Intelligent Technologies for Knowledge Management at a Modern Company

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Abstract. The article investigates problems of digitalization and digital transformation of human resource management at modern organization. Authors suggest implementing approach based on the methodology of digital maturity and adapting it to tasks of human resource departments; the article includes the description of stages of digital maturity of human resource management and steps of its digital transformation of this managerial function. The Forth Industrial Revolution impacts on human capital strongly: its structure is dramatically changing and “talents” begin playing leading role at business companies. In new conditions a special attention is paid to knowledge management as a key function of human resource management. One of problems in knowledge management is to find out talented staff and create conditions for full integration their intellectual potential in production and business processes. Digital transformation of human resource management creates a new possibility for “talents” detection and improvement of their motivation. The authors suggest applying the instrument of knowledge mapping and demonstrate practical examples of its usage at companies. The described approach is especially useful for scientific and research organizations.

Keywords: Digital twin and tracking · Human capital · Intelligent technologies · Knowledge management · Mapping knowledge · Talents

1 Introduction

The COVID-19 epidemic and self-isolation regime led to the stuck of industrial production and the significant reduction of activity for the most business companies [5]. On the one hand, the branches of industry and enterprises where production and business processes cannot be implemented without human participation were most affected. On the other hand, the current situation has become a strong stimulating factor for decision making on the digitalization and digital transformation of the economy. The wide implementation of technologies that do not require direct and constant participation of people becomes an urgent task of survival and competitiveness for business in most sectors of the economy.
In the recent past, the tasks of digitalization and digital transformation of enterprises were considered, rather, as an object of discussion of specialists than real strategies and projects. But the future has already come, and even skeptics have recognized the need for development of production without human labor. Therefore, the relevance of developments in the field of artificial intelligence as a core component of digital production should not be questioned.

The first experience of digital transformation of production shows that the transition to unmanned technologies begins, as a rule since the automation of technological processes in which unskilled personnel are involved. Automation is primarily subject to physically heavy or monotonous operations, as well as production processes with hazardous working conditions. However, even for the simplest manufacturing operations, automation often requires innovative and high-tech solutions.

A few years ago, one of the authors took part in studies on optimizing garbage processing in the Moscow region. Currently, waste sorting for disposal in Russia is mainly carried out manually. This is a monotonous, heavy, and potentially dangerous job that does not require special professional skills. However, in order to replace workers engaged in sorting in this technological process, it is necessary to design a robotic complex with sophisticated mechanisms for collecting recyclable waste. As a result, automatic sorting control should include machine learning blocks and have intelligent algorithms for making operational decisions. To develop such a complex and exclude people engaged in primitive physical labor from the technological process, it takes to attract highly qualified and creatively thinking specialists in new professional fields with advanced digital competencies. Without addressing the issue of the economic feasibility of digital transformation of household waste sorting, nevertheless, it is necessary to pay attention to the emerging phenomenon of changes in the structure of workers: a decrease in the share of unskilled labor and an increase in the need for specialists with high intellectual potential and advanced digital skills.

According to the authors’ studies, now significant shifts are taking place at the labor market: the demand for IT specialists and representatives of other professions with developed digital competencies is growing. Nevertheless, the deficit of IT specialists, which has been noted lately [1], is temporary: on the one hand, the number of graduates of educational programs in IT is increasing [12]; on the other hand, information technologies are also developing in direction of automation – design of software products without direct participation of programmers [9]. In the long term, when the transition to the new technological paradigm (Industry 4.0) [18] will be completed, with a general reduction in the need for labor resources due to automation of the main and supporting productions and services, there will be a growing demand for specialists with creative abilities and developed digital competencies, with unique knowledge background and skills to elaborate non-standard and unique solutions [14]. The authors share the point of view that knowledge and creativity will determine the competitiveness of enterprises in the conditions of Industry 4.0, and Human Capital will become the main factor of business’ value.

