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FOURTH INDUSTRIAL REVOLUTION:
WHAT COMPETENCES
ARE NECESSARY FOR EMPLOYEES?

ABSTRACT

The fourth industrial revolution has considerable impact on labor market transformation — occupations, approaches to work change. Already today the success of the company in many respects depends on ability of her employees to use technologies, and in particular, to do it creatively and innovatively.

On the basis of empirical data it is analysed as far as staff of Russian companies feels influence of the new industrial revolution, what skills are necessary for adaptation in conditions of digital transformation of business, whether linear office employees are ready to technological transformations in companies and whether they possess necessary skills and abilities.

Research is conducted in three stages. Directly empirical analysis is carried out on the basis of data collected by means of questioning through a webform (selection has made among 153 persons).

It is concluded that among general skills a requirement will grow in is unique human abilities, such as emotional intelligence, creativity, skill to communicate and so on. Importance of technical knowledge increases: ability to work effectively with software, programming, general digital literacy grows. If the conditional part of "soft" skills is developed at employees at sufficient level already today, technical abilities cause concern.

As a whole, for creation of successful and competitive labor companies need to work in two directions – to form systems of training and monitoring of skills and knowledge according to requirements of market and also to advance ideas of lifetime learning, that is, continuous independent education.

KEYWORDS

INTRODUCTION

В истории скачки экономического роста сопIn history, leaps in economic growth are associated with the beginning of industrial revolutions. After widespread introduction of automation, global economic development has been slowing down for past 50 years. All this time, companies did not stand still and repeatedly attempted to find new sources of growth. For example, transfer of production to offshore reduces costs largely due to cheap labor. At one time, China was considered most popular offshore zone, but even there labor did not remain cheap for long: the average salary of a citizen of the PRC overtook Russian one already in 2015 [Skalabre O., 2018].

In 2018, World Economic Forum in Davos considered the fourth industrial revolution and its impact on business and society as one of the most important. This revolution represents development of technological progress, in which widespread digitalization takes place and a wide variety of newest technologies are introduced, causing changes in production, business processes and society as a whole.

These changes include:
- new ways of automation, which will lead to optimization of production processes and improvement of quality of products by reducing scrap, speeding up entire value chain, etc.;
- data transmission of all types in real time, which will allow, for example, to control parts of production process in real time; speed of collecting and analyzing data of all types depends on speed of response to changes in production ecosystem or to customer expectations;
- control of condition of all elements of production chain;
- improvement of working conditions, environmental friendliness of production and other areas in long term due to possibilities of precise automated control;
- high autonomy of production, allowing to reduce many cost categories.

Industry 4.0 assumes the cardinal transformation of business, which causes many difficulties, there are many obstacles for its distribution. Experts and practitioners ranked main difficulties in descending order of importance:
- lack of and scarcity of digital skills; resistance to change;
- the need for costs of change and long-term investments;
- change of business model and business culture from the point of view of internal changes (for example, marginalization of hierarchical structures that dominated for many years), greater openness to outside and consistency of relations (for example, development of supplier-buyer relations);
- data security and privacy [PracticalPathways, 2017].

Why is it worth paying attention to digital transformation of company? Today, digital technologies in general are still at approbation stage, although there are many successfully solved cases already [A. Trachuk, Linder. N. M., 2017a]. For many companies, new technologies seem to be an interesting and promising topic, but rather a matter of the future. some kind of remote one. At the same time, new technologies are creating new markets and products. Companies that are actively developing new technologies and are looking for applications are first to discover key competencies for themselves, up to a kind of "blue oceans" [see, for example: Lavrov K. I., 2017; Trachuk, 2012; Trachuk, 2013].

Progress is developing rapidly, and with it – competition too. Many companies are already successfully using components of new industrial revolution, and consequently, even more companies will take advantage of development of benefits from digital technologies. In such conditions, delay can turn into an insurmountable lag [see, for example: Levina A. M., Trachuk A. V., Linder N. V., Ubeiko N. V., 2017].

Technologies are objectively capable of improving productivity, production speed and quality of goods [Trachuk A.V., Tarasov, 2015]. Admittedly, due to direct economic benefits of Internet of Things, it allows you to optimize costs, control resources and equipment; it is most promising technology among all that are offered in Industry 4.0.

Suppliers, consumers, lenders and entire business ecosystem are tuned for change, which means that those who have not yet done so are forced to submit to general trend (see, for example: [Trachuk A. V., Linder N. V., 2015; Trachuk A. V., 2014a]). Companies wishing to preserve and increase their competitive advantages should now change along with entire business environment. One of "bottlenecks" on this path is human capital. At the same time, it is one of key parameters of a successful technological transformation. On other hand, labor market itself will change: new occupations will replace old ones, structure of employment will change, finally, there will be a need for new skills and abilities.

Digitalization affects not only industrial production. In recent years, number of devices connected to Internet has increased significantly. Thanks to online services, many residents pay bills, spend their leisure time, shop online. Accordingly, their preferences and requirements are changing, there is a demand for a completely new approach – in-depth personalization. In the future, one who can predict desires of a customer and create trends, will become the leader in business [see, for example:

Arsenova E. V., Sokolova T. Yu., 2017; Linder N. V., Dmitrieva A. I., 2016].

The largest technological and industrial giants and whole countries believe in new industrial revolution: Germany, USA, China, Japan, India and many others, where they are already reforming production to requirements of Industry 4.0.

In this study, an attempt was made to assess what competencies employees need in technological transformation of business, willingness of modern employees for such transformation of companies, and also to create appropriate tools for assessing their competencies.

