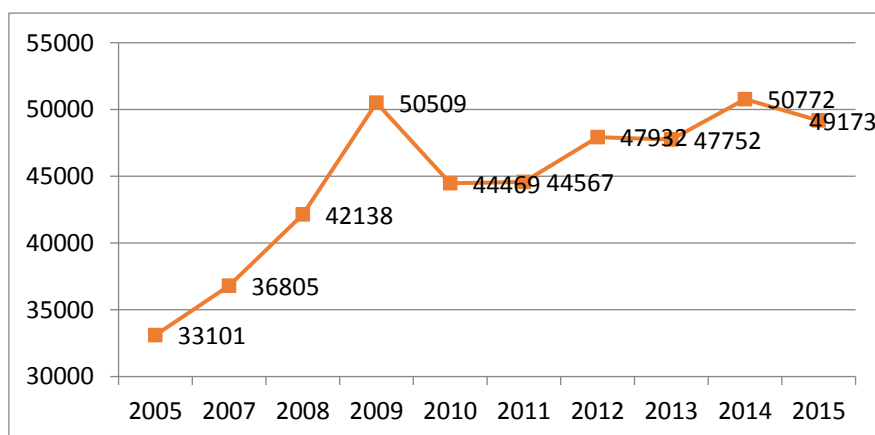
Russian Federation						
Year	2010	2011	2012	2013	2014	2015
Total	25 794 618.1	33 407 033.4	35 944 433.7	38 334 530.2	41 233 490.9	45 525 133.8
Goods manufactured and shipped, works done and services rendered by the organization using its own forces	1 243 712.5	2 106 740.7	2 872 905.1	3 507 866.0	3 579 923.8	3 843 428.7
Privolzhsky Federal District						
Year	2010	2011	2012	2013	2014	2015
Total	5 339 666.2	6 943 143.9	7 458 276.8	7 973 825.4	8 525 700.2	9 251 559.2
Goods manufactured and shipped, works done and services rendered by the organization using its own forces	545 954.9	781 944.9	950 604.8	1 128 642.7	1 179 545.3	1 198 881.4
Republic of Mari El						
Year	2010	2011	2012	2013	2014	2015
Total	56 666.9	70 335.7	79 173.1	69 828.6	95 144.3	112 662.6
Goods manufactured and shipped, works done and services rendered by the organization using its own forces	1 632.2	3 432.8	804.8	1 551.6	9 925.6	10 323.2



Over the last 5 years increase in sales volumes of the innovative goods, works and services by the constituent units of the Russian Federation has been observed. It is associated with many factors, strong support of small business development being one of them. It allows to raise innovations in Russia on a new level. First of all, the government has decided to pay special attention to higher educational institutions innovative structure and organized state programs and funds for them to take part in competitions and receive grants. Industrial lines at the existing enterprises have been modernized and equipped up to the state-of-the-art increasing the capacity of those enterprises multi-fold. Indeed, the figures for smaller areas are much lower than for Russia in general. Let us consider Privolzhsky Federal District. The volume of the own works done, services rendered and goods sold by an organization amounted to RUB 5 339 666.2 in 2010, as for the results of the accounting year they received RUB 9 251 559.2 showing noticeable growth. The Republic of Mari El showed the figures of RUB 56 666.9 in 2010 and RUB 112 662.6 in 2015, accordingly.

Meanwhile, it is necessary to note that there are cases of innovations simulation, because most enterprises prefer to invest into borrowed technologies of production rather than into their own research. This is supported by the results of regression analysis which has shown high correlation of the volume of innovative goods, works and services with the volume of investments into fixed capital ( $R^2=0.94$ ), research and development (0.92) and technical innovations (0.97), the correlation given having some features which are not typical for innovations: the relationship is characterized by linear dependence and the function reacts to the changes of argument instantly, without a time lag. This may be due to the problems with reliability of the data given by the enterprises, but it is more probable, that innovations are simulated.

**Figure 1 - Number of patents issued, pcs**



Financing of science from the federal budget is illustrative of inefficient expenditure of investment resources: constantly growing expenditures on civil science (they have grown from RUB 17 396.4 mln to RUB 437 273.3 mln in 2000-2014) and R&D (from RUB 76 697.1 mln to 847 527 mln over the same period) did not give growth in the number of patents issued (see Fig. 1). Low factor of correlation between the number of patents issued and the volume of budgetary injections into science prove low efficiency of state money spending. The bang for the buck index for technological innovations shows sensitive dynamics and a low level: each invested ruble gives a four ruble innovative production, which is comparable to fifteen-year old parameters. [3]

**Table 3 - Expenses of organizations for technological innovations, per a constituent unit of the Russian Federation**

	2010	2011	2012	2013	2014	2015
Russian Federation	400 803.8	733 816.0	904 560.8	1 112 429.2	1 211 897.1	1 203 638.1
Privolzhsky Federal District	79 303.3	165 199.9	244 103.7	284 845.9	331 308.2	300 124.5
Republic of Mari El	221.7	549.1	935.1	858.5	990.9	744.0

Expenses on technological innovations are connected with updating the equipment mainly by purchasing it abroad. Russian industry and applied science cannot provide all enterprises with modern equipment. So, significant part of financial resources of the country goes and will go annually on importing this equipment. Opening branches of foreign machine-building companies or joint ventures in Russia (e.g., motor industry) can somehow soften this problem [2].

Financial resources are also required for upgrading the equipment. Extractive industry companies possess such resources, while the enterprises of other branches of industry frequently do not. Stimulating innovative activity, it is expedient to provide sources of financing expenses of enterprises for purchasing modern, both domestic and foreign-made, equipment to modernize manufacturing process [3]. There are different ways to solve the problem. Some of them are registration of the conveyed equipment as contribution into charter capital of promising Russian enterprises, leasing development, stimulating bank investment crediting, interest rates subsidizing. Thus the problem of upgrading the equipment will be one of the basic problems for the years to come, its solution being necessary to activate innovative activity in Russia. However, this is not the only challenge for innovative business development. The recession of sales is connected with inability of SIEs to distribute and advertise their production correctly. The ways of coping with this problem and increasing sales are presented in Tab. 4. The analysis was carried out, which resulted in revealing optimal techniques having their benefits and drawbacks. Using the table, you can choose the technique ideal for you.

