Management of Personnel Competencies in the Implementation of Industry 4.0 Projects

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Abstract: The article considers the approach to the management of personnel competencies in projects of Industry 4.0 in terms of current production facilities. The authors systematized research in the field of personnel competency management and revealed the specifics of the implementation of Industry 4.0 projects in the conditions of existing production facilities. The authors proved that for the solution of complex problems related to the modernization and implementation of Industry 4.0 projects, taking into account decision-making in conditions of uncertainty, unpredictable changes and high risk, staff should have a set of basic, professional, super-professional and integral competencies. A set of necessary staff competencies has been formed for the successful implementation of Industry 4.0 projects in the existing production environment. A model for the transformation of staff competencies in the implementation of Industry 4.0 projects under conditions of existing industries was developed.

1. Introduction

The relevance of this study is due to the growing need for transformation of approaches to the management of personnel competencies in the era of Industry 4.0. Implementation of Industry 4.0 can only be successful if the company has staff that is able to do it correctly.

Industry 4.0 is characterized by advanced digitalization and integration of industrial production and logistics processes, as well as the use of the Internet and “smart” objects (machines and products) and the merging of physical and virtual worlds through the implementation of information and communication technologies (ICT).

Important issues in the implementation of Industry 4.0 are: to what extent the staff is ready to implement Industry 4.0 projects, what kind of staff is needed, what competencies they should possess, how to increase the level of knowledge of employees in the Industry 4.0 technology era. The purpose of the article is the systematization of research in the field of personnel competence management and the development of a model for the transformation of personnel competencies during the implementation of Industry 4.0 projects in existing production facilities.

The main objective of the authors is the identification of problems and contradictions in the formation and development of competencies of staff in terms of Industry 4.0.

The subject of the research is the problem of effective management of competencies of personnel in the implementation of Industry 4.0.

Methodological approach to the research is based on the methods of logical analysis, grouping and comparison, and generalization. The hypothesis of the authors, requiring changes in the workforce competencies, is based on the idea that the new generation of workers will be involved in the complex processes of creating fundamentally new technologies and markets.

To test the hypothesis, an analysis of the requirements for competences of staff was conducted in the context of implementation of Industry 4.0 and the reaction of the labour market to new challenges. The analysis allowed to identify the key characteristics of the model of personnel competences management in Industry 4.0 projects.

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1.1 Literature Review

The issues of transformation of competencies and skills of personnel in the era of Industry 4.0 were considered in [1–6], etc. Individual elements of staff competence management in terms of Industry 4.0 are considered in [7] and [8].

The development of education in the context of digitalization of the business environment and the implementation of Industry 4.0 is considered in [9–14].

The interaction of education system and companies on the issues of training of personnel with the necessary competencies in the era of Industry 4.0 is considered in [15] and [16]. The changes in the approaches to education in the context of digital transformation, including the creation of adaptive learning systems, are discussed in [17]. Particular issues of personnel management in the implementation of Industry 4.0 are considered in [18] and [19].

The analysis showed that, despite a sufficient number of publications on Industry 4.0, there are questions of assessment of the personnel readiness for implementation of Industry 4.0 projects, as well as the issues of personnel competencies management in the implementation of Industry 4.0 projects in terms of current production facilities, that have not been studied sufficiently.

2. Methodology

This study introduces a model of personnel competencies management in the implementation of Industry 4.0 projects in terms of current production facilities. Methodological approach to research is based on the methods of logical analysis, grouping and comparison, and generalization.

Since the topic is too broad for any single empirical analysis, the authors seek to lay a theoretical foundation for the future empirical research. This requires integration and rethinking of the various streams of research literature, for which interpretive review of the literature was selected as the most appropriate method of studies. The study covers an overview of scientific articles on the topic of research from Scopus and Web of Science databases for the last five years (2014–2019), as well as the reports of major consulting and analytical organizations (such as Boston Consulting Group, Deloitte and McKinsey), the materials of World Economic Forum on the topic of Industry 4.0.

The basic methodology is the following.

The first phase involves the analysis of the existing publications on Industry 4.0 to identify features of the implementation of Industry 4.0 projects in terms of current productions.

The second phase will be devoted to the classification of basic requirements for the skills of staff necessary for the implementation of Industry 4.0 projects in terms of current productions.

The third phase generates a set of competencies of the stuff required for the successful implementation of Industry 4.0 projects in terms of current productions.

