EMPLOYEES COMPETENCES FOR INDUSTRY 4.0 IN POLAND–PRELIMINARY RESEARCH RESULTS

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Abstract

Over the last few years, the fourth industrial revolution has attracted academia and practices worldwide, however there are still many gaps related to the Industry 4.0, particularly related to the competences issue, because new concept requires new technology as well as workers with new competences. In the presented research it was assumed that there are Employees competences necessary for the development of Industry 4.0 concept in companies. So the question is, how much are these competences important for Polish companies? If they are meaningful, there will be sought Employees meeting those requirements, which will result in the development of the fourth industrial revolution in Poland. The lack of importance of these competences is interpreted by researchers as a lack of willingness of Polish Employees to develop a new era. The main objective of the presented research was to investigate the importance Employees’ competences, key to the development of Industry 4.0 in Poland. The indirect aim was to diagnose the willingness of Polish companies to implement the new concept, in the aspect of obtained results. In research, there was used survey method, on a randomly selected group of companies.

Keywords: Employee’s competence, Industry 4.0

1 INTRODUCTION

Today, we are facing the new technology revolution, which is often referred to as the fourth industrial revolution [1] defined as ‘Industry 4.0’ or ‘Industrie 4.0’, which was a part of German high-tech strategy [2]. In the paper, there was used German definition of Industry 4.0 as: ‘the ability of ad hoc networking between intelligent machines, production facilities, components as well as storage and transportation systems via the Internet to form powerful value networks’ [3, p. 11]. According to the presented definition, Industry 4.0 brings new standard of value chains. The new concept becomes a response to the current challenges appearing in fast changing environments, related to the transformation of processes caused by the use of new technologies, both existing and new, which work together leading to new opportunities for companies [4, p. 165]. Those technologies include: Internet of Things (IoT), Data Mining, Cyber-physical systems (CPS), etc. [4, 5, 6, 7].

In the result of those technologies, there occur big amount of data, which requires to be stored, processed and analyzed. Another aspect of Industry 4.0 is possibility of linking the virtual and physical world, resulting in interconnection of people, objects and systems, through the real time data exchange [8], what is related to issue of the smart objects. Smart machine, smart product and augmented operator were described as paradigms of Industry 4.0 in [9, p. 469-470].

Considering all presented information, authors have stated that, Industry 4.0 may be perceived as a chance but also as a big challenge for companies, particular in relation to humankind transformation, as Industry 4.0 introduced changes, which have not been experienced by humanity so far [10, p.1].

According to the literature review on the Industry 4.0 topic, it was claimed, that researchers are mainly focused on technology perspective of new concept, however it should be noticed, that human cannot work without the technology, and technology will not work without people. In the result, authors postulate to consider the role and importance of human in the Industry 4.0 concept realization, particularly that with the transformation of the company’s business model, the model of work organization is changing. In the result, there are transformations of the job profile, in terms of managing complexity, abstraction and problem-solving [11,p.53].

According to experts, in Industry 4.0, repetitive operations will be performed by machines or robots, instead of people, who will integrate, manage, control work of machines and analyze large amounts of data, with the use of the newest technology [11]. Considering that, authors assumed that in Industry 4.0 there should be not used term ‘Worker’, but ‘Engineer’, who should be outfitted with a wide range of new competences according to the Industry 4.0 requirements, what was highlighted by many researches (e.g. in [13, 14, 15, 16, 17]).

To sum up, it was stated that in order to introduce Industry 4.0 into business practice, there should be ensured Employees with appropriate competences. In the result, authors have adopted the approach that competences of Employees are one the major challenge for Industry 4.0 development. Considering that, in the presented research, there were adopted the results of German research conducted on the key competences of Employees for development the Industry 4.0 concept. The research questions are defined as:

RQ1: Which Employees’ competences relevant for Industry 4.0 development, are important for companies in Poland?

RQ2: Which Employees’ competences relevant for Industry 4.0 development, should be developed?

In order to answer the question, in the he first part of this paper there was served a background of the conducted research, focused on the Employees competences. In the second part there was described used research method. Third section introduced results of the conducted research. Finally, the last section outlines the contribution of the paper and proposes paths for further investigation of the topic.
2 BACKGROUND

2.1 Competences

Competences can be analyzed at different levels, including: individual, collective or company’s level [13, p.228; 14 p.1222-1224]. In this paper, authors are focused on the individual competences of Employees. Although there are many definitions of the competence in the literature, there is lack of clarity, what was perceived by many researchers (e.g. [18]). With reference to examined definitions of competence, authors stated that [19, 20, 21, 22,23]:

- Competences are creating human potential, including the Employee’s potential (considered in the paper);
- Competences require development;
- Competences are required in order to realize the company’s strategy and to achieve established goals;
- Competences include everything what is required for tasks’ realization (at work, at private life).