**Table 4 - Comparison of the ways of involving the client**

	Benefits	Drawbacks
<i>Altercasting</i>	Based on natural needs of people Desire to resemble somebody and desire to be admired	Does not affect everyone
<i>AAB</i>	Suggestion to buy with a method of denying To cause one's own desire to buy products	Confusion Consumer may reject to buy the product
<i>«Golden handcuffs»</i>	There are always favorable offers and promotional actions for the buyer	Causes suspicion about the quality of the goods
<i>«Isolation»</i>	Control of emotions and doubts of a person, concentration of his / her attention on your concrete product	The consumer does not receive enough of arguments which confirm your competence

« <i>Priority objective</i> »	Sense of something supreme, affecting emotions	Risk to go too far and disappoint the client
« <i>Stop-thinking</i> »	Instant decision-making	Works only for the first time, does not affect everyone
« <i>Lexis</i> »	Strong involvement in advertising, desire to learn something new	Negative effect is possible

#### 4 CONCLUSION

Thus, it is possible to draw a conclusion that the innovation is a change in the economy, the industry, the society, the behavior of buyers, manufacturers, and workers. The result of innovative activity is always know-how which represents, partially or in full, confidential knowledge, experience, skills, including the data of technical, economic, or administrative nature [5]. Innovative activity is one of the determining factors of business and economy development all over the world. Given modern vigorous and even aggressive rates of development of economy and business, as well as very strong competition, it is impossible to exist without constant modernization of enterprises and improvement of products. To maintain business innovative, one is required to be in trend, to keep up with the development of innovations and to understand all modern know-how as well. Innovative business is progressing, though slowly. New platforms for talents development, forums for searching young scientists are created, competitions and start-ups are held, and science towns are developed for doing research projects and their results promotion into public. Here are the organizations participating in financing small business enterprises innovative activity in the Russian Federation: Bank of development and foreign trade activities State Corporation, JSC Russian Bank of development, JSC Russian Venture Company, Fund of assistance to development of small forms of the enterprises in the field of science and technology, CJSC MICEX, all-Russia non-governmental organization of small and medium-sized business “Opora Rossii” (Support of Russia), Russian Association of Venture Investment, JSC Sberbank.

In Russia, undergoing the transition to a modern model of economic growth, the level of innovative activity is inadmissibly low for a world power. It is necessary to note, that on a national scale the effect from innovative activity is almost imperceptible. Constant and productive contacts between science and business, as well as effective national innovative system as a whole are not formed. Elimination of basic problems in the development of science, education and innovations demands essential resource and time expenses.

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## INTERACTION OF PROFESSIONAL EDUCATION WITH THE LABOUR MARKET AND THE SOCIAL PARTNERS

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**Summary:** *The effective system of interaction between the government, educational institutions of higher, secondary and continuing professional education, society, business circles, the individual in the quality assessment of the system of continuing professional education is presented. This system helps to improve continuing professional education making it more effective and relevant. Based on the current domestic and foreign institutional and methodological approaches to quality assurance of programmes of continuing professional education by means of interaction of continuing professional education with the labour market and the social partners, the system of interaction between the continuing professional education and the labour market and the social partners is proposed. The guidelines to improve that system within quality assurance programmes are given. The rationale of interaction between the continuing professional education, the labour market and the social partners within those programmes is scientifically founded. The advances to improve the quality of continuing professional education programmes are made.*

**Keywords:** *additional professional education; supplementary professional programmes; social partners, labour market, CPE quality assessment*

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## 1 INTRODUCTION

The strategy for Russia's modernization, the country's inclusion in the global political, economic, public space spot the necessity to reform the system of continuing professional education in the field of quality assurance, to bring the system into line with the requirements of the labour market, employers, educational and professional demands of citizens and to ensure the effectiveness of organizations implementing supplementary professional programmes [1], [2].

As part of the innovative development of the RF continuing professional education (hereinafter CPE) system, one of the key renewal is creation of transparent and objective assessment of the quality of educational services with the participation of consumers who are the most interested party in improving the quality of education [3].

How do we create an effective system of interaction between the state, higher, secondary educational institutions, continuing professional education, society, business circles and individuals in the system of education quality assurance? How do we make it effective and relevant? Who and what tools can and should be used to evaluate the quality of the content and implementation of those programmes [4]?

The mechanisms to assure the quality and the training standards conformity to the requirements of professional standards, industry trends and labour market requirements, standards and indicators of the accrediting institution are being developed in the procedures of

public accreditation of educational programmes. The Ministry of Education and Science commissioned the Commerce and Industry Chamber of the Russian Federation to create the system of professional and public accreditation [5].

In that way, the professional and public accreditation, from the viewpoint of the representatives of the Ministry of Education of the Russian Federation shall reflect only the interests of the industry employers being consumers of educational institutions outcomes. The representatives of professional and industrial associations lack acute shortage of qualified personnel and in this connection they are highly interested in training and actively involved in the development of approaches to elaborate institutional mechanisms of professional education quality assurance including professional and public, sectoral accreditation of educational programmes, qualifications assessment and certification, public accreditation of educational institutions [6].

The representatives of professional communities start accepting the expertise of educational programmes as an object of their activities, develop mechanisms, instruments and procedures for the expertise implementation, they now understand the essence of educational activities and approaches to the its quality evaluation [7]. Today ROSATOM State Corporation, ROSNANO JSC, the Association of Lawyers of Russia, the Russian Union of Industrialists and Entrepreneurs (RUIE), the National Association of Builders (NOSTROY), the Federation of Restaurateurs and Hoteliers of Russia, etc. are actively developing models of public accreditation of professional education programmes in the educational institutions training specialists for the respective sectors of the Russian economy.

The objective of the paper is to build up a unified view of the interaction of continuing professional education and the labour market and the social partners. This view should be aimed at bringing it into line with the labour market needs, employers' requirements, educational and professional demands of the population and at backing the effectiveness of institutions implementing supplementary professional programmes.

## 2 METHODS

Dialectical-materialist theory of knowledge was the methodological basis of the research at the philosophical level; the basic provisions of the systems approach were applied at the scientific level (V.P. Bespalko, E.F. Zeer and others); technological approach (V.P. Bespalko, N.V. Bordovskaya, V.M. Bukatov, T.A. Ilyina, and others); competency approach (A.A. Verbitsky, V.G. Ivanov, V.A. Komelin, T.V. Masharova, A.P. Tryapitsina, and others), acmeological approach (B.G. Ananyev, A.A. Dergach, K.A. Abulkhanova, and others), environmental approach (T.V. Meng, V.I. Slobodchikov, V.A. Yasvin, and others), interdisciplinary approach (S.Yu. Semenov, D.I. Feldstein, and others), cluster one in professional education (E.A. Korchagin, A.V. Leontyev, G.V. Mukhametzyanova, N.B. Pugacheva, E.R. Khairullina. and others), value-motivational approach (L.S. Vygotsky, S.L. Rubinstein, D.A. Leontyev, and others); studies of management theory in education (M.M. Potashnik, V.M. Lizinsky, T.I. Shamova, and others); methodology of evaluation (D.A. Novikov, A.I. Orlov, P. Lempinen, R. Arnold, A. Correa, A. Schelten, D. Stufflebeam and others); at the specific scientific level the methodology and theory of pedagogical research (V.A. Bolotov, V.A. Slastenin, V.D. Shadrikov and others) was applied.