DIGITIZATION AND EMPLOYEES' COMPETENCIES IN A CHANGING CONTEXT

It is very difficult to predict changes in labor market. Nevertheless, there is a widespread practice of examining main trends affecting it:
- In next 20 years, there will be a wave of technological changes that will affect both producers and consumers. Introduction of robots, artificial intelligence, 3D printing and other components of new industrial revolution will lead to spread of skills in use of digital devices among population and demand for highly qualified technical specialists.
- According to latest predictions, there is an active aging of population in developed countries. If in 2000 only 10% of world population was over 60 years old, then this proportion would reach 21% by 2050. In conditions of insignificant population growth in developed countries or, for example, in Russia, this means increased competition for human resources.
- Globalization reduces formal and informal barriers between countries in both trade and labor migration. This item is of key importance for developing countries, as the factor of technological lagging can be migration of highly skilled staff due to unemployment, low wages in the market, shortage of staff in richer and more advanced countries. This trend already exists, and most economists believe that it will continue, including attracting qualified staff to offshore. In particular, investment banks in the United States and Europe do this, hiring employees in India, and have used time difference for many years to work with skilled employees abroad, especially in India [Dromey J., McNeil C., 2017].
- By 2050, the share of urban population around world will increase from 50 to 72%. Urbanization leads to an increase in number of qualified staff, emergence of new projects, such as "smart city", and increased competition.
- Presumably, humanity will consume averagely 40% more basic resources by 2030. The threat of resource shortage and climate change are extremely relevant worldwide. The development of environmental approaches to production and consumption, research in the field of environmental safety and many related areas will require even more specialists [Pukha Yu., 2017].

Many researchers have expressed concerns about social consequences of new industrial revolution. Its peculiarity lies

in large-scale automation, for example, possibility of machine interaction without human intervention at all levels, from simple production to taking management decisions. Such properties will inevitably lead to a change in the structure of employment.

The first ones who will be left without work or will be forced to improve skills will be employees engaged in monotonous and repetitive work, as it is profitable and easy to automate. It is believed that this will happen through introduction of technologies of robotics, artificial intelligence and standardization of tasks.

K. B. Frame and M. Osborne of Oxford University have estimated that 47% of occupations in the United States are likely to be automated over next 20 years [FreyC. B., OsborneM. A., 2013]. Researchers assessed the likelihood of automation of 702 occupations; first of all, there could be replaced specialists in telephone sales, taxes, insurance evaluators, sports industry officials, waiters, real estate agents, secretaries, administrative assistants, couriers, etc. Representatives of creative, technical and social occupations will face the lowest risk, such as: social employees, choreographers, doctors, managers, highly qualified computer specialists, anthropologists, archaeologists, etc. In foreseeable future this assumption seems quite likely, but technologies are developing rapidly. In particular, today there are complex algorithms capable of synthesizing text that is virtually indistinguishable from the one what is written by human. While maintaining pace of improvement of this project by mid-2020s, about 90% of news will be generated by a computer.

For a similar study, the PWC company used additional data and an algorithm based on machine learning and came to conclusion that, with a high probability, automation will affect about 38% of occupations in US and about 30% in UK. According to OECD, figures will be about 10% in the United States and 12% in Britain [The Future, 2017].

In another OECD report almost 40 countries were analyzed, a forecast was made about disappearance of 14% of jobs, primarily for those occupations where automation is possible by 70% or more. These are about 66 million jobs, according to the study [The Survey, [s.a.]].

On one hand, presumably, with widespread automation of processes, fall in share of human labor will have a strong impact on developing countries, where technological lag is offset by low labor costs today. At the same time, production will return to developed countries, in particular to Europe and USA, and developing countries will lose their practical key resources. On other hand, automation reduces costs and aligns countries in the level of technological development. For example, not so long ago, Japan, China, South Korea were among laggards. Changed conditions can be a great incentive for qualitative development.

Another trend of changes regarded by experts is change in the structure of labor market. This transformation is due to fact that:
• New technologies will allow to automate a significant number of processes, which will lead to loss of jobs;
• New technologies create new business opportunities, and therefore create jobs.

Since the first industrial revolution, every wave of technological change has led to literal disappearance of a significant number of jobs. The loom turned out to be more competitive than home weaving, but it created jobs in factories. Many occupations being in demand today did not exist five years ago. From this point of view, experts believe that labor market will not be narrowed,

but will change its structure, compensating for decreasing in employment by increasing demand for engineering, computer specialties. The new industrial revolution will not replace people with machines, on the contrary, it is competences and abilities of people that become the key resource that determines competitive advantage of companies.

New technologies define new requirements for employees and create demand for new skills. A new digital reality will require a different set of skills [Industry 4.0, 2017]. Thus, there is a gap between skills needed for a job and actual skills that employees have. Studies show a striking degree of influence of latest technologies on nature of work [Manyika J., Chui M., Bughin J. et al., 2013].

At the end of 2017, the Deloitte company surveyed 1603 top managers from 19 countries in America, Asia and Europe and found out that: only a quarter of respondents believe that their employees are sufficiently prepared and have necessary skills to work in the future.

According to PWC survey with participation of more than 2,000 respondents from 26 countries, about half of companies consider lack of digital culture and lack of relevant competences among employees to be the main difficulty in digital transformation. There are several important aspects to this:
• New technologies allow creating new products, services, changing approach to production, that is, creating competitive advantages
• availability of technological solutions already determines place of a company in the market;
• The effectiveness of introduction of new technologies depends on employees.

Thus, according to researchers, in the future company's success in the market is determined by quality of its employees, who must have necessary competencies.

To prevent conceptual discrepancies regarding the concept of competence, approaches to definition of this term should be considered.

The concept of "competence" dominated literature on management strategy in 1990s, but does not lose its relevance today. A large study of definitions of the term and its uses in USA, UK, France, Germany [Delamare le Deist F., Winterton J., 2005] showed a multiplicity of approaches and a variety of interpretations. A similar situation is present in Russian scientific literature.

One of most concise, but capacious definitions of the concept sounds like "the ability of a specialist to solve a certain range of tasks" [Prakhova M. Yu., Zaichenko N. V., Krasnov A. N., 2015]. Generalization of expert assessment of 16 definitions of the concept under consideration contains following wording: "Competence is such a combination of knowledge, skills, habits, motivational factors, personal qualities and situational intentions, which provide an effective solution to tasks of a particular class in a particular organization at a particular workplace in a certain production team" [Bazarov T. Yu., Yerofeev A. K., Shmelev A. G., 2014].

