

Trends, Factors and Guidelines for the Development of Human Resources for Industry 4.0



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Abstract Human resources have proven to be a determining factor in the implementation of Industry 4.0. This is because the digital transformation of society critically depends on mental attitudes, behavioral patterns, motivational attitudes, the specifics of different generations, and the qualification and competence of people. In light of this, research shows the mutual influence of Industry 4.0 and human resource development. It has been proven that demographic trends, as well as technological trends in conjunction with trends in the transformation of the labor market under the influence of digitalization, have a significant impact on the search for approaches and methods of human resource development adequate for new conditions. This paper substantiates the importance of taking into account the differentiation of generations to create a new digital reality and adapt to it. Based on the identification of key factors of human resource development, the study identifies methods and development techniques of human resources in the context of Industry 4.0 at the organizational level.

Keywords Human resources · Industry 4.0 · Digital transformation · Differentiation of generations · Employee competencies

1 Introduction

Currently, the success of the Fourth Industrial Revolution and the associated achievement of the digital transformation of society depend on the connection between a new reality and a new mentality. Industry 4.0 (as a core strategic representation of the Fourth Industrial Revolution) is associated with technological breakthroughs, integration of the physical and digital world, and cutting-edge technologies in the digital economy. Despite this fact, its actual implementation depends on people and not technology. Finding appropriate human resources for Industry 4.0 is not an applied

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but a fundamental research issue that determines the strategy and tactics of digital transformation. It is the transformation of public consciousness that is the engine of the new industrial revolution.

The transformation of public consciousness is connected to the search for answers to numerous questions: is stability more important than change; are modern technologies hostile or an inevitable simplification of everyday life; what is the social norm; what is acceptable and what is not; what are the ethical boundaries of artificial intelligence, etc. The answers to these questions directly affect the scale and success of digital transformation and the transition to new industrial development. Evidently, the exploration of trends, factors, and guidelines for the development of human resources under the conditions of Industry 4.0 is becoming more relevant to research.

Human resources are not a monolithic mass. Each generation has a specific attitude towards the future, political regimes, the conjuncture of the economy, the hierarchy of public life, etc. Based on this thesis, it is becoming more important to discuss the global changes related to digitalization and look for solutions to the problems of creating modern technologies and adapting to them through specific strategies and mechanisms to the development of human resources, taking into account generational differentiation. Jorge Luis Borges wrote: “Yesterday’s man is no longer the same as today” [4]. This quote not only describes the problem of a person’s inner perception of him/herself but also generally touches on the issue of generations.

It is also necessary to take into account the trends of socio-economic and technological development, which helps to further determine the opportunities for the improvement of human resources development in Industry 4.0. Therefore, modern research also considers demographic, technological, digitalization trends, and transformation of the labor market. It is advisable to benchmark from developed countries as a model example in this case. Developed countries can be considered as a reference point and an example of the development patterns that other countries are likely to adopt in the future. This is also true for revolutionary technological changes. In a particular time frame, everyone lives in the same year and in the same historical stage. The concept of “lag” in progressive development is no longer connected with the “isolation” concept, since digital technologies take individuals out of the system of hierarchies and into horizontal networks of interaction. This interaction is typical for digital generations. However, there is a question about the readiness for new forms of social communication and interaction with people and technologies for older generations. A related research question is—what actions should be taken to develop human resources in Industry 4.0, taking into account the above factors.

Thus, on the one hand, the success of Industry 4.0 depends on the development of human resources. On the other hand, Industry 4.0 itself leads to changes in human resources, approaches, and ways of their development. With this in mind, this paper aims to study the factors, trends, and guidelines for the development of human resources in the conditions of Industry 4.0.

2 Literature Review

The concept of Industry 4.0 has appeared relatively recently—there is only a decade of research concerning the relevant issues [8]. Economics, along with other fields of knowledge, has shifted the focus of studies towards the end-to-end digitalization of the economy and a new technological revolution [26]. This scientific work is based on studies devoted to economic digitalization research and Industry 4.0, reflecting on the transition from digitalization to digital transformation, changing societies and the structure of relations in society [3]. Research on changes in the labor market, trends, and digitalization links with different generations are also considered [14].