The theoretical basis of the study rests on: the design and simulation of public accreditation systems theory (G.N. Motova, V.G. Navodnov, Yu.P. Pokholkov, V.D. Shadrikov and others) [8], [9], [10]; the theory of institutional methodology (S.B. Avdashev, I.A. Ashmarov, S.V. Istomin and others.); the research of quality assurance of supplementary professional programmes (N.N. Aniskina, V.G. Ivanov, E.V. Kazakova and others); general and specific scientific works on the characteristics of adult education (Yu.N. Barmin, S.G. Vershlovsky,

N.O. Verbitskaya, T.V. Masharova, V.I. Slobodchikov, G.I. Ignatyeva and others); papers on professional and continuing education and training (A.A. Verbitsky, F.N. Klyuyev G.M. Romantcev, I.P. Smirnov, E.V. Tkachenko, O.V. Tulupova and others); investigations of the formation of man as a subject of training process (V.V. Davydov, I.S. Kon, A.V. Mudrik and others).

The methodological basis of the model is formed by the systems approach as a general methodological principle of science; the conceptual foundations of professional public accreditation presented in the papers of V.G. Navodnov, G.N. Motova, V.D. Shadrikov, V.A. Bolotov, Yu.P. Pokholkov, R. Arnold, A. Correa, A. Schelten, D. Stufflebeam and others [11].

The autonomous non-profit institution National Center for Public Accreditation (Natsakkreditsentr) (Yoshkar-Ola) was the experimental basis of the research.

### **3 PRESENTATION AND INTERPRETATION OF THE OUTCOMES**

Compared with many European countries, the interaction of CPE with the labour market and the social partners in the system of professional education and training quality assurance in Russia is very low, therefore the CPE system has to find a partner being industrial, professional and public institutions aimed at conducting an independent assessment of the short programmes and thereby to produce an 'external' order.

Based on the analysis of theoretical and practical material on the quality assessment of supplementary professional programmes using the contrastive-comparative analysis of domestic and foreign practices of accreditation procedures, taking into account providers and consumers' views and all other CPE system parties concerned, the best practices in the system of CPE quality assessment and the evaluation technologies with due consideration of the Concept of Adult Continuing Education in the Russian Federation being developed, we will attempt to propose improvements to the quality of supplementary professional programmes (hereinafter SPP).

It is essential that the educational institution personnel who develop and implement the SPP, would have a common vision of SPP implementation through continuous further training in education quality evaluation and assessment technologies so that the staff will:

- be aware of the goals and objectives in the field of SPP quality evaluation stated in the legal acts;
- have an idea of the best domestic and foreign practices of continuing professional education SPP quality evaluation (Bologna and Copenhagen processes, the European instruments for evaluation of the professional education and training quality);
- be able to structure their knowledge of education quality evaluation (licensing, public accreditation, monitoring and control (supervision) of the quality of education);
- be able to apply the theoretical knowledge of regulatory and information-methodological documentation on SPP quality evaluation in practice;
- study and share practical experience on development of similar SPP and their implementation in other educational institutions of the region, country.

The employees of educational institution should be actively involved in strategic decision-making while developing and implementing the SPP; participate as members of working groups in preparation for the external quality examination of the SPP; undertake regular internship in the field of SPP quality evaluation; enhance informational support of the SPP, sufficiently apply the latest information and communication technologies for training.

It is necessary to build organisational, methodological, analytical and professional competencies with the educational institution staff for them to be prepared for CPE programmes

quality evaluation, including teachers' professional experience compliance with the specialist field:

- Buildup of organisational competency involves actualisation of objectives, mission and objectives of the educational institution in the system of educational services quality assurance, preparation of the educational institution for inspection of the quality of training, development of internal quality system and its stable functioning.
- Buildup of analytical competency includes systematisation of scientific and methodological, regulatory and professional information, preparation of analytical materials for the educational activities management in the educational establishment to improve the SPP evaluation quality.
- Buildup of methodological competency involves the application of existing regulatory documentation of training quality evaluation in the educational institution, development of methodological documentation, methodological support for the SPP quality evaluation.
- Buildup of professional competency involves knowledge of the rules and regulations, documentation, SPP quality evaluation documentation; the skill to apply theoretical knowledge for examination activity; forensic thinking, comprehensive skills for SPP examination procedure.

The administration of the educational institution should carry out the ongoing work to develop the internal examination environment by means of:

- Creating the internal examination environment to positively motivate employees to introduce changes in the educational environment (the internal examination of the programme with regard to the sectoral focus, tracking industry specifics in the structure and content of the programme;
- Buildup the staff's motivation to accept the innovations improving the quality of educational services;
- Informational openness and transparency of programmes examination procedure (internal and external one) for the staff of the institution (the official website of the university, newsletters, the accredited programmes register, expert training courses at the university);
- Assessment of methods and tools of independent and voluntary examination/accreditation of the services rendered in the sphere of education and training;
- Cooperation of educational institution with employers recruiting staff trained in the corresponding field of study (target training, employers' participation in the educational process through theoretical and practical training, internships, employment, development of curricula and discipline steering documents, participation in the programmes examination and accreditation);
- Monitoring of demand for SPP graduates in the labour market;
- Development of institutional mechanisms in the system of SPP quality assurance jointly with the consumers;
- Creation of transparent, open system for informing citizens of the educational services, the information being complete, accessible, updated and accurate;

The accrediting organisation authorized by the employers and their associations should support its official recognition in this country and abroad; have strong business reputation and enjoy the public trust; have independent status and autonomous responsibility for examination activities; for the examination quality and outcomes; comply with the conditions under which no third party (government agencies, educational establishments, ministries and other parties

concerned) could assert influence over the procedure and examination results (recommendations, and report of external panel, etc.); ensure information transparency (regularly updated official website of the accrediting organisation, the media coverage, etc.); accessibility of information and guidance papers governing examination activities (SPP examination indicators and criteria of CPE, Regulations, Guidelines, Guidance Papers, expert training programmes, etc.); transparency of the examination procedure of CPE [12].