The fourth stage forms the model of transformation of competences, the key elements of which are the levels of competences and the elements of the programme of competence development of personnel in the implementation of Industry 4.0 projects in terms of current productions.

3. Results

3.1 Specifics of the Implementation of Industry 4.0 projects in Terms of Current Production

Implementation of projects for introducing Industry 4.0 technologies in the conditions of existing production involves imposing to workers higher requirements. The consciousness and time of employees is freed from the coordination of old operations, the employee needs to master new tools, operations and technologies [20].

During the implementation of projects for introducing Industry 4.0 technologies the role of skills related to planning of works and their organization, teamwork and communication, ability to act in problematic situations, predictive abilities, etc is growing. The objective of the companies will be not only to introduce new technologies, but also to help employees in adapting these technologies.

Analysis of the existing publications on the problems of Industry 4.0 has shown the key issue for enterprises that seek to realize the potential of productivity growth, which gives the introduction of

Industry 4.0, is the formation of susceptibility and readiness of employees at all levels to the transformation processes.

Low level of sensitivity, and the readiness of enterprises for the implementation of Industry 4.0 is often associated with high social and psychological risks connected with a change in people's perception of their own “I” in a rapidly technological world.

In [21] it is stated that technological, demographic and socio-economic changes will influence the employment and required skills. This will cause difficulties in recruitment, training and personnel management. If these issues are not resolved in time, they will entail economic and social costs for business, economy, and society as a whole.

The organizers of the study mention the fact that in the process they realized that business owners are aware of impending disaster, but they are not in a hurry to make decisions.

More than two-thirds of companies surveyed point out that managing change is now for the company's management one of the most important priorities. Important barriers to change are poor understanding of the scale of these changes and limited resources. More than two-thirds of respondents say about investing in training of employees as a key strategy in change management. The following strategies gained a little more than 20%: interaction with institutions, strengthening the role of women in the labour market, attracting talented foreign specialists, and developing a mentoring system.

Further development of Industry 4.0 technologies implies the need to develop and implement new tools for the socio-psychological adaptation of the personnel of existing enterprises to work in new working conditions and new qualification requirements. The successful implementation of Industry 4.0 involves the transformation in the following main directions:

- A review of the role of employees in the organization and the production process, the development and use of creative potential of employees, the transition from the position of “contractor” to the position of “creator”;
- New modes of labour control, labour control in real-time, maintaining a balance between work and privacy;
- Continuous development and advanced training, new learning formats (“network exchange of best practices”, digital training technologies, etc.), the introduction of lifelong learning concept;
- New forms of work organization (development of formats for project work, networking, remote work, etc.).

3.2 The Set of Necessary Staff Competencies for the Successful Implementation of Industry 4.0 projects in Terms of Current Productions

The results of the study [22] show that there is a serious gap between desired and available competencies of graduates, which causes the risk of increasing contradiction between supply and demand for a new generation of professional personnel.

The proposed target model of competences of staff in terms of implementation of Industry 4.0 projects is shown in Figure 1.

The traditional approach to determining staff competence involves the allocation of professional competencies and, the so-called supra-professional competencies.

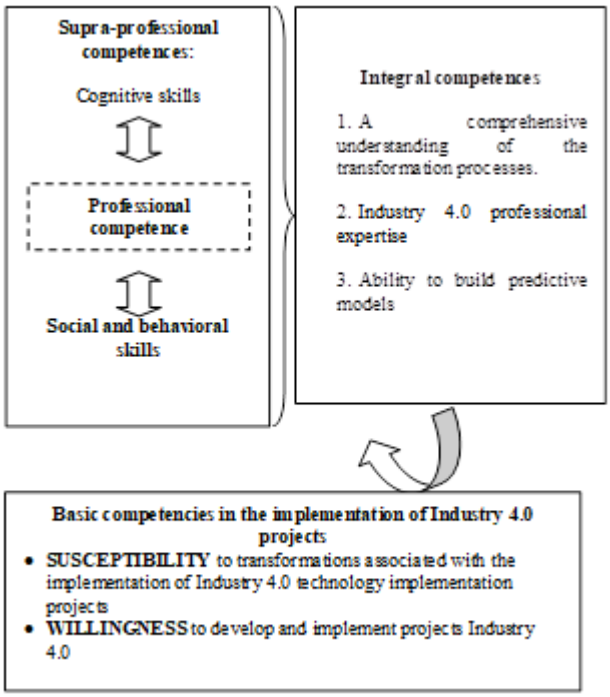

Figure 1 Target model of personnel competencies in the context of implementation of Industry 4.0 projects

Source: composed by the authors.