An analysis of various scientific sources made it possible to draw several conclusions. The development of human resources in the professional plane is directly related to the issues of the formation of qualified workforce. In modern realities, the need for employees who can create and apply high-tech technologies in their work or learn this quickly is an organizational function. Accordingly, organizations face several skill alignment problems. They need to change the trajectory of employee training and retraining, design new workspaces, organize the high-quality implementation of work associated with employee interaction with computer technology. The availability of the relevant human resources competence profiles is a trigger for a company's development, stimulating the active introduction of Industry 4.0 technologies, including industry-specific ones, robots, Big Data, the Internet of Things—everything that modifies, transforms, and accelerates production processes [7]. The introduction and scaling of modern technologies require adaptation for employees [20].

Modern technologies are not only appropriate to use to improve the efficiency and productivity of labor. They also allow the creation of new formats of human interaction with machines. This helps to improve the adaptation to digital technologies by the older generation. It can also be achieved, for example, by the organization of a pleasant workplace, a working atmosphere, an emphasis on self-development, and employee autonomy [12].

Thus, human resource development should be expanded to the formation of strategies and methods for creating comfortable working conditions in the organization, especially in the digital aspect [25]. This includes professional development, hiring, training, and retention mechanisms. The practice of human resource management is redirected to maintaining an environment of high qualifications and a high level of knowledge [11]. Despite a large number of publications in the designated subject matter, the research of these issues remains insufficient and requires further study. To a large extent, this is due to the novelty of the trends and conditions accompanying Industry 4.0 and the importance of finding ways to develop human resources that are adequate to these trends and conditions. Existing scientific papers usually consider either the issue of human resource development in Industry 4.0 in the context of generations or age groups, or in the context of changes in the labor market under the influence of digitalization, or in terms of organizations' reactions to the changes

taking place. This paper aims to study the relationship of trends, factors, and guidelines for the development of human resources for Industry 4.0. The study covers external and internal factors of human resource development in a new organizational context, which is also its significant distinguishing characteristic.

3 Methods

In order to uncover the problem of human resource development in the context of digital transformation in the economy, a literature review was conducted using databases such as Web of Science (WoS), Elton B. Stephens Company (EBSCO), Scopus, and Google Scholar.

The research selection process is shown in Fig. 1.

The systematic analysis consisted of reviewing publications mainly no older than 2018 (earlier sources were considered in terms of studying the impact of digitalization on different generations and age groups).

Articles in English and German were analyzed as the term Industry 4.0 originated in Germany where strategies of the new industrialization are being successfully implemented [13].

Initially, research was conducted for combinations of keywords from selected subject areas. When formulating keywords for the search, the issues of human resource development in Industry 4.0 in the context of generations, demographic and technological trends in their connection with the transformation of the labor market, digitalization of labor in organizations were taken into account.

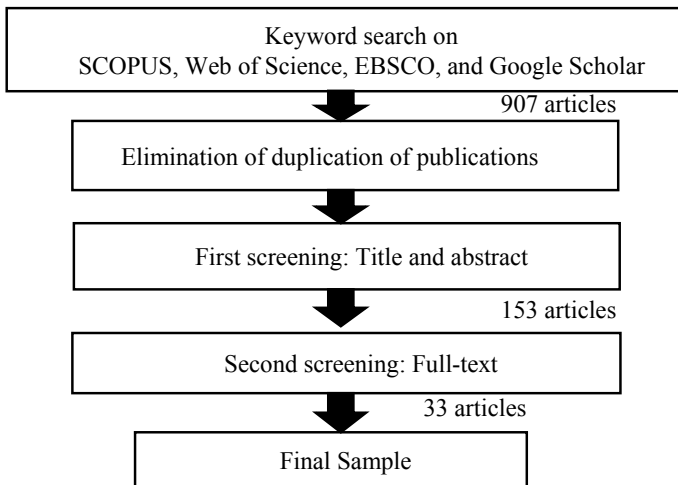


Fig. 1 Research selection process

Based on this logic, content analysis, categorical analysis, comparative, and evolutionary analysis were further carried out, making it possible to identify particular trends, factors, and guidelines for the development of human resources in the context of Industry 4.0.