The organisation shall have adequate facilities, financial and human resources to provide for effective and efficient work of the accrediting organisation; the internal quality assurance policy; an independent body to take decisions on the recognition of the SPP quality (Accreditation Board, Experts' Board, etc.); provide the feedback system and the aftereffects on the procedure and the outcomes of examination with all the parties concerned; develop mechanisms for institutional cooperation between the authorities responsible for quality assurance.

Public accreditation of programmes implies using motivational mechanisms for employers and social partners' participation in SPP quality assessment [13], [14].

Public mechanisms include: joint development of regulations; employers' involvement in the social partnership; government subsidies to employers providing additional training opportunities for industrial training; establishing corporate universities; setting up specialised departments at enterprises; provision of loans for running refresher and retraining courses for highly skilled personnel; allocation of state subsidies for on-the-job training; tax incentives for the enterprises.

Social mechanisms include: employers' participation in programmes elaboration jointly with the working groups; employers' involvement in coordination and examination of programmes and curricula at the stage of their development and validation; employers' involvement in the training activities of the educational institution; membership in the certification and examination boards; employers' engagement in evaluation of graduates' professional and general cultural competencies; educational institution's surveys of employers using purposely designed questionnaires; creation of the specialised examination environment; selection, training and certification of employers; institutionalisation of expert employers' activity.

In addition, it is necessary to create the motivational mechanisms recognising both material and non-material (moral) employers' contribution to the training quality evaluation. The motivational mechanisms should be based on the labour market needs and the education services market and ensure their maximum alignment; combine material and non-material interests of the labour market representatives in the quality of training; promote competitiveness and demand for educational programmes in the labour market; encourage employers to finance continuing professional training programmes (further training programmes, professional training programmes, etc.); ensure employers' active participation in board of regents of educational institutions, etc. [15].

#### **4 CONCLUSION**

Involvement of employers and social partners in the evaluation of the quality of training enhances their prestige and respect in the labour market and in the community; it provides a unique opportunity to constantly improve and to be involved both in the business process and in the academic one; it provides opportunities for career advancement through training programmes for expert training and further certification. It is important to have psychic income from the professionally performed examination which is supported by appreciation and gratitude of the educational institution.

The programmes of continuing professional education developed and implemented in the interaction between educational institutions of higher, secondary and supplementary



professional training, corporate universities, employers and their associations and establishments engaged in independent quality assessment are in demand with the consumers.

It is important to improve the motivational mechanisms for employers' social partners' participation in evaluating the quality of training, to work towards the employers' and the social partners' sense of responsibility and desire to actively participate in the evaluation of the quality of training, build confidence in the fact that their involvement is helpful and relevant for both the labour market and the educational institution. The more active employers' and social partners' involvement in the development and evaluation of programmes at the stage of students' training, the better they are taught, the less employer's effort is required to finish training or retraining, and therefore, savings in time and the employer's funds are evident.

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## KNOWLEDGE - BASED COMPONENTS OF COMPUTER-AIDED DESIGN FOR ENGINEERING HEATING NETWORKS

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**Summary:** Now there is a functional extension of computer-aided design (CAD), which allows you to implement new features. One of these solutions is the prediction of the state utilities, including heat, through the use of intelligent components of the automated systems. Functionality aimed at modeling of processes in engineering networks and objectives for energy efficiency, detection of problem areas, identify the irrational arrangement of heaters and others.

**Keywords:** CAD, intelligent components, engineering thermal networks, automation, energy efficiency, thermal physics, forecasting, modeling processes.

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## 1 INTRODUCTION

The problem of the distribution of heat in the heating elements of engineering networks, as well as detection of problem areas are now among the most time-consuming tasks requiring the use of intelligent automation components based on existing CAD. Intelligent components CAD implemented software modules using fuzzy logic, and focus on the use of the knowledge base of frame architecture [1] In the intellectual environment uses media interface (MI), the use of which there is an exception error in the calculation of heat flows and the elimination of the situation with two possible embodiments. The effectiveness of MI can be guaranteed the implementation of algorithms for classification and identification of situations, predicting their development in real time, as well as timely synthesis of actual descriptions of the behavior of the system in a variety of cases. MI is implemented on the basis of algorithms for imaging heat flow prediction of freezing the building structure, layout heaters; detect problem areas in the sewer networks, as well as algorithms to identify patterns of baseline data on the temperature readings.

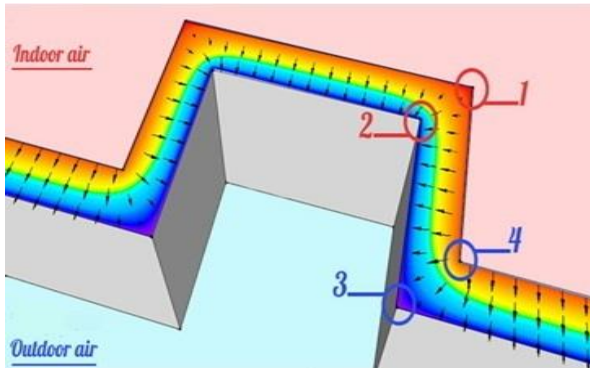
## 2 VISUALIZATION OF HEAT FLOW

### Component visualization of heat flows utilities.

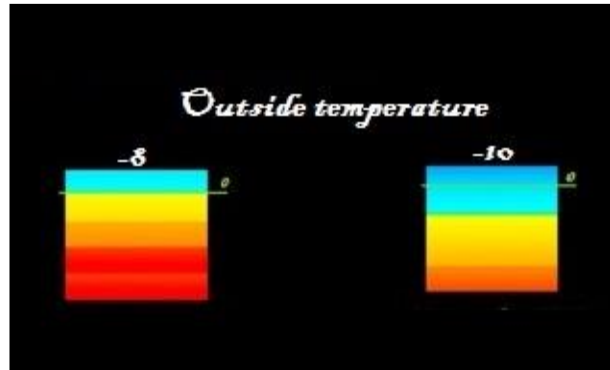
At the initial stage of the algorithm takes the form analysis of changes in the thermal circuit (TC), which is initialized in the team to change the settings. When initializing is performed to detect the temperature sensors and the formation of the data samples. Based on the temperature data samples occurs recognition situation: the presence or absence of problem zones. The

method of recognition of the situation lies in the ability to set ambient temperature conditions outside the contour, as well as granting councils in the case where the heat flux from the heater can heat the entire path. Problematic areas (PA) in this case will be considered the region in which the effect is minimal and insufficient heaters for heating engineering network or part of the air flow in the room.