In parallel with these processes, the role of knowledge management at companies is changing. In the middle of the 20th century, experts in Microeconomics [4] increasingly began to single out information into an separated (fourth) basic factor of production, emphasizing that the role of classical factors [15] will decrease in the future, and role of
information and knowledge will increase in the same time affecting not only the competitiveness of the business, but also the consumer value of products and services [4]. As a result, at the turn of the millennium, the function of knowledge management appeared and began developing in companies [2]. Information and knowledge transformed into human capital, as the 4th factor of production, acquire the greatest value for companies [11], therefore, in modern conditions, knowledge management is becoming a key managerial function at a modern organization. Based on these phenomena, Senge proposed a model of a developing organization [19] as an organization that knows how to create, acquire, and disseminate knowledge and changes its behavior in accordance with new information, original opinions, and modern models of thinking. However, despite all the advantages of organizational development based on knowledge management, at Russian companies this managerial function has not yet become widespread. Even at big companies that have sufficient means to form modern knowledge management systems, this task was set as a part of the general policy of “forcing to innovation” as a mandatory section of innovative development programs, which are also mandatory strategic documents for big companies with state participation [6].

As the authors’ consulting experience shows, creation of knowledge management system often includes only development of internal corporate information system or portal for exchanging data between employees at a company. In fact, knowledge management function boils down to the growth of reference libraries and the desire to formalize and describe all technological and business processes, capture the best work practices, and ensure their dissemination across all structural divisions of an organization. The utopianism of this approach to knowledge management was proved by critics of the rational bureaucracy conception by Weber [22]: informal knowledge and the necessary organizational changes always are ahead of the highest-performing systems for converting new knowledge into information [21], because they are secondary to the generation of new knowledge.

At the same time, often knowledge management in Russian companies is equated with a function of human capital development, the main goal of which is to raise competencies of employees. In this context, knowledge management is provided by corporate centers of education such as corporate universities, academies, training institutes, etc. Often, at large companies these structural divisions concentrate on the formation of soft skills and the social and personal growth of staff. At the same time, IT support of integration of formal and informal knowledge into a single complex remains without proper attention. But at a modern company value of products and services for customers and consumers and the cost of the business are generated by synergy of information resources (formalized knowledge), network of staff communications, and growing human capital, as authors described above.

To achieve real positive results of knowledge management, it is necessary to balance development of human capital and information technologies, which ensure the transfer of individual employees’ knowledge to public information, generate and productive circulate knowledge within a company. According to the authors’ opinion, the function of knowledge management should develop at the junction of modern information technologies and techniques of socio-psychological work. Another feature of modern approaches to knowledge management as a necessary function of human resources management is, first of all, that it should be focused on employees with
advanced competencies and soft skills, with a high level of creativity and the ability to find creative and original solutions of production problems. In this regard, in the field of human resource management in recent years a new function has emerged – talent management [10], which is directly associated with knowledge management.

2 Methodology

The research carried out by the authors is based on the theory and positive practice of knowledge management at modern companies. At the same time, the authors share the position of other specialists who emphasize the need to integrate modern information technologies and human resource management functions in order to identify, formalize and disseminate knowledge within a company and ensure the fullest use of human capital. To substantiate the approach to identifying knowledge and its carriers among employees of the enterprise, general scientific methods were used: description, generalization, systematization of organizational knowledge. The rationale for the choice of information technologies for use in the field of human resource management was based on the use of special (desk) research methods: analysis of open sources of data on the technological capabilities of modern information technologies in general and the use of artificial intelligence (big data analysis, machine learning, pattern recognition and natural language processing), as well as a comparative analysis of various options for implementing knowledge management functions.

Among other methods of scientific research, it is necessary to single out a socio-logical case analysis, which makes it possible to identify “talents”, systematize the motives of their labor activity, and highlight the most effective incentives for professional activity. Modeling of business processes in the field of human resource management was used to develop an approach to digitalization and digital transformation, which makes it possible to record the stages of digital maturity and the criteria for the transition from one stage to another. The level of digital maturity of human resource management at companies was assessed in accordance with the methodology developed by Acatech and KPMG, which have become a global methodology for digital transformation.

The need for digitalization and digital transformation of knowledge management processes in an organization is justified on the theory of value management, which proves the direct impact of human capital development on the growth of company’s capitalization.