Competences characterize how highly efficient employees achieve success. From our point of view, most successful interpretation of competence as "the ability to apply or use a set of related knowledge, skills and abilities necessary for successful performance of" important working functions" or tasks in a

particular working environment" [Krathwohl D.R., 2002].

Thus, term "competence" will be considered as a set of knowledge, skills, abilities, motivation and features ensuring successful implementation of professional tasks.

Knowledge of competencies allows you to:
• make sure employees are professional enough;
• select and hire new employees more efficiently;
• evaluate performance more efficiently;
• determine what skills and abilities staff lacks;
• provide more relevant training and professional development;
• plan career development and continuity;
• improve effectiveness of change management [Developing a Competency, 2017].

A variety of approaches is also observed when identifying types of competencies, in other words, models. The specialists of Willis Towers Watson consulting company distinguish four types of competency models:
• Enterprise models include competencies that are relevant to all employees, regardless of position or level;
• functional competencies apply to a single business function (for example, finance) or a line of business;
• role models include competences specific to role or level of organization (for example, staff manager or manager), these models are created to differentiate behavioral expectations and requirements at different levels;
• Task-based models are developed for a specific occupation, for example, a call center employee or an accountant [Developing a Competency, 2017].

When building a competency model, each of them has 3-4 indicators, that is, descriptions. For example, Teamwork competency:
• using a suitable interpersonal communication style to direct team members to a goal;
• decision-taking and other responsibilities are allocated to relevant employees;
• resource management aims to perform tasks with maximum efficiency;
• performance of tasks beyond set ones to achieve goals.

In accordance with objectives of this study, organizational models will be further considered, and partly role-playing and functional ones. For formation of competences, it is required to build a chain "goal - skill - competence". We consider the middle link, that is, skills or experience that determine functional core of competence.

COMPETENCE OF EMPLOYEES AS AN INDEPENDENT OBJECT OF THE STUDY

In conditions of fourth industrial revolution, smart machines will be able to perform many tasks that people are doing now. Then what unique human skills will be appreciated? If augmented reality gives employees access to huge amounts of data and helps in taking decisions, what should employees be so that they can fully utilize the potential of technology?

Technological changes are promoted by employees in engineering, computer and mathematical specialties since they are ones who create changes. Based on their competencies, they are responsible for creation and implementation of

technology in terms of technology itself. However, how will technological revolution affect other professional categories, in particular, office employees? Competences should be considered in relation to each particular occupation, but we can talk about a certain layer of skills and knowledge common to employees in all occupations.

The studies on impact of fourth industrial revolution focus on impact of technological, demographic and socio-economic changes on business models, transformation of employment conditions and need for skills, all of which will lead to serious problems with recruitment, training and management of staff. According to respondents, today there is a growing need for a wide variety of skills in different workplaces in different industries. Even those jobs that will be reduced will require different skills to work.

On average, more than a third of basic skills demanded in most occupations by 2020, are not considered the key to work yet. In all industries, about two thirds of respondents intend to invest in retraining employees as a part of a change management strategy and planning future labor resources. In general, contrary to expectations, social skills (persuasion, emotional intelligence and training others) will be more in demand in all industries than narrow technical skills, such as programming or operating and monitoring equipment. In essence, technical skills will need to be complemented by strong social skills.

There is a wide range of skills required in the future [The Future, 2016]. General IT skills and use of software and general programming skills are gaining importance. For employees of various specialties, it will be important to be able to handle complex information, communicate with employees and customers using new digital technologies, solve problems and be able to plan. Achieving a good level of basic knowledge of digital technologies is a prerequisite for professional development. The new environment formed by technology requires improvement of some existing and additional skills.

For example, according to analytical report by G20, there is a growing demand for non-standard analytical skills related to creativity, problem solving, communication, teamwork and entrepreneurship — all skills that help employees remain effective in face of change [A Skilled Work, 2010].

The Expert Group on Future Skills Needs [The Future, 2016], an Irish expert group, interviewed business representatives, educators, trade unionists and politicians in order to find out what skills would be needed in the future. She divided collected information into several groups: basic or fundamental skills (literacy, numeracy, digital literacy); skills related to people (communication, teamwork); conceptual/thinking skills (information gathering and organization, problem solving, planning and organization, training, innovation and creativity).

The scale of changes in production and corporate structure will lead to empowerment of employees in the field, which means that they will have to solve extremely diverse professional tasks. In addition, employees should be able to quickly adapt to change and constantly learn something new [Lorenz M., Ryussman M., Strak R. et al., 2015]. In the future, employees will need critical and creative thinking, initiative

and responsibility, adaptability, innovation, enterprise, emotional intelligence [Shmelkova L.V., 2016].

According to a study by McKinsey consulting company, more occupations will require social and emotional skills and high cognitive abilities, such as high-level logical thinking, which today are applicable only to relatively few job places. Nevertheless, company honors skills of programming and technical expertise. Even automated occupations will require a certain amount of human participation. For example, machines are capable of performing basic operations for extracting and processing information, but the demand for work requiring a higher level of analysis will continue to grow [Jobs lost, 2017].

Skills are also grouped as follows:
- theoretical skills:
  - cognitive (intellectual) skills that determine ability to learn, analyze and take initiative;
  - metacognitive skills, i.e. ability to purposefully combine different skills and critically evaluate their usefulness in a particular situation;
- non-cognitive skills:
  - punctuality,
  - reliability,
  - responsibility,
  - good faith,
  - honesty;
  - social (interpersonal) skills (ability to communicate or work in a team, ability to direct, coordinate and motivate employees);
- digital skills:
  - IT skills, i.e. using Internet, processing and exchanging information, using software and programming skills, i.e. being able to autonomously use computer programs and adjust them to user requirements,
  - digital literacy, that is, a basic understanding of how digital technologies work, what opportunities they offer and what risks they entail [Gold R., Bode E., 2017; Trachuk A.V., Sayapin A.V., 2014; Trachuk A.V., Linder N. V., 2016].