Examples of imaging detection of problem areas and the colors of heat fluxes for various situations are shown in Figures 1 and 2:



**Figure 1** - Example visualization of detected PA



**Figure 2** - Examples of color imagin

The main features of the visualization is, above all, clear and easy to read color gradation heat flows shown in Figure 2. In the case of overlapping heat flows from the heater and utilities they are superimposed on each other, the result of this visualization will overlay the resulting heat flux, the temperature of which corresponds to the actual temperature in the building.

### 3 THE ARRANGEMENT OF THE HEATING ELEMENTS

#### Intelligent layout algorithm TC in CAD

The task of the intellectual component [2] CAD thermal utilities, to provide the most optimal variant layout, trace a connection with the heating unit. The final step of the algorithm is to visualize the nature of heat flow to a specific situation in view of the identification algorithm situations and decision-making. The practical use of the software module using the algorithm allows using it as the design of new buildings and the reconstruction of old ones. Identifying situations thermal circuit eventually has only two options: no problem zones (zones freezing), or their availability. Identify the main steps of the algorithm identifying situations and decision-making:

**Step 1.** On the basis of a priori constraint matrix formed with the use of IP-linear programming techniques form the principal-WIDE intervals.

**Step2.** We form the matrix of restrictions contour defining the edge-tzu to heat flow.

**Step3.** Checking matrix "code solution" to the existence of adequate solutions

**Step 4.** If a solution is found, then the operation code decides on visualization heat flow in a certain way.

**Step 5.** If solution is not found or there are several solutions (add situation), then using a probability matrix is a solution with maximum probability.

**Step 6.** If the poll matrix "code solution" unique situation, absent from, in binary code relationships memory values selected the most suitable frames sector, where it is then the criterion of confidence Eden ratifies the most suitable situation.

Thus, the selection function is implemented by the new situation of choice (code binary operations) the most appropriate sector of frames in the knowledge base. [3]

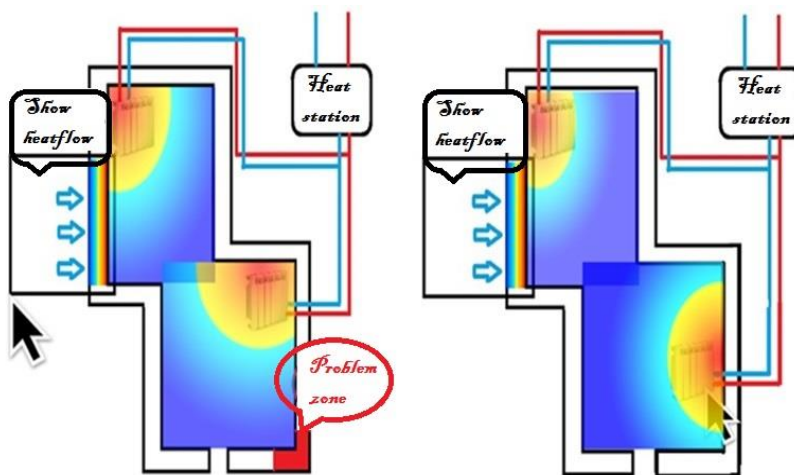
### Examples of rules in the Knowledge Base:

**Rule 1.** IF the coordinates of the distribution of the heat flow heater and the coordinates of the heat flow path of engineering networks are THEN calculate the resulting heat flow.

**Rule2.** IF the resulting heat flow at a temperature above the optimum THEN find the area of the problem area.

**Rule 3.** IF I find a problem area zone THEN build a minimal vector to the contour of utilities to find on field problem.

**Rule 4.** IF I find a problem area or problem area THEN you give a certificate of non-optimal arrangement and recompose again. Example visualization component layout is shown in Figure 3.



**Figure 3** - Eliminating problem areas using the component layout

## 4 CONCLUSION

Application of the design of intelligent components, to avoid some of the problems related to the visualization of the data in the calculation of the CAD module to reduce the error in the calculations, and to increase the visibility of the results, as well as to provide support for decision-making in the field of building automation systems. Efficiency calculations utilities can reduce the time for calculation of parameters walls and improve their accuracy, which is an important requirement in the design of buildings and structures. The need to use these components for the CAD due to the requirement to solve the problems of distribution of thermal heating elements in the IP, as well as the need for detection of problem areas.

These tasks are currently among the most intractable in the environment of poorly formalized and demanding automation applications. The complex offers intelligent components when building CAD integration will allow more accurate visualization of the heat flows via the MI. This will increase the accuracy of calculations and impact in the future on the quality of the layout of the heating elements in the circuit utilities.



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## INDUSTRIAL RELATIONS AS A FACTOR OF ECONOMIC RESILIENCE

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*Labour Economics is primarily the employers' and employees' behavior in response to the common stimuli of wages, prices, profit and non-monetary factors in the field of labor relations ...R.A. Ehrenberg, R.S. Smith [1]*

**Summary:** *Based on the foreign and domestic scientific concepts the theoretical, legal and practical issues of industrial relations, as a form of economic resilience, have been studied. The comparative monitoring survey of the social partnership development in the Russian Federation and in the Republic of Mari El helped to evaluate the regulation of industrial relations with consideration for engagement of employees in managing and distributing the business activities outcomes. The experience of the Republic of Mari El in enhancing the role of tripartite commissions to provide the employee's economic resilience in terms of wages, favorable work conditions creation, employees' life and health preservation and protection against unemployment have been summerised.*

**Keywords:** *industrial relations, economic resilience, wage earner, wages, costs of labour, labour market, labour protection, occupational health and safety.*

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## 1 INTRODUCTION

Industrial relations lay down the foundations of social stability in the society. The evolution of industrial relations development in the world lies deep and is directly related to the improvement of differentiation of labour. For instance, in the 19<sup>th</sup> and 20<sup>th</sup> centuries the development of industrial relations was accompanied by social conflicts, having been caused by the struggle of the working class for their political, social and economic rights. The research is aimed at studying the changes occurring between the subjects of employment relations and theoretical developments of such foreign experts as: W. Petty, F. Quesnay, A. Smith, J.B. Say, D. Ricardo, K. Menger, O. Böhm-Bawerk, F. Wieser, K. Marx, A. Marshall and others [2].

The authors of the concepts of the nature of industrial relations and the methods of their regulation in the Russian Federation are L.I. Abalkin, E.G. Antosenkova, S.D. Valentey, E.Sh. Gontmaher, R.S. Greenberg, R.P. Kolosova, S.G. Strumilin and others.

In accordance with the Conventions and Recommendations of the International Labour Organisation the most important lines of industrial relations improvement are the problems of organisation and costs of labour, demand and supply for labour generation, labour management and quality of living [3].