In the context of the implementation of Industry 4.0 projects in existing production facilities, the main professional competencies are digital skills: programming, systems development, information management, data processing and analysis, design of production systems, artificial intelligence technologies, robotics.

Supra-professional competencies in the context of Industry 4.0 are systems engineering thinking, intersectoral communication, project management, lean manufacturing, working with people, working in conditions of uncertainty, artistic skills, environmental thinking, teamwork skills, initiative and perseverance in achieving a goal, high learning ability to organize their activities.

The vast majority of training courses and programs are focused on the formation and development of students of various professional competencies. However, in practice, to fulfill production tasks, each employee simultaneously realizes both professional and supra-professional competencies, and the effectiveness of solving a problem is determined by the individual's ability to assimilate "integral" competencies that are formed at the junction of professional and supra-professional competencies.

According to the authors, such integral competencies include the following:

- A comprehensive understanding of the transformation processes in their sphere of activities associated with the transition to Industry 4.0;
- Professional expert knowledge of Industry 4.0 technologies in their field of activity;
- Ability to build predictive models in their field, to develop and implement a plan for effective implementation of Industry 4.0 technologies in their field of activity.

In addition to professional and supra-professional competencies necessary to fulfill production tasks in the context of implementing projects of Industry 4.0 and working in an intelligent enterprise, each employee must have a psychological readiness to work in new conditions. In many respects, susceptibility to the new and psychological readiness are formed as components of "integral" competencies. The employee develops self-awareness, strive for new knowledge and self-development, which forms his willingness to act in conditions of uncertainty, the desire to contribute to the work of the team (organization).

The development of Industry 4.0 has led to significant structural changes in societies, the success

of which is currently associated with obtaining and dissemination of knowledge. The concept of continuing education has become one of the basic principles of the work of educational institutions around the world. Traditional methods of obtaining and disseminating knowledge have become insufficient, and in some cases poor. This is especially true for special as well as interdisciplinary knowledge and competencies.

3.3 A Model for the Transformation of Competencies in Implementation of s Industry 4.0 Project in Terms of Current Productions

When implementing Industry 4.0 projects in the context of existing production facilities, it is proposed to single out the following levels of competency carriers:

- Approval of strategic decisions;
- Development of functional strategies;
- Development and justification of projects;
- Project implementation management;
- Contractor in the project.

The Industry 4.0 competency development program is formed for each level of competency carriers in accordance with the level and content of tasks to be solved.

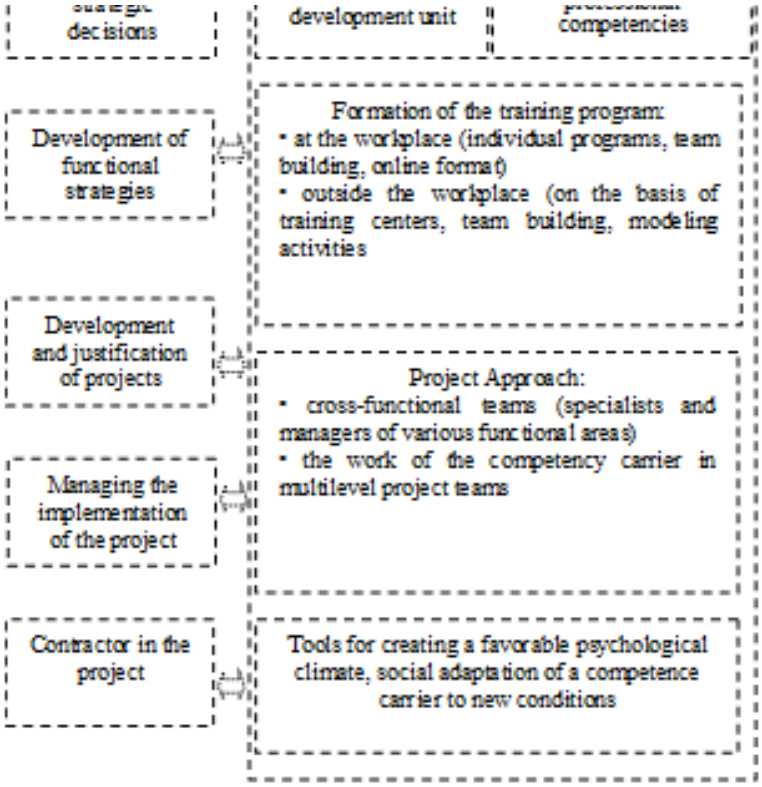

Figure 2 Model of transformation of personnel competencies in the implementation of Industry 4.0 projects in the conditions of existing production

Source: composed by the authors.