Non-cognitive skills contribute to accumulation of theoretical skills, improve readiness for learning. Lack of non-cognitive skills (lack of curiosity, determination, or self-confidence) is often accompanied by relatively low cognitive abilities.

In 2015, 45% of EU population had an insufficient level of digital skills, 21% did not have any at all since they did not use Internet. Today, about 40% of office employees using software daily do it inefficiently [Skills for a Digital World, 2016].

Thus, there are several trends:
- introduction of new technologies will require staff skills in the field of innovation, at least from the point of view of an effective user;
- ubiquitous automation gives greater importance to unique human skills (creativity, empathy) that are not yet available to a computer;
- automation will reduce work with data; nevertheless, employees will continue to perform more complex tasks of interpretation and taking substantiated decisions;

- changing approaches to workflow organization will lead to an increase in value of working skills in a horizontal structure.

Despite effect described above, many company owners and top managers are not worried about preparedness of their employees. Although most of them consider working with employees as a priority, only 22% of respondents to McKinsey study [Jobs lost, 2017] expressed concerns about impact of change on their company. Moreover, a quarter of research participants believe that their employees have sufficient skills today.

Most studies are conducted with participation of top management, owners, that is, decision takers or experts. There are relatively few studies on how line employees perceive impact of new industrial revolution on a company, what skills are important and what level of training there should be.

ANALYSIS OF LEVEL OF PROFESSIONAL COMPETENCE OF EMPLOYEES
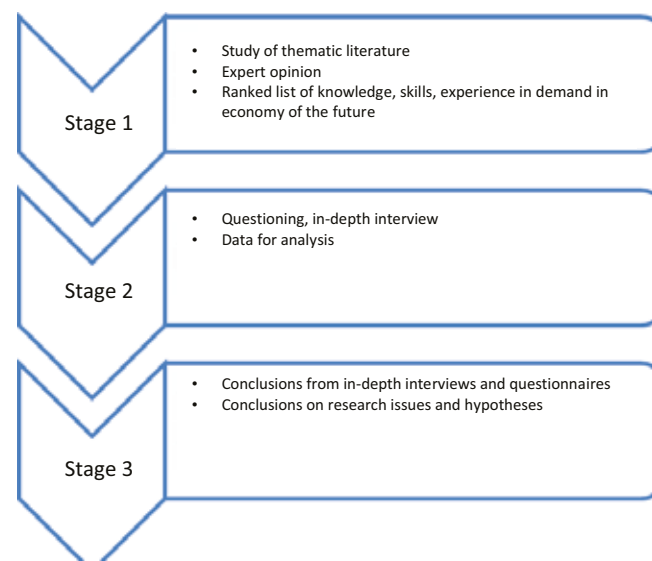
Methodology of the study

The following questions were raised herein:
- Do most line employees of Russian companies feel influence of the new industrial revolution?
- How do they assess prospect of entering into it in coming years.
- What general skills of line employees will be required: personal, technical ones or a combination of them?
- Is line office staff ready for technological transformations in companies where they work?
- Do they have enough skills and experience which are potentially most in demand in the future?
- Are employers involved in preparing employees for change?

Results will assess level of an employees' readiness for change.

The object of the study were line employees engaged in office work/intellectual work. It is from their point of view

Fig. 1. Research structure

Stage 1
- Study of thematic literature
- Expert opinion
- Ranked list of knowledge, skills, experience in demand in economy of the future

Stage 2
- Questioning, in-depth interview
- Data for analysis

Stage 3
- Conclusions from in-depth interviews and questionnaires
- Conclusions on research issues and hypotheses

that these skills and expectations are assessed with respect to fourth industrial revolution.

The study can be divided into three stages (fig. 3).

First stage. 11 scientific articles on topic were analyzed, where analysis of changes in workforce around world has been conducted. Based on literature, professional knowledge, skill, experience (in accordance with the definition of competencies, further competency parameters), which will be most in demand among the majority of employees in economy of the future (101 parameters in total), are highlighted. Identical or equal parameters are summarized; as a result, there are 40 (unique parameters) left. The sample contained only unique values, each of which was assigned a letter:: $x_1, x_2 \ldots x_n$. For formalization of choice of significant parameters and their ranking, a set of knowledge, skill, experience S, demanded in economy of the future, is defined:

$$S = \{x_1, x_2, \ldots x_n\}; \tag{1}$$

$$\sum_{i=1}^{k_1} E_1(a_i) = 1; \quad a \in [0,1]; \tag{2}$$

where k_1 – is number of estimated parameters, $k_1 \neq$ n; a_i – is assessment of degree of demand for a parameter in economy of the future;

for function E_2 – is an assessment of degree of significance b, set forth by expert 2, a representative of top management in a company in engineering industry with experience in introducing latest technologies:

$$\sum_{i=1}^{k_2} E_2(b_i) = 1; \quad b \in [0,1],$$

where k_2 – is number of estimated parameters, $k_2 \neq$ n; b_i – is an assessment of degree of demand for parameter in economy of the future.

Experts evaluated parameters for which the value of function $L(l_i)$ was greater than the median one. This restriction was introduced in order to interview more respondents, and questionnaire was not too large. The parameters for further research are defined and ranked as follows:

$$S' = \begin{cases} E_1(a_i) \vee E_2(b_i) \neq 0; \\ \dfrac{L(l_i), E_1(a_i), E_2(b_i)}{n'} \end{cases}$$

where S' – is a set of knowledge and skills demanded in economy of the future; n' – is a number of assessments of membership hereof.

Despite the fact that opinions of only two experts are reflected herein, such an amount is sufficient to test the methodology. In the future, when expanding expert base, it is possible to complicate formalization of expert opinion. From the point of view of fuzzy logic, each element of a set can satisfy a certain set of properties. Expert opinions on each skill and experience can be defined as values of membership function of fuzzy set S, while the function has specified values in range [0,1], where 0 is the element not included in a fuzzy set, 1 is the element describes an element completely included in a set.

According to results of first stage, knowledge and skills most likely to be in demand in the future are theoretically selected and ranked (fig. 2).