The developed approach was verified and approved on the basis of the development and implementation of a digitalization and digital transformation project for human resources departments at some research institutes of the Russian Academy of Sciences, where knowledge management issues are of particular importance. The practical implementation of the developed approach has proven the legitimacy of using the knowledge mapping method in a company based on modern intelligent technologies, which allows implementing the basic knowledge management functions described above. The condition for applying the approach is digitalization and digital transformation of both the company in general and human resources management. A comparative analysis of the effectiveness of knowledge management and the loyalty of key
employees (“talents”) at companies before and after the implementation of the developed approach, proved the promising development of methods and tools for mapping knowledge by building horizontal communications and disseminating knowledge, which give a positive synergistic effect and lead to an increase in human capital.

3 Results

3.1 Methodology of Digitalization and Digital Transformation of Human Resource Management as a Key Factor of Intelligent Knowledge Management

The digitalization and digital transformation of business processes in the field of human resource management is based on creating the prerequisites for the development of new approaches that were previously unavailable due to the lack of technological capabilities for working with data. As the company’s Industry 4.0 maturity index [17] rises, opportunities for knowledge management and the creation of conditions for the productive activity of talents expand. At the same time, creative employees with advanced competencies not only increase the value of the business through the development of human capital, but also they achieve full self-realization and recognition in the team, which relates to the needs of the highest order in the hierarchy of Maslow [3]. The highest human needs are the strongest internal stimulus to increase productivity and increase loyalty for talents [3]. Therefore, digital technologies of human resource management should be aimed at identifying talents, creating conditions for the full mobilization of their potential, and ensuring circulation and easy access to corporate knowledge. The authors of the article have developed an approach that allows us to solve this problem. But for its implementation it is necessary to develop intelligent information technologies of human resource management.

The 1st stage of digitalization and the digital transformation of human resource management named as “Computerization” is the creation of digital twins of employees – electronic files, which include full information characterized employees: personal data, a socio-psychological profile, assessment of competencies, job responsibilities, information about honors and incentives, etc. The availability of a computing database on staff is a prerequisite for a modern enterprise. To stimulate business towards digitalization of human resource management, the Russian government obliged all organizations without any exception to switch to digital workbook since the 1st January 2020 [7]. This is a positive trend in labor migration which facilitates access to personal data [13].

Intelligent technologies begin to be applied from the first stage of the digital maturity of personnel management. For example, the routine process of entering data into a computer base can now be automated using machine vision and recognition technologies. So, a student project, carried out under the leadership of one of the authors, has now become a dynamically developing startup, whose software product is increasingly being used in the personnel services of research institutes of the Russian Academy of Sciences when digitizing personal files of employees.
The 2nd stage of digital maturity (“Connectivity”) in human resource management consists in establishing relationships between various functional databases at a company (including databases of personal e-files of employees) among themselves. It also includes connecting external sources of new and updated data (digital tracks) about employees. At the same time, it is necessary to develop new business processes based on ensuring the functioning of these databases. It is important that all the data within the organization ultimately form a single information base for making managerial decisions. The objective of this stage is to synchronize digital twins and their prototypes.

The 3rd stage of the digital transformation of human resource management (“Visualization”) includes the expansion of analytical technologies’ implementation. In the human resource departments at Russian companies, computer tools of human resource analytics are being increasingly used. However, as the experience of the authors’ practical consulting shows, often attempts to implement analytical tools of human resource analytics fail, because the first two stages either incomplete or even ignored.

Authors’ researches also show that human resource analytics tools are often based on a weak technological base. According to expert estimates [16], approximately 80% of the personnel analysis and human resource reporting processes at Russian companies are based on the use of spreadsheets (as a rule, MS Excel, and often even without using macros). Therefore, despite the development of some business processes in the field of human resource analytics at Russian companies, the level of development of their digital maturity has not yet reached the 3rd stage of maturity. The objective of this stage is to learn how to answer the question: “What is happening?” on real time, basing on analysis of digital twins of staff [17].

It is logical that because of having data on events and their consequences – digital tracks and the results of the employees’ work, machine learning and big data analysis technologies, which are also called artificial intelligence technologies, are being increasingly used on the next (fourth) stage of digital transformation of human resource management. Companies are faced with an alternative: either to increase the staff of a human resource department, recruiting analysts, or to connect the capabilities of artificial intelligence, which allows to identify causal relationships and factors that determine the efficiency and effectiveness of work. Due to the automation of production processes, the number of employees in a company is usually reduced, therefore, an increase in the number of analysts leads to irrational proportions between administrative and production personnel. Thus, it is obvious that the use of intelligent technologies at the 4th stage of the digital transformation of the human resource management function becomes an inevitable condition for all organizations.