Teaching units aimed at the development of professional and supra-professional tasks, while the share block cross-professional tasks increases with the level of tasks. The contractor in the project should have the most profound level of professional competencies and the basic level of supra-professional competencies, and those responsible for making strategic decisions, respectively, are the other way around. For the remaining levels of competency carriers, the structure of blocks of professional and supra-professional competencies is selected in accordance with the specifics of the tasks to be solved and the field of activity.

Training programs are formed on the basis of the generated request in professional and supra-professional competencies, preference is given to training at the workplace and team work.

As a result of passing the training program, the employee should form “integral” competencies corresponding to his field of activity and the level of tasks to be solved.

Competencies are developed and developed in the process of team work on projects. Participants in the project team must first receive at least basic super-professional skills: teamwork, effective communication, etc.

External working conditions (rules and regulations, working hours, organization of work) are formed in such a way as to maintain receptivity to transformation processes and the psychological readiness of employees to implement projects implementing Industry 4.0 technologies.

4. Discussion

As a result of the study, the stated hypothesis is supported that serious changes are required in the competencies of the staff, since a new generation of employees will be involved in the complex processes of creating fundamentally new technologies and markets.

It is shown that for the successful implementation of Industry 4.0 technologies, enterprise personnel must first of all have basic competencies, including susceptibility to transformations and readiness to develop and implement Industry 4.0 technology projects.

In contrast to the traditional approach supported by the majority of researchers [1] [3] [4] [16], which involves the allocation of professional competencies and supra-professional competencies, the article substantiates the need for the development of “integral” competencies that are formed at the junction of professional and supra-professional competencies, which is a prerequisite for the successful implementation of Industry 4.0 technology projects.

Today in modern economic science there is no single universally accepted definition of a model of competencies and an approach to its construction. The literature presents various concepts, typologies, approaches [7] [8] [10] [17] [23]. The competency model should take into account the specifics of Industry 4.0 technologies, and in practical application, the industry specifics of a particular enterprise.

Based on the model of competency transformation proposed in the study when implementing Industry 4.0 projects in the context of existing production, enterprises implementing the development option - an intelligent enterprise, will be able to accelerate the transition to digital transformation along the entire value chain and take advantage of the leader in the fourth industrial revolution.

Also, the proposed model allows minimizing the socio-psychological risks of introducing Industry 4.0 technologies in the current production environment, creating the employees' susceptibility to new things and their readiness for transformational processes, both within their workplace and in the economic and social spheres of society as a whole.

5. Conclusion

It becomes obvious that in addition to technological topics such as big-data or IT infrastructure, the human factor is of great importance for the successful implementation of Industry 4.0 technology projects.

Analyzing the results, we can draw the following conclusions:

- Development of Technology Industry 4.0 will lead to significant structural changes in societies whose success is associated with the acquisition and dissemination of knowledge;
- In order to successfully implement Industry 4.0 technologies, further development of the theoretical and methodological foundations is necessary for the concept of continuing education and training in order to form a set of competencies that adapt to the conditions of Industry 4.0 technologies.
- The implications of this study are:
- The results of the study can be useful to enterprises in the development of personnel competency cards, proper instructions in accordance with personnel requirements in the era of technology Industry 4.0;

- The results obtained are of interest to educational institutions involved in the process of transforming educational models in response to new challenges of the technological revolution.

The development and implementation of Industry 4.0 technologies, on the one hand, can significantly increase the efficiency of the national economy due to increased labour productivity; on the other hand, the implementation of Industry 4.0 technologies implementation projects without taking into account the transformations taking place in the social and educational environment will lead to increased social tension and unemployment due to the replacement of human labour with machine labour and artificial intelligence systems.

Promising areas for further research are the following:

- Accounting for projected changes in the labour market in the competency model, including the growth of the group of older workers in the workforce;
- Development of methodological foundations for constructing staff competency maps for various categories of employees;
- Development of methodological foundations for constructing roadmaps of events for the successful implementation of Industry 4.0 projects.

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