4 Results

Digitalization is associated with the transformation of society and directly related to the transition from the “Old” world to the “New” one. That is, from a hierarchical system (SPOD—Steady, Predictable, Ordinary, Definite) to a decentralized (network, chaos) system VUCA (Volatility, Uncertainty, Complexity, Ambiguity) [28].

Technological trends in the context of digitalization are [28]:

- digitalization of all life spheres,
- Internet of Things and Internet of everything,
- Big data, machine learning and artificial intelligence,
- transition to the digitalization of personal space,
- development of bio- and neurointerfaces,
- automation and robotization.

The aforementioned trends lead to the automation of cognitive work, changes in the structure of professions, quantitative and qualitative characteristics of human resources.

Digital reality gives birth to “a new person”. This new kind of person is faced with complex and dynamic changes in their surrounding world. It is much more difficult for them to make decisions. This is made lucid by the example that earlier, the most important decision for a person was the choice of a profession. This decision was made once and forever. In the realities of the modern information society, it is necessary to constantly study, develop one’s skills and competencies, retrain, that is, to deal with the problem of choice again and again [6]. Now a person is constantly in the flow and must be able to navigate permanently changing situations. Digital consciousness destroys the usual, traditional guidelines and values, but at the same time, no obvious new ones have been formed. The problem of digitalization is the development of personnel, human capital, what to teach, and how to teach. In modern realities, where everything changes so quickly, it is hard to achieve an understandable goal, and the team, human resources are the most relevant tools for achieving long-term goals.

At the same time, the formation and development of human resources are influenced by more general demographic trends [19]. These include [32]:

- population decline—especially in Russia, according to experts, it will continue until 2024–2025. To the greatest extent, this is felt in the field of recruiting, since the number of applicants is not excessive;

- aging of the population—the median age is 45 years, and 69% of the population have secondary special and higher education;
- an increase in life expectancy from 65 years in 2000 to 73 in 2019. This leads to an increase in the age at the workplace;
- by 2025, generation Z (born in 1997 and younger) will make up about 25% of the total workforce;
- reducing the importance and relevance of the experience of older generations.

These trends lead to the fact that in addition to the aging of the population, the number of young, digital people in the workplace is also increasing, and the mechanism for managing this category of human resource is still questionable. In this regard, a difficult management situation occurs, as it is impossible to find a unified model of human resource development. It is necessary to link the trends of digitalization and their impact on human resources with the general concept of the transformation of society. Society is inexorably changing, and this does not only refer to constant progress, but each stage of change is associated with a transition factor closely related to and implemented by a specific generation.

The theory of generations was developed by Strauss and Howe in 1991 and was first mentioned in their joint publication “Generations: The History of America’s Future, 1584–2069” [10]. It describes generational cycles by the example of the United States of America and is also actively interpreted for various countries and social groups. By itself, this theory is ambiguous. Critics, for example, David Brooks [5], Diana Gomez [9], and Jonathan Alter [2], mostly note that this is not a scientific justification of the patterns of changes in society, but rather a generalized horoscope prediction filled with stereotypes. Nevertheless, the concept of allocating generations to analyze the effects of digitalization on human resources is relevant and acceptable.

The concept of “a generation” implies a group of people born in a certain period and possessing a specific, similar set of values that have developed during the process of socialization, so the conditions, external externalities are the same [10]. The term “generation echo” is also defined. It is the group of the population formed at the junction of the transition from one generation to another. The conflict between generations is not only related to age characteristics but is based on differences in values. There are a lot of interpretations of the names of generations, as well as time intervals to which certain generations belong.