Second stage Data identified and collected in groups:
- the degree to which the concept of new industrial revolution is known to line employees, its influence on companies today and in the future;
- assessment of availability of knowledge and skills that are in demand in the future and their level of development

Fig. 2. The structure of the first phase of the study

Исходные данные
- Научные статьи и работы
- Международные исследования и обзоры
- Тематические форумы, экспертные интервью и выступления

Анализ
- Статистическая оценка
- Формализация экспертного мнения

Результат
- Ранжированный перечень знаний, навыков, умений, востребованных в экономике будущего

(hereinafter referred to as parameters of competence);
- assessment of adequacy of measures to prepare employees for future changes in labor market.

To identify this information, questionnaires and in-depth interviews were used. Questioning is a series of questions (of various types) with aim at collecting information from respondents [Gault R. H., 2012] for obtaining statistical data structured by means of certain types of questions. The questionnaire provided an appeal to respondent, information about researcher conducting survey, goals and objectives of the study. The main part contains four sets of questions to present:
- The portrait of a respondent. The respondent needed to indicate gender, age, occupation, industry, position, work experience. Closed, half-closed and filter questions are set.
- The respondent's awareness of the concept of "fourth industrial revolution", of influence of this phenomenon on the respondent's work today and in the future. Closed and semi-closed, multiple-choice questions are used.
- Important parameters of competence in the future. All parameters of competence were explained by researcher. Closed questions are presented using Likert scale. The respondent needed to assess how competent he was on a scale from 0 to 10, where 0 is the minimal skill level, 10 is an outstanding skill level.
- Sufficiency of measures to prepare employees for changing labor market requirements. Closed questions and semi-closed questions with multiple choice are used.

The closed structure of questionnaire was selected so that respondent could answer questions faster and researcher received more completed questionnaires. Respondents positively assessed how convenient it is to fill out questionnaire and how informative it is.

It is believed that people tend to rate themselves higher than others assess them [Ushakov DV, 2004]. The study suggested that respondents were able to assess their own qualities and abilities objectively. This factor is leveled in two ways:
- the anonymity of survey was supposed to prevent an

attempt to maintain image and status when answering questions;

• in preface it was proposed to show maximum objectivity by assessing own skills in overall distribution after the end of the study.

Questions from questionnaire were also used in in-depth interview. Table 1 shows approximate structure of the main part of questionnaire with an indication of types of questions and relevant examples.

For the purpose of the study, a questionnaire was drawn up under following structure:

• Characteristics of a respondent. Information collected allows you to check correlation between age, professional, job criteria and level of knowledge of those or other competencies.

• Awareness of the concept of "new industrial revolution". The information gathered should help to draw conclusions about perception of line employees of impact of new industrial revolution on a company, taking into account working process today, the future of a company.

• The level of mastery of competencies. It is necessary to assess the extent to which employees possess these or other competencies most demanded in the future from the point of view of experts, and to conclude that employees are ready for future changes.

• Retraining measures for employees who undertake companies to adapt employees to changing working conditions. In addition, the task is to assess sufficiency of these measures.

The survey was conducted via a web form. A random sample consisted of 153 people. The sampling error was 7.92%.

Additionally, five in-depth interviews were conducted in order to adjust questionnaire, taking into account how respondents understand terminology and question wording. The in-depth interview focuses on second and fourth units of questions. It was necessary to evaluate whether respondents understand what "fourth industrial revolution" is, how this understanding is shaped, what measures companies are taking to prepare their employees for change (fig. 3). This step partly allowed to form conclusions.

Third stage The analysis of obtained data and formation of conclusions. Data is interpreted in accordance with units of questions:

• Unit 1. Conclusions about quality of sample are formed and compliance with study conditions is assessed.

• Unit 2. The level of understanding of the concept of fourth industrial revolution, perception of its influence on work of employees today has been determined.

• Unit 3. The level of knowledge of necessary competencies was determined and a model was proposed for assessing employee readiness for changing conditions of labor market.

• Unit 4. The level of concern of a company about competence of its employees is assessed. Conclusions about adequacy of training measures and need to change them are formulated.

These findings were adjusted and supplemented by in-depth interview results (fig. 4)

Thus, the obtained methodology allowed us to determine the level of knowledge of various competences skills of line employees

engaged in intellectual work and to formulate recommendations for raising this level, which partly involves preparing companies for fourth industrial revolution. Subsequently, this methodology can be refined according to the described scenario to increase the level of reliability of result.

Summary and analysis of research results

First stage. 11 scientific and research works on relevant topics were analyzed, 101 non-unique competence parameters were selected, from which 40 unique parameters were obtained, among which 10 most significant ones were selected by means of statistical analysis and expert evaluation (Table 1)..

Dedicated competence parameters can be divided into permanent and new ones (approximately 20% out of total). The latter are more likely to include various digital skills such as programming, using software, etc.

From the point of view of comparison of expert opinions, most important signs are ranked in a similar way. At the same time, in some parameters data deviate from that one in literature (fig. 5).Thus, experts equally appreciate the demand for learning and digital literacy. In this regard, the second hypothesis can be considered confirmed.

Second stage Summarized characteristics of respondents:
• 21–35 years old (83%), 36–45 years old (10%);
• 53% are women, 47% are men;
• the majority of respondents have a work experience of less than 10 years;
• line employees dominate (72%), junior managerial staff (16%).

Approximately 37% of respondents have never met the term "fourth industrial revolution". Only a quarter expressed their firm conviction that they are familiar with this concept, and 63% of them believe that new industrial revolution is introduction of new technologies into production: artificial intelligence, robots, Internet of things. Nearly 56% also include universal automation and digitalization of processes, and 30% include introduction of latest technologies in everyday life. More than 72% of respondents are already feeling the impact of latest technologies on their daily activities, 7% deny this. 90% of respondents believe that technologies will affect their work in the future, for example, by automating a part of processes or changing list of required skills.

Survey results correlate with in-depth interview data: only three out of five respondents indicated that they were familiar with term "fourth industrial revolution", but found it difficult to define it, pointing mainly to digital economy and widespread penetration of Internet. The main sources of this knowledge were relevant articles in media and data obtained in various training sessions.