The 4th level of digital maturity (“Transparency”) is designed to find the answer to the question: “Why is it happening?” [17]. At the 5th stage of the digital transformation of human resource management (“Predictive Capacity”), predictive analysis of technologies that allow forecasting and modeling the consequences of making decisions. Such kind of technologies reduce the risk of managerial errors leading to depletion of human capital. In addition, knowledge of causal relationships also allows predicting the negative consequences of external events independent of the company and taking prevent measures to protect them from their occurrence. In fact, at the 5th stage of
digital maturity, there is a transition to proactive human resource management, which significantly reduces the risks in the field of work with personnel. The main task of the 5th stage is to learn how to answer the question: “What will happen?” [17]. Intelligent technologies based on machine learning, computer vision, and Big Data analysis will become the main for the functioning of HR-departments at organizations.

The 6th stage of the digital maturity of human resource management is called “Adaptability”. At this stage, the number of HR-staff is significantly reduced, since the main business processes are fully automated and are carried out without the participation of people. HR-departments are being transformed into research and analytical units integrated with IT-departments in which new intelligent methods and analytical tools in the field of Human Resource Management are developed. The task to be solved at this stage: “How can an autonomous response be achieved?” [17]. The dynamically developing Industry 4.0 technologies fully capture the sphere of work with employees in all areas. Therefore, it is necessary to understand how modern information (and especially intelligent) technologies can change Human Resource Management and its individual functions.

3.2 Results of Implementation of Intelligent Technologies for Knowledge Mapping in an Organization as a Part of Digital Transformation of Human Resources Management

The application of the digital transformation model developed at Acatech and KPMG [17], and the use of intelligent technologies were carried out by the authors in some organizations for human resource departments, which allowed to increase the efficiency and productivity of work. It is clearly, the advantages of using Artificial Intelligence in human resource management were manifested in some research institutes of the Russian Academy of Sciences, the human resource departments of which are currently carrying out their digitalization and digital transformation. Obviously, talents for such kind of organization are of lasting value, and the knowledge management function is one of the main. Therefore, the use of the method proposed by the authors in this area turned out to be not only in demand, but a really working tool. It is the mapping knowledge system and building horizontal communications (between different departments within an institute), generating a positive synergistic effect. At the 1st stage, personal files of employees were digitized, and an archive of electronic personal documents was created. Already at this stage, the technology of automatic database filling based on intelligent scanning and recognition of documents (based on computer vision) was used.

Subsequently, this technology will be used to update and replenish the electronic document archive, which, to ensure information security, is completely autonomous and is not connected to any network. In fact, the only entrance to the archive is a scanner that recognizes documents and the technology of diversity of the entered data in the corresponding data fields. Also, at the 1st stage, a socio-psychological profile was compiled, and an assessment was made of the level of digital competencies of employees, as well as data on publications and ongoing research were introduced. At the 2nd stage, a corporate portal was created, on which personal accounts of employees were posted, as well as regulatory and reference documents. The open part of the
personal account – information about scientific achievements, publications, and annotations of the studies performed – were automatically entered on the personal pages of the Internet-site. Closed data was used both by financial and economic services for calculating wages under an effective contract, and by research managers to form research teams. The electronic data archive with the appropriate setting became the basis for the generation of grant applications with participation in research competitions. Already at this stage, one of the main functions of knowledge management began to be realized – the circulation of knowledge within the organization. The employees of some research departments began to better understand the areas of research and the approaches of other departments, new professional communications arose, and research was initiated at the intersection of various fields of science. However, this process proceeded spontaneously, and it was not always possible to fix its results. Moreover, the circulation of knowledge within the organization depended on the characteristics of individual employees, their psychological readiness to share knowledge with others and the ability to describe their scientific achievements.