It is already becoming clear that if strategies for adapting to the digital environment of older generations are not developed, this will lead to an increase in digital inequality and several negative effects. Moreover, research shows that there is a digital divide not only between generations but also between different socio-economic groups of older adults [22]. Furthermore, the digital generation perceives the new reality in a completely different way, constructing it rather than adapting to it. At the same time, even children who are prone to interact with smart devices may not trust the information they receive [31].

In addition to demographic trends, it is important to note new trends in the labor market caused by Industry 4.0 [32]:

- the norm of life has become remote employment of the population and freelancing; many IT companies prefer to transfer employees to remote employment, which allows companies to reduce costs, and employees receive additional preferences in the form of convenience. However, there are also limitations: without the skills of self-organization and time management for employees, this mechanism will be a failure. Freelancing as a form of employment is also growing;
- due to the increase in information and its accessibility, education is being transformed, this is due to the technologies of remote interaction. This changes self-education, technologies, approaches, and focuses in education;
- platform solutions (Uber, YouDo, etc.) connecting service providers and consumers without intermediaries. This allows people to switch to self-employed mode;
- the disappearance of traditional professions, and the formation of new ones under the category of “Knowledge”, that is, those professions that are not supported by algorithms, but are based on skills;
- globalization of demand for a number of the most popular professions (basically it concerns the IT sphere);
- polarization of qualifications—demand for human resources categories of “Knowledge”, decrease in demand for the category of “Skills”;
- high rate of productivity changes, their complexity, and novelty;
- general complication of all professions and branches of knowledge.

Thus, it is important to note changes in competencies, but also the complexity of the profession as a whole. For example, just 10 years ago, such a profession as a Web designer was a single one in this segment, and by 2021 it had transformed into about 20 new professions (Fig. 2).

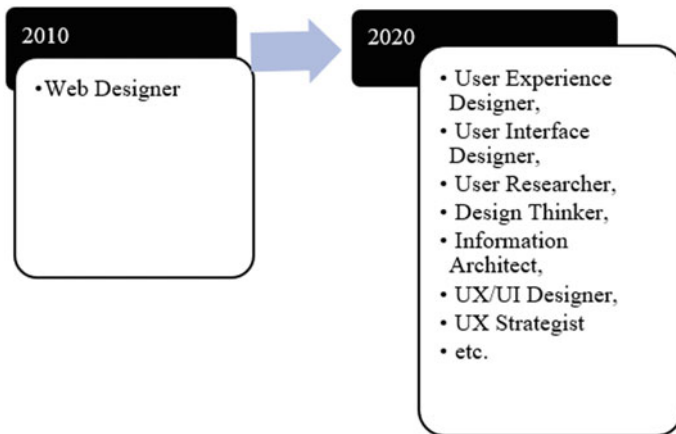


Fig. 2 The tendency to complicate professions by the example of the profession of a Web designer [32]

This indicates that the labor market is shifting, and the problem of human resource development is expanding.

Based on the trends described above, the definition of the problems of Industry 4.0, and the connection of the theory of generations with the transformation of society, it is advisable to note that the complexity of political, social, and business structures in modern realities tends to reach the limit, the point of bifurcation.

The system is in a near-critical state, and at any moment, the “phase transition” can occur—an irreversible change. Nassim Nicholas Taleb, who analyzes the impact of random events on the global economy, in his book *Skin in the Game: The Hidden Asymmetries in Daily Life* [27] notes that in the digital world, it is possible for a person to adequately assess the situation and perceive the growing difficulties only by risking everything and “putting his skin on the line”. All the risk and responsibility must be assumed, not to be afraid to act. The transformation of a human resource is a risk and efficiency; they are inextricably linked, since only by venturing to master new technology, change a profession, one can talk about a human resource transformation, of its consciousness and view of the digital world.