In both survey and in-depth interviews, more than half of respondents recognize influence of fourth industrial revolution not only on production processes, but also on society as a whole. Unfamiliar with the concept were 37%, which is lower than expected.

Among in-depth interview participants, four out of five admit that technological innovations affect their daily work today, and are able to indicate exactly how it manifests itself. Three out of five observe big changes in the level of demand for skills of various kinds of automation, from advanced level of using software to knowledge of programming languages.

Table 1
Types of questions used in a questionnaire at the second stage of the study

Unit	Question type	Question example
1	Closed one	Enter your age
	Semi-closed	Indicate your occupation
2	Closed one	Do you know of (encountered earlier in professional activities or everyday life) the concept of "fourth industrial revolution"?
	Semi-closed one, multiple choice	What do you mean by the concept of "fourth industrial revolution"?
3	Closed one, Likert Scale	Rate, how creative you are, from 0 to 10, where 0 means I do not possess, 10 means an outstanding level
4	Closed one	Do you think your company is taking enough measures to upgrade your skills and abilities listed in unit 3?
	Semi-closed one, multiple choice	What measures to improve your skills and abilities of those listed in unit 3 are taken by your company?

All participants of in-depth interview are confident that in the near future a part of their work will be automated, which will allow solving tasks faster, making more informed decisions and, in general, "will make daily routine more comfortable."

Thus, there is the reason to disprove first research hypothesis: Today, most line employees of Russian companies do not feel influence of the new industrial revolution, but they agree with possible prospect of entering it in coming years, at least in terms of recognizing the impact of fourth industrial revolution on today's workflow. Confirmed by fact that most employees understand what fourth industrial revolution is, they feel its influence on their work. In addition, the vast majority of employees is confident that new technologies will affect their daily work in the future.

Regarding third set of questions, the majority of respondents rate a significant part of their competence parameters. More than a half of employees rated their ability to adapt well is significantly above average. During in-depth interviews, 4 out of 5 participants acknowledged that they perceive changes

Fig. 3. The structure of the second stage of the research methodology

- Formation
  • Research matters
  • Results of the first stage of the study
  • Questionnaire
- In-depth interview
  • According to the step 1 questionnaire of this scheme
- Questioning
  • Web form
- Result
  • Data for analysis

easily and adapt to them easily, including changes affecting their working conditions.

Approximately the same distribution of answers about learning, but average score is slightly lower than the assessment of ability to adapt. The unity of opinions was supported by in-depth interview participants.

Participants appreciate their ability to work in a team: more than a quarter of respondents rated this indicator to maximum, remaining options found support among equal groups of respondents: about 15% by all estimates was above average. Participants of in-depth interview acknowledge that they show good results in teamwork and consider this ability to be one of their strongest sides.

The planning abilities are assessed by participants as above-average, however, distribution is estimated to be even. 37% admit that they have such abilities at a level slightly above average or moderate. Participants in in-depth interviews showed a more pessimistic result, averagely evaluating skills as average or below average, because, in their opinion, they rarely use this skill in their daily activities, hoping that planning is done by management staff.

The most appreciated ones were communicative abilities: 65% rated their abilities extremely high, including 26% as highest possible. The participants of in-depth interview did same: three out of five rated themselves as high as possible, the rest of them rated themselves very highly.

In emotional intelligence, average is slightly above actual average. During in-depth interviews, participants found it difficult to understand what was going on. Before questioning, question wording is clarified: an explanation that allowed to level possible ignorance of term was added. Surprisingly, about 10% showed an extremely low level of emotional intelligence. The rest were distributed evenly, mostly giving themselves an average rating.

Unexpectedly, but creativity index is even lower. Almost 20% indicated their abilities as below average, no one noted that they did not possess those. The overall score was slightly above average. Participants of in-depth interviews showed similar average results: at work they are rarely given opportunity to express their creativity and offer something new, which means their potential remains hidden.

The lowest scores was received by conditional group technical skills. Digital literacy rates were rated as slightly above average. More than a half of respondents rated software usage skills as

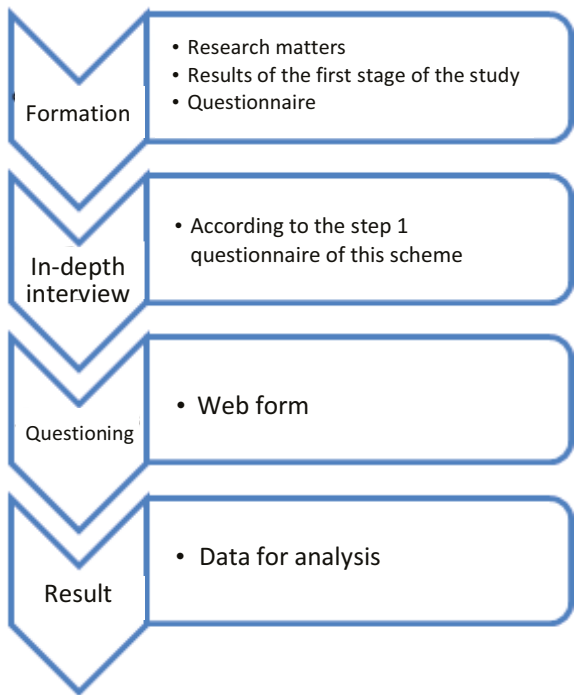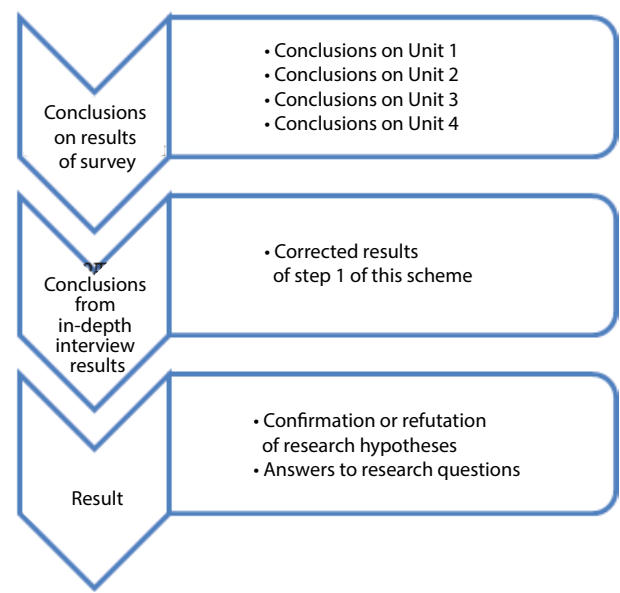Fig.4. The structure of the third stage of the research methodology