Therefore, at the 3rd stage, a technology was developed for analyzing the internal communications of employees, which allows one to identify key employees – Knowledge Centers, which are most often contacted by other employees of the organization. The intelligent system was built on the principle of Google search [16]: the employee to whom the most requests came received the highest rating. The employee, with whom there were practically no communications, was at the bottom of the list. To avoid the “mark-up” of the rating, the intelligent system analyzed communications and considered only those that were related to the research being conducted. In the future, artificial intelligence also plans to evaluate the usefulness and competence of the answers, which will also affect the employee’s rating, and therefore – the amount of salaries. Another area of communication research within organizations is the confirmation and assessment of the level of competence of employees in subject areas of research. For example, an employee in his/her personal account declares his/her competence in area X (for example, based on the results of past training in this area), but neither research nor the requests of colleagues concern this subject area for the next 6 months. In this case, his statement of competence in area X is not supported. In addition, an employee to whom appeals are recorded in the subject area Y automatically receives a competency rating in this area. As a result, an intelligent recommendation system was created to attract the most competent employees (“talents”) to research, and the task distribution system was to balance the workload of the institute’s employees. The authors called this approach knowledge mapping and now it’s currently being applied in human resource departments of big companies.

4 Discussion

Problems of talent management is a main subject of many recent publications in which authors study different aspects of this new phenomena in human resource management. The term of “talent management” was introduced in the late 1990s. One of the first authors who attracted attention to talent staff as core component of knowledge management was Vaiman in 2010 [20]. Later, Khoreva, Vaiman, and van Zalk described
how talent management practices influenced on loyalty of employees with high potential and stimulated them to develop their competencies [10]. Experts in area of knowledge management, Milton and Lambeau, revealed the principles of development of knowledge management system at companies [11]. Prepared by this authors Guide (The Knowledge Manager’s handbook) touched the problems of talent staff. Researchers Purdenko, Matusova, and Andryeyeva assessed the effectiveness of the creative activity of employees and studied the creative management system at companies [14]. They supported the point of view of Senge who had written that the only sustainable competitive advantage of an organization at present is the ability to learn faster than competitors [19]. All these publications are very close to authors’ position in common. Some statements were used as a background of the authors’ researches. Continuing studies in talent management as a core component of knowledge management at a modern companies authors researched impact of digitalization and digital transformation on human resource management in common and talent management in particularly. Studies of Industry 4.0 and knowledge economy, presented by the works of Gusenko [7], Schmidt [16] and Ivanova, Odinaev, Pulyaeva, Gibadullin, and Vlasov, [8] decomposed to the level of companies and concentrated on application of modern Intelligent Technologies to talent management’s area. In addition, the presented research takes into account the impact of the events of 2020 associated with COVID-19 [5]. A feature of this article is the presented methodology, adapted to the tasks of human resource departments. The main focus of the work is on knowledge mapping, which is based on intelligent technologies with digital twins and digital tracking of staff. This approach is especially useful for scientific and research organizations.

5 Conclusion

Digitalization and digital transformation (Industry 4.0) reduce the share of routine and non-creative work operations and processes. In modern organizations, human capital is not only growing qualitatively, but also changing structurally: the number of employees is decreasing, at the same time, the intellectual potential of staff and, correspondingly, the value of organizational knowledge are growing faster. In a digital company, a leading place is given to creative employees with great intellectual potential. They form the human capital and ensure the competitiveness of the business. Transformed into human capital knowledge, as the 4th factor of production, acquires the greatest value for companies, therefore, in modern conditions, knowledge management is becoming a key function in a modern organization. Hence the model of a developing organization (Senge [19]) as an organization that knows how to create, acquire and disseminate knowledge and changes its behavior in accordance with new information, original opinions and modern models of thinking. Knowledge management is at the junction of classical human resource management and information technologies. The growth of the value of knowledge in business has led to the separation of the talent management function in the organization’s personnel management system. To identify talents and mobilize the intellectual capital of each employee, the organization’s knowledge is mapped – that is, the identification and fixation of employees with key competencies – carriers of certain knowledge. Progress in IT is
related to artificial intelligence, which is based on machine learning and Big Data Analysis. Accordingly, progress in knowledge management is associated with the expansion of intelligent information models and systems. Authors demonstrate a possibility to implement Artificial Intelligent technologies to human resource management sharing their experience in developing of knowledge mapping system, based on intelligent technologies, for scientific institutions in Russia.

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