Therefore, to form new strategies for the development of human resources, it is important to assess the factors of effectiveness. These include the influence of expertise and the influence of personality.

The first aspect includes knowledge in a specific professional field, the ability to apply it to solve professional problems, i.e., hard skills. The second aspect is the influence of personality—ways of actions, behaviors that ensure effectiveness outside the professional context—soft skills. The modification of the competence of human resources is primary since knowledge and information that was relevant 5 years ago may be considered outdated today. The general knowledge system has remained relevant, but the specifics of implementation have changed—long-term goals are not set, effectiveness is needed for a particular task only at present. Narrowly focused specializations are emerging and manual labor is transformed into automated labor. It follows from this that basic competence is the willingness to learn, master new knowledge, digital skills are key competencies, and specialization has been transformed into a narrower one that requires in-depth expertise. It is also important to “raise” ready-made experts, but it is much easier to do this than to retrain. In turn, to form an effective human resource management mechanism, it is necessary to focus on “new” expertise, which will include such new management principles as: trust, engagement, teamwork, culture of space for experiments and mistakes.

At the same time, different strategies and tools are required for the formation of digital competencies [15].

This analysis shows that professional competencies are becoming less important. The focus shifts to the modification of people, a systematic understanding of the professional field on the part of the employee—the basic laws, relationships, and solutions. It is all connected exclusively with people and working with them without formal guidance.

The following basic competencies of the digital economy were formulated in the SHL 2019 research [24, 28]:

- Continuous learning and innovation—the ability to adapt, learn quickly and innovate.
- Insights—when creating ideas, analytical and logical skills, critical thinking are required.
- Networking is the ability to build productive relationships, collaborate, and influence others.
- Perfection of execution—determination and consistency of actions when working on a task.

Within the framework of the World Economic Forum, the following Industry 4.0 skills were highlighted: complex problem solving, critical thinking, creativity, people management, coordination with others, emotional intelligence, judgment and decision making, service orientation, negotiation, cognitive flexibility [32].

It is necessary to create a culture of innovation that will involve all categories of generations in the process of digitalization of human resources. Two problems need to be solved: how to overcome the reluctance to develop; how to form a willingness to put into practice all that one has learned.

It is important to understand that people do not want to change. The transformation of competencies is possible only through the process of self-awareness on the spot. Attitudes hinder transformation and adaptation to new realities, especially for older generations of the population. Figure 3 shows a schematic structure of stereotypical human behavior in this sense.

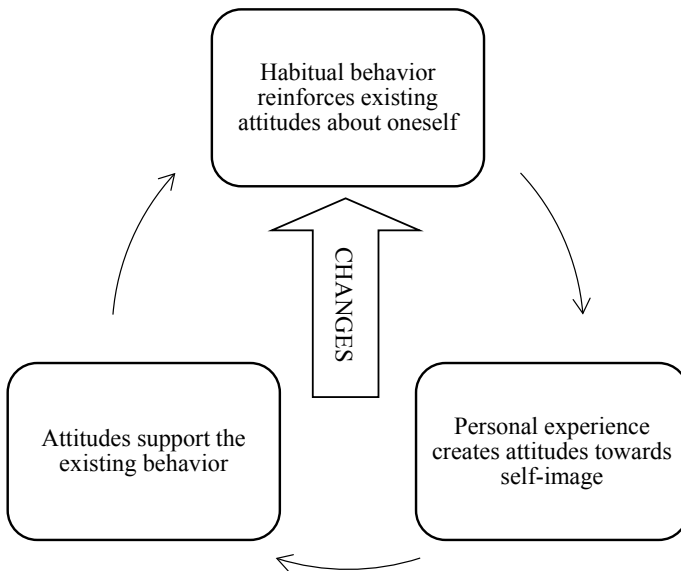


Fig. 3 The structure of stereotypical behavior

The implementation methods of this manipulation include the evaluation of human resource activities, receiving critical feedback, introspection on the part of the individual of his/her weaknesses and strengths, areas for development. As a solution at the organizational level, a number of measures can be taken and such tools can be used [30]:

- Conducting introductory courses, lectures for employees—determining the problematization of what one has to work with during the management process of multi-generational human resources.
- Evaluation of participants in the process of digitalization and modernization of the organization and workflow. This includes dynamic aptitude tests, professional and personal questionnaires, and motivational questionnaires.
- Analysis of the results of this assessment, the formation of quantitative and qualitative reports. These are reports such as “aptitude test profile”, “potential assessment report”, “recommendations on development tactics”.

These solutions can be used both for the main human resources and for reserves.

This is due to the fact that it is necessary to raise and develop personnel independently, and by forming a reserve base, one can be confident in the long-term effectiveness of the organization. So, the use of such tools will allow one to identify and assess:

- the level of “striving to achieve goals”—an assessment of the desire for professional development, career growth, achievement of ambitious goals;
- competencies—assessment of readiness to effectively solve work tasks in conditions of great responsibility, complexity, and uncertainty;
- potential level: moderate level of potential—formation of a development recommendation for the current position; high level—development both in the current role and in the future; very high level—complex developmental tasks are needed.

The determination of the level of one’s potential consists of an assessment of the indicators of “striving for achievements” and “average level of abilities”. Based on the evaluation results obtained, it is more possible to conduct group feedback with a team, plan for an individual course of human resource development, form a group training track for participants with high and very high potential (the result at the moment). This includes project activities and forming a personnel development system (the result is aimed at the future).

5 Discussion

The study showed several results. It is necessary to pay attention to new needs in professions, competencies, and the working environment to determine priorities for the human resources development for Industry 4.0. With this in mind, the paper suggests recommendations for human resources development at the organizational level. At the same time, there are also restrictions on using the proposed guidelines.

The situation is different, for example, for large industrial, medium-sized and small enterprises. Small businesses have a gap in the development of employees' soft skills and hard skills for Industry 4.0 [16]. In addition, it is necessary to consider the shift in the allocation of human resources between different sectors of the economy in various countries [33]. This will allow establishing strategies for personnel development in specific conditions.

The processes of digital transformation are implemented unevenly and with specifics in different regions of the world (including developed and developing economies). The balance of priorities in the development of human resources can change in numerous economic conditions. For instance, it is necessary to provide job security and continuous training opportunities for employees in developing economies such as India under Industry 4.0 disruptions [1]. In turn, for companies in Brazil, the development of methods for evaluating employees in the context of Industry 4.0 and evaluating resources for the transformation of organizations is of particular relevance [21]. For European countries, it is reasonable to involve employees during the implementation of Industry 4.0 [29].

Also, the novelty of the issue of human resource development in the context of Industry 4.0 requires further research. The authors will focus future efforts on studying the differentiation of the directions of human resource development strategies in different conditions of implementing Industry 4.0.

6 Conclusion

Therefore, in the context of Industry 4.0, the development of human resources needs to be considered from several positions.

First, it is necessary to consider human resources development in correspondence with the impact of new trends in digitalization and technologization on the labor market. Transformation on both the demand side and the supply side of the labor market needs to be considered. In this sense, Industry 4.0 sets the conditions for the development of human resources and is at the same time dependent on such development. It covers changes in professions, competencies, working environment, governance approaches, and other issues.

Second, the choice of guidelines and methods for the development of human resources requires taking into account demographic trends and the differentiation of generations. It is necessary to take into account that, first, the general demographic situation is changing, which affects the development opportunities of human resources with different characteristics. Second, different generations demonstrate different mental attitudes and behavioral patterns in the context of Industry 4.0.

Third, the development of human resources receives a concrete embodiment in the plane of the labor market at the level of specific organizations. This determines the importance of developing holistic strategies for personnel development, including the creation of a new digital environment and culture, as well as the adaptation of management models to new demands using specialized methods and tools.

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