Table 2
Ranked list of competency parameters required in the future

Parameter	Expert 1	Expert 2	Expert 3	Weight
Adaptivity	0,06	0,18	0,20	0,13657
Learnability	0,12	0,17	0,15	0,12647
Digital literacy	0,12	0,10	0,15	0,10314
Communication skills	0,16	0,10	0,10	0,08640
Teamwork	0,10	0,10	0,10	0,08317
Planning	0,06	0,06	0,15	0,06323
Software use	0,08	0,11	0,07	0,06320
Programming	0,08	0,10	0,07	0,06320
Creativity	0,14	0,08	0,01	0,05977
Emotional intelligence	0,10	-	0,10	0,04983
Totally	1	1	1	–

Fig. 6. Employee Competency Card

average ones. Participants in in-depth interview did the same, but after clarifying a number of questions regarding understanding, levels of use of software components and comparative evaluation and total score dropped to "slightly below average."

The worst is situation with programming skills: it is completely absent at more than 30% of respondents and only at 11% above average. Only one participant of in-depth interview acknowledged that he has small abilities in this area. However, all participants find this parameter very useful and in demand in the future, therefore they would like to get it.

Visualization of results (рис. 6) allows us to estimate the shift of parameters of competence in direction of "soft" skills. There is no noticeable correlation between age or other indicators, on one hand, and level and skill set, on other, not detected. Thus, line employees have most developed communication skills, teamwork skills, etc., while level of digital skills is very low. Most non-technical skills are high, while emotional intelligence and creativity are relatively low. Although according to ranking, creativity and emotional intelligence are rated as least important, they are still among ten most wanted competency parameters. There are significant shortages of digital literacy, use of software and programming. The average assessment of level of all parameters is slightly above average, which indicates an

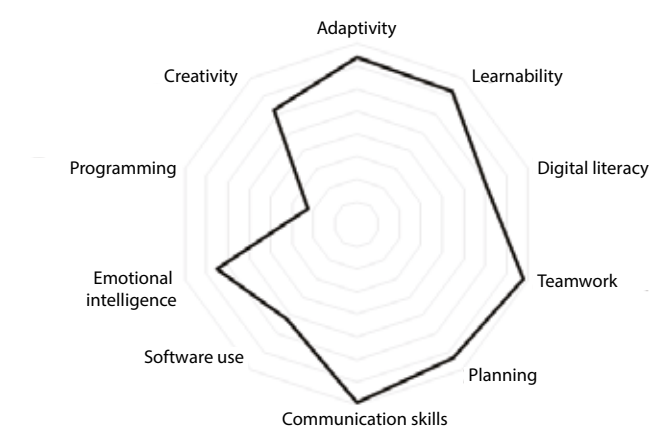insufficient level of skills for successful work in the future. This confirms third hypothesis.

According to fourth unit, views of respondents are distributed almost in equal proportions. Only 15% of participants unequivocally agree that their company is doing enough to raise level of competency parameters, more than 27% definitely do not agree with this statement. Conversely, 23% of participants rather disagree that measures are sufficient, whereas 35% rather agree.

According to in-depth interview, the majority of respondents believe that a company takes many measures to educate its employees, so that they master these parameters, but relatively few in terms of technical competencies.

Among main measures, almost half of respondents noted internal training: trainings, workshops and seminars. About 39% say that they devoted time for self-development, 31% also use training outside the company, when employees are sent for advanced training, courses at other organizations, etc. Also, 31% recognize the use of coaching, mentoring, or an overall employee development plan. Only 27% of respondents indicated that there is a system of certification or control of employees' skills and abilities. The other 27% believe that their company is not trying to increase their level of competence.

More than 73% of employees approve the idea of improving staff training system (fig. 7). In-depth interview participants emphasize that they would like to get an opportunity to improve their technical skills. In addition, most of them expressed opinion that their companies approach training of employees formally and do not provide opportunities for quality training. So, respondents' opinions on the level of adequacy of measures to train employees are divided, but the absolute majority of employees believe that this system should be improved in the field of studying previously defined competence parameters.

Fig. 5. The distribution of weights according to analysis of literature and formalization of expert opinions

CONCLUSIONS AND FURTHER RESEARCH

Modern approaches to organization of processes should pay special attention to interaction of people and technology. The emergence of new technologies or technological approaches is the result of systematic management of innovations. Nowadays, individual promotion of innovation is relatively difficult, since a lot of extremely diverse knowledge is needed. Increasingly, innovation comes from teamwork. Accordingly, it is necessary to unite people with various professional skills and personal abilities. To support successful operations, today a company must understand how its employees are able to cope or even contribute to digital and technological changes.

The study allowed us to collect diverse data, on the basis of which conclusions were drawn and answers to research questions were given. The main conclusions are:

- Most employees are aware that they exist in a world where technological changes are taking place, and they feel influence of these changes on their activities. In addition, employees are confident that their tasks and necessary skills will change.
- Among most demanded will be qualities that allow to exist in face of changes most effectively: adaptability, learning ability, creativity, effective interaction with other people, etc. Nevertheless, importance of technical skills will grow, albeit at a basic level, too.
- Employees have many components of competence, but the level of conditional technical skills is noticeably below normal. A number of "soft" skills is on average level, they can be considered as ones needing improvement.
- Training systems in companies need to be improved, in particular by expanding the range of knowledge gained, especially in the area of technical skills.