## 2 GOAL

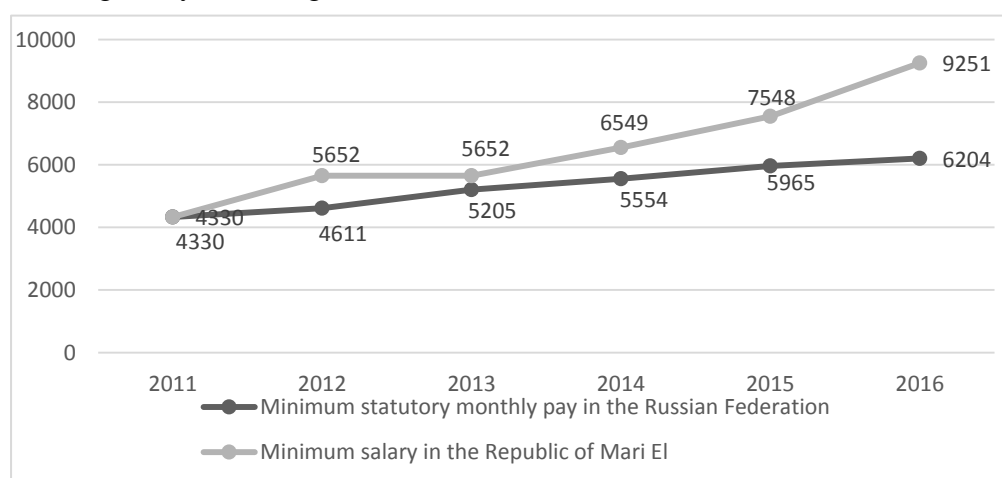
To provide the employee's economic resilience in the market economy conditions in the Russian Federation a social partnership for regulation of industrial relations is widely used. It helps to engage employees in running the enterprise and in the distribution of business activities outcomes in view of the requirements of the Constitution of the Russian Federation [4] and the Labour Code of the Russian Federation [5]. In such a way, the Russian Tripartite Commission was established and the General Agreement between the national associations of trade unions, the employers' national associations and the Government of the Russian Federation for the period of 2014 - 2016 was signed at the federal level. The Agreement covers such areas of regulation of relations as economic policy, wages, incomes and living standards of the population.

## 3 METHODS AND RESULTS

As is well-known, the centre of industrial relations is a human factor. Attaching the special importance to the employee's economic resilience in the Republic of Mari El, the Republican Tripartite Commission for regulation of industrial relations has been working since 1999. The Commission concludes the Republican tripartite agreement between the Government of the Republic of Mari El, the Union of Trade Union Organisations Association of the Republic of Mari El and the Republic's Association of Employers. Besides, 18 Republican industrial agreements, 17 regional agreements, 25 sectoral and municipal agreements and 6 other agreements have been concluded [6].

The related parties' interaction helped to solve the following problems of industrial relations in the Republic of Mari El:

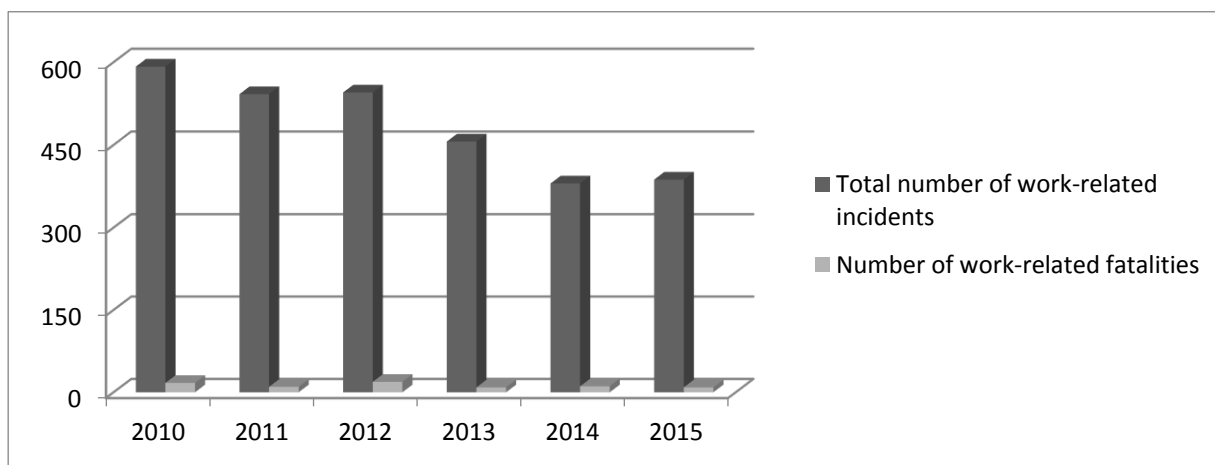
**1. Raising the minimum wage for industrial workers.** Monitoring the minimum wage dynamics at the industrial enterprises of the Republic in accordance with the above Agreement showed the wage growth by 213.6% (from 4,330 rubles in 2011 to 9,251 rubles in 2016) over 5 years. A comparison of this figure with the minimum statutory monthly wage established in the Russian Federation suggests a positive trend: from 8.7% in 2012 to 49% in 2016. If the minimum wage for the whole country in 2016 is 6,204 rubles, the minimum wage at the manufacturing industries of the Republic of Mari El is 9,251 rubles. Even after July 1, 2016 with the increase in the minimum wage to 7,500 rubles, the minimum wage established in the Republic is higher by 23% (Figure 1);



**Figure 1** - The dynamics of minimum monthly wage growth established in the Republic of Mari El and that in the Russian Federation (rubles).

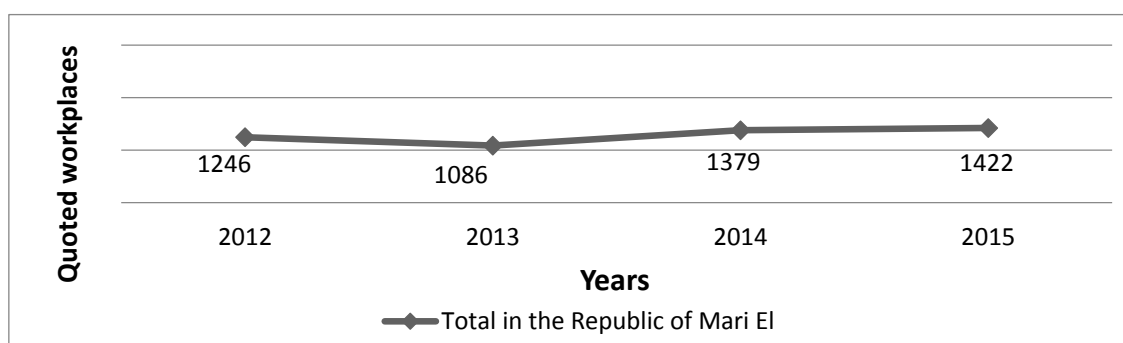
**2. Development of favorable working environment, occupational health and safety.** The focused effort to ensure the constitutional employees' right for work in conditions meeting the safety and hygiene requirements is made in the Republic.