It is company's policy that determines the level of employees' competence. Main ways:

- work with existing staff: training, motivation and remuneration systems, professional compliance control systems, etc.;
- hiring new employees, including introduction of new qualification requirements, selection procedures, etc.

To assess level of staff training, you can use a methodology similar to that one used in this work. There are several

limiting conditions:

- For each company and position, requirements for parameters of competence vary greatly. This study was related to general skills of certain categories of employees.
- Predicting demand for certain skills is extremely difficult, especially for long term. The above mentioned approaches of experts are still underdeveloped, and many of them, not related to technology, are extremely subjective.
- The assumption of objectivity of our own assessment can be leveled by replacing employee's independent assessment with the one of his colleagues and managers.
- The approach used is designed for a small sample and a small circle of experts. However, the analysis can be complicated, for example, by constructing correspondence functions based on elements of theory of fuzzy sets. This method of formalizing a large number of expert opinions will give a more accurate idea of belonging of one or another parameter of competence to a list necessary in conditions of technological changes.

The proposed method is a kind of rapid assessment of employees' readiness for changing labor market conditions:

- Step 1. Determination of key parameters of competence, that is, skills, knowledge, skills that will be in demand in a company in the future. In this case, experts of company will determine these parameters, based on industry sector, position and other conditions.
- Step 2. As many experts as possible rank certain parameters of competence and assign them a level of significance, so that total assessment of all parameters by each expert is equal to one.
- Step 3. All expert estimates are averaged, and obtained values form the weight of the parameter. You can reduce the number of final, most important parameters by dropping indicators that weigh less than the median.
- Step 4. Depending on objectives, conduct a survey and set a rating on a 10-point scale for each parameter for each employee. If the purpose of such monitoring is a general assessment of readiness of a group of employees, for example, a department, then it is enough to conduct an anonymous survey. Such an approach will ensure an adequate level of objectivity. If you have to evaluate each or any individual employee, you can interview colleagues or managers.
- Step 5. By multiplying weights of parameters and employees' ratings, you can get an indicator of the future
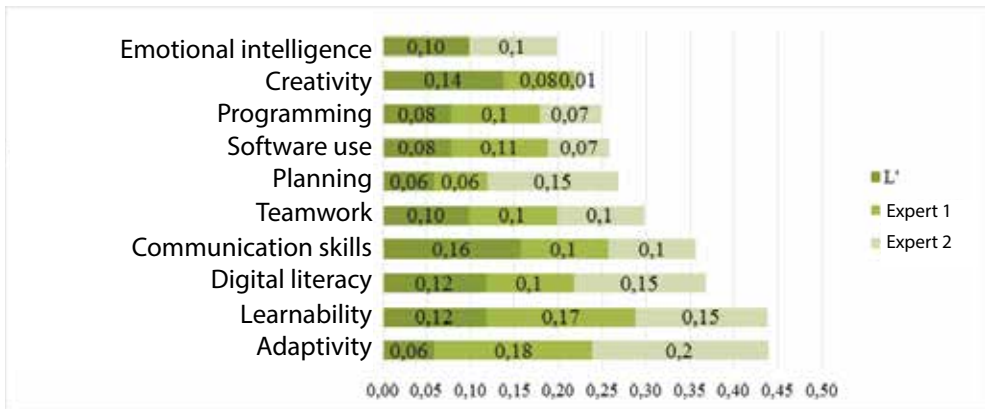
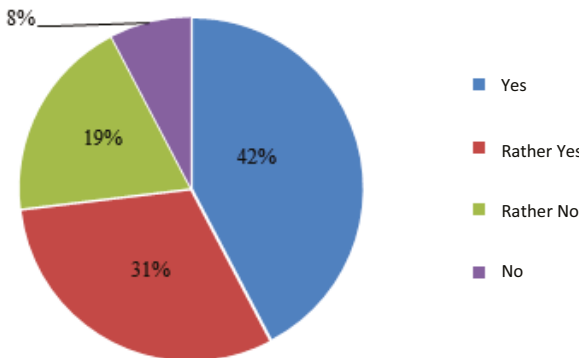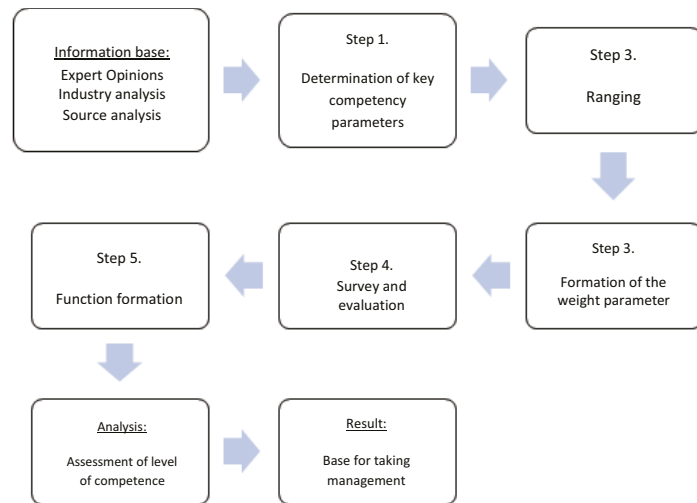Fig. 7. The need to improve training system in a company

Рис. 8. Экспресс-анализ уровня компетентности сотрудника

competence. This parameter itself is not informative, as, most of rates in other cases, but it is perfect for comparing, for example, individual employees or when selecting a new candidate for a job after a trial period.

Thus, the function of the future competence is obtained:

$$C_j = \sum_1^n S'_n * v_n,$$

where C_i – is the indicator of the future competence; S'_n — is the parameter of i-th competence; v_n – is the weight of the parameter of competence. The sequence of express analysis is shown in fig. 8.

The proposed approach allows not only to assess levels of departments, but also to relate different departments or different employees.

At any level of parameters of competence, the key role of staff readiness for change is played by education. Most employees are trained "on the job," which means that the value of internal training systems increases.

To create a successful and competitive workforce, companies need to act in two directions: to form training and monitoring systems for skills and knowledge in accordance with market needs and to improve employees' competences by promoting the idea of continuous independent education.

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