The employers calculate the funds required for financing occupational safety measures; take action to remove from operation the equipment and facilities which endanger workers' safety; introduce innovative technologies eliminating adverse industrial environment effects; take measures to raise payments for heavy work and hazardous work conditions. This work under collective agreements helped to reduce significantly the work-related incidents, including production fatalities. If in 2010, 692 employees had on-the-job injuries, in the Republic, in 2015 this figure was 380 or by 36 percent less (Figure 2).

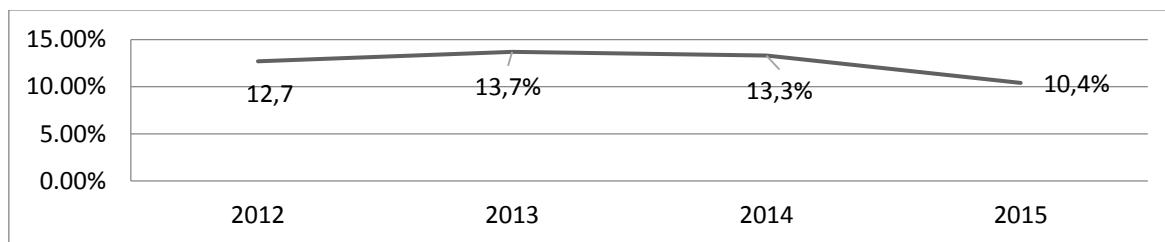


**Figure 2 - Dynamics of occupational injuries indicators, including fatalities.**

**3. Protection against unemployment.** The target programme of Promotion of Employment of the Mari El Republic's Population for 2013-2020 is successfully implemented. This programme states the quota for employment of socially vulnerable groups. In-service training for engineering staff and workers' upgrade training is provided at the large-scale enterprises. The economic conditions for entrepreneurship and self-employment opportunities are created. Further training for jobs to be in demand in the labour market is available. The expansionary measures in the Republic are taken for the employers to participate in the creation of specialised jobs for the disabled. The package of the above measures provided means for keeping the level of registered unemployment and tensions in the labour market, for increasing the number of quoted workplaces for the disabled people (Figure 3) and reducing their share in the composition of the unemployed (Figure 4).



**Figure 3 - Dynamics of quoted workplaces, pcs.**



**Figure 4** - Dynamics of the share of the disabled people among the unemployed, %

#### 4 CONCLUSION

However, the monitoring survey has shown that there are still the opportunities to improve industrial relations in order to enhance the workers' job security. According to the authors, the purchasing power of the population at the expense of the balance of salaries and wages between the managerial staff and the personnel as a whole should be increased. The Republican Coordinating Board to monitor the workers' rights compliance in the field of occupational safety and health should be established. A civilised labour market by means of its equation with the educational services market, as well as the labour demand and supply should be set.

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## LABOUR SAFETY AS THE ELEMENT OF ECONOMIC SAFETY OF A WORKING PERSON

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**Summary.** *Theoretical and practical aspects of labour safety as the element of economic safety are investigated based on international and domestic experience. The practice of regulation of the given sphere regarding the decrease of the number of injured and dead from the accidents at work at federal and regional levels is argued. The problems and their origin are revealed and the mechanisms of stimulating employees and employers are determined on the basis of social research on three categories of respondents.*

**Keywords:** *labour safety, economic safety, working person, accident at work, occupation disease*

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## 1 INTRODUCTION

Safety of a person at work is a challenge not only for states, but also for employers with reference to the results of labour activity, corresponding to the General declaration of the rights and freedoms of the person, conventions and declarations of the International Labour Organisation (ILO). Favorable working conditions in the Russian Federation act as a national principle of decent life. By the international estimations, 2.34 million people perish annually from labour injuries and occupational diseases. Daily, 5,500 deaths out of 6,300 fatal cases are caused by occupational diseases [1].

These problems are in the center of attention of foreign and national scientists, among which: L.S. Tal (labour safety within the framework of the labour right); V.J. Kanel, I.M. Setchenov (medical aid to the injured); E.I. Astrakhan (industrial traumatism); F.F. Erisman (professional hygiene).

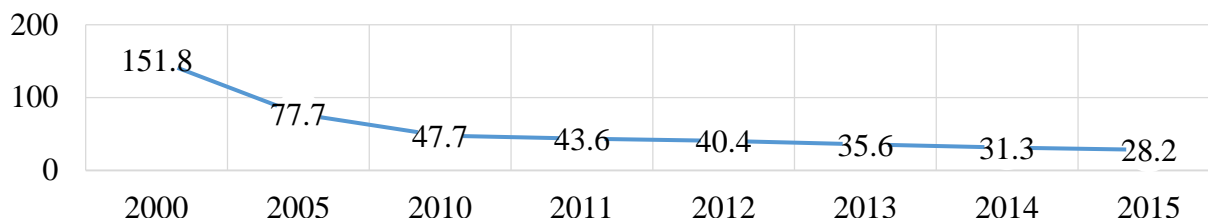
The regulations of ILO in the field of labour protection and hygiene can be classified into four basic categories: political and branch instructions [2]; special risks; protective measures.

According to ILO data, the greatest quantity of accidents occurs in France (more than 700 thousand), and the least quantity (more than 1 thousand) occurs in Iceland. Occupational diseases prevail in Greece (more than 28 thousand), and their least quantity (115) is recorded in Ireland [3].

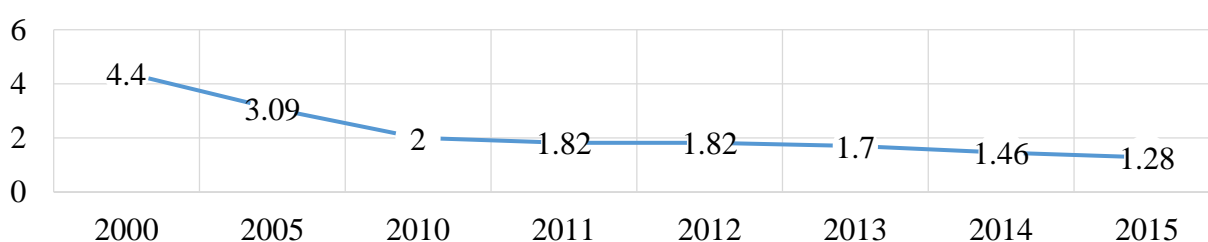
The basic guarantors of safe working conditions in Russia are the Constitution of the Russian Federation (item 37) [4] and the Labour Code of the Russian Federation (section X) [5]; the basic institute in the field of well-being of a working person is the institute of a labour safety.

## 2 METHODS

The argument for positive experience in this country is 5-time decrease of the number of injured from accidents during 16 years (Fig. 1), the number of deaths fall 3 times (Fig. 2) [6, p. 81].

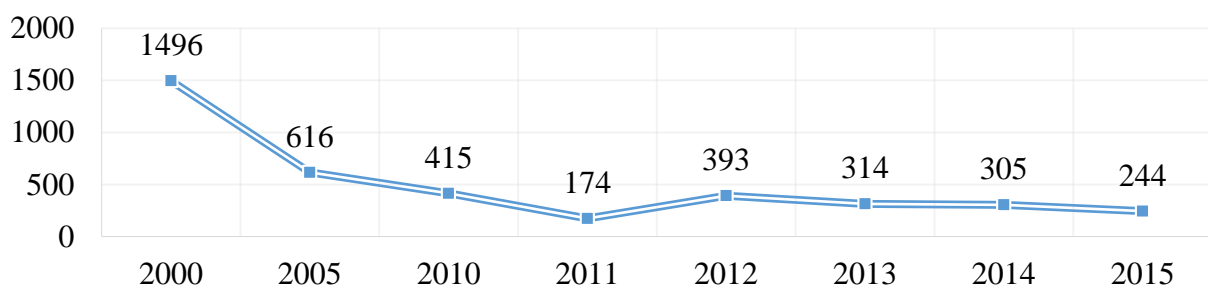


**Figure 1** – Dynamics of injured in accidents at work in Russia, thds. Persons

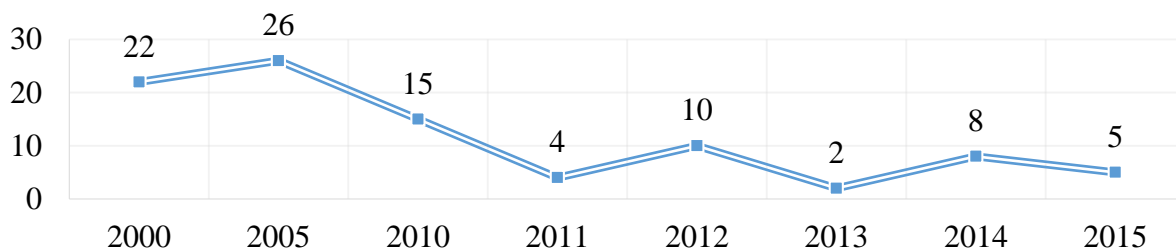


**Figure 2** – Dynamics of deaths at work in Russia, thds. Persons

Positive tendencies have developed in the Republic of Mari El as well. Thus, in 2015 the total number of injured decreased by the factor of 6 (Fig. 3), and the number of deaths fallen by the factor of 4. (Fig. 4) [6, p. 82].



**Figure 3** – Dynamics of injured at work in accidents in Mari El, persons



**Figure 4** – Dynamics of died at work in Mari El, persons

Nevertheless, the author's monitoring has allowed to reveal the problems and difficulties in this sphere: in this country each fourth workplace (24.7 %) corresponds to harmful and

dangerous working conditions, causing, on the one side, working time fund losses (more than 1.1 trn roubles), and, on the other side, decrease in gross national product to 7 % [7].

Similarly to this, every third workplace (35.1 %) in the Republic of Mari El from all the workplaces covered with a special working conditions estimation procedure in 2015 appeared to have harmful and dangerous working conditions.

### 3 RESULTS AND DISCUSSION

With a view of revealing the above-stated problems sociological research of three categories of respondents, clients of the regional branch of Social Insurance Fund in the Republic of Mari El, was carried out:

- injured in accidents,
- occupational safety engineers of large enterprises of the Republic of Mari El and
- professionals from the bodies of the state executive authority.

In the experts' opinion, the priority positive tendency existing both in Russia and in the Republic of Mari El (Tab. 1) is providing a legislative framework for economic encouragement of the employer to improve the working conditions (86.7 %). The respondents have placed second (40 %) the provision of a legislative framework for guarantees (remuneration) to those working in harmful (dangerous) working conditions and establishment of the differentiated approach in granting these guarantees.

**Table 1 - Ranging of respondents' opinions on priority directions of labour safety development**

№	Direction	Value					
		1	2	3	4	5	6
1	Providing a legislative framework for economic encouragement of the employer to improve the working conditions	86.7	-	13.3	-	-	-
2	Providing a legislative framework for guarantees (remuneration) to those working in harmful (dangerous) working conditions and establishment of the differentiated approach in granting these guarantees	6.7	40	13.3	13.3	13.3	6.7
3	Formation of the institute of special estimation of working conditions	-	13.3	26.7	13.3	13.3	26.7

All three categories of respondents consider that the basic problems are: absence of essential responsibility of the employer for adverse working conditions (53.3 %), absence of corresponding mechanisms for estimation of labour safety state-of-the-art in the environment of innovative technologies and in view of risks increase at work (33.3 %). Every second respondent (53.3 %) has noted concealment by the employer of the accidents occurred and occupational diseases (Tab. 2).

**Table 2 - Ranging of respondents' opinions on priority problems in the sphere of labour safety**

№	Problems	Value				
		1	2	3	4	5
1	Absence of the due responsibility of the employer for adverse working conditions	53.3	6.7	–	26.7	13.3
2	Absence of corresponding mechanisms for estimation of conditions of labour safety in the environment of innovative technologies and in view of risks increase at work	33.3	13.3	33.3	13.3	-
3	Concealment by the employer of the accidents occurred and occupational diseases	13.3	53.3	20	13.3	-

#### 4 CONCLUSIONS

To increase the efficiency of economic safety in the sphere of labour safety it is considered expedient to take the following measures:

- 1) to develop mechanisms of provision of economic incentives for employers to improve working conditions by perfection of the system of social insurance - matching of real working conditions and risks with the size of discounts and extra charges under insurance tariffs;
- 2) to build a preventive mechanism of health preservation and well-being of a working person;
- 3) to improve the structure of labour safety management at regional and municipal levels;
- 4) to follow risk-oriented approach in providing the safety of workers at work;
- 5) to introduce the culture of labour safety, raising the responsibility both employers and employees.

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