Considering all presented information, it was assumed that competences include: knowledge, skills (soft skills and technical skills) and attitude, reflected in actions [24, p.29] (Fig.1).

The knowledge component may be achieved in formal or informal way, including the following types: know-what, know why, know-how and know-who [25, p.12]. The next component of competence is skill, determined by practical activity, including experience [24, p.29]. Finally, attitude express willingness and readiness for using the knowledge and skills in actions [24, p.29].

In the literature may be found categorisation of competences, including the following categories [16, p.10]:

- technical, related to job-related knowledge and skills,
- methodological, consisted of skills and abilities for general problem solving and decision making;
- social, which include skills and abilities of cooperating and communication with others;
- personal consisted of individual’s social values, motivations, and attitudes.

Sometimes there is misunderstanding between the term competence and qualification. Authors claimed that there is linkage between competences and qualification, because competence development aims to identify required competences when qualification should close occurred gaps.

In the result it was stated, that competences are an essential issue, because of the influence on Employee’s work efficiency [26, p.13]. Consequently, it was pointed that, competences are the most valuable capital of the Employer [24 , p.25], which should be well managed and developed.

Focus of the paper relies on the competences for Industry 4.0, as the new challenge for companies, what results in requirement for new competences.

2.2 Research background

Authors of the paper have used research conducted by researchers from Fraunhofer Institute for Factory Operations and Automation (IFF), on the development of competences for Industry 4.0 [11].

The scientists from Germany, were examining competences development on the basis of a non-representative online survey conducted among German companies, accompanied by interviews with science and industry experts. In the survey questionnaire as well as during interviews, there were appeals to existing research (e.g. Deloitte [26] McKinsey&Company [28]. The purpose of the research was, to identify the set of required competences of Employees, in order to implement Industry 4.0. In the result, there was obtained a list of Employees competences, for the Industry 4.0 development, divided for three categories, what was presented in the Table 1.

Table 1. Employees’ competences for Industry 4.0 [11].

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Competence</th>
</tr>
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<tbody>
<tr>
<td>L1</td>
<td>Interdisciplinary thinking and action</td>
</tr>
<tr>
<td>L2</td>
<td>Process’s knowledge growth</td>
</tr>
<tr>
<td>L3</td>
<td>Participation in innovative processes</td>
</tr>
<tr>
<td>L4</td>
<td>Problem solving</td>
</tr>
<tr>
<td>L5</td>
<td>Personal responsibility for decision-making</td>
</tr>
<tr>
<td>L6</td>
<td>Social skills and communication</td>
</tr>
<tr>
<td>L7</td>
<td>Leadership</td>
</tr>
<tr>
<td>L8</td>
<td>Ability to work processes coordination</td>
</tr>
<tr>
<td>L9</td>
<td>Scope of work complex control</td>
</tr>
<tr>
<td>L10</td>
<td>Ability to cooperate / interact with machines</td>
</tr>
</tbody>
</table>

The list of competences developed in [11] and presented in Table 1, was the basis for solving performed research problems (RQ1, RQ2) referring to competences, which should be developed in Polish companies, in the context of Industry 4.0.

According to the German research it was assumed in the paper, that the development of Industry 4.0 in an enterprise is possible only if the competences required for its implementation, are crucial for the company. Otherwise, the perspective for Industry 4.0 is pessimistic.

3 METHODOLOGY

In the presented research there was used the documentary analysis in order to examine state of art of competences issues in the context of Industry 4.0, as well as the survey method conducted in Polish companies aimed to collect information about Employees competences important for Industry 4.0 concept introduction.

There was prepared questionnaire survey, conducted among Employees of manufacturing companies (43% population), trading companies (11% companies), service companies (41% population) and public sector (5% companies). However, 44% of survey participants were Employees of large companies, 33% were representing small companies and rest of them (23%) were from middle-size companies.
With reference to the research question RQ1, respondents of the survey were asked to indicate importance of each Employee’s competence (from Table 1) for Industry 4.0, considering company, where she/he is employed.

4 RESEARCH RESULTS

The subject of the study was research carried out on competences relevant for introduction Industry 4.0 in companies. There were examined 10 competences pointed out in the Table 1. The summary of the obtained results was presented in the Fig.2.

![Figure 2. Importance of Employees competences for Industry 4.0 in Polish companies – summary results.](image)

Considering the summary of the conducted research, it can be noticed that all the examined competences are perceived as important for Polish companies. Among the competences with the highest importance, respondents indicated problem solving (69.84%) and personal responsibility for decision-making (65.08%). Considering both positive answers (low, high importance) four competences were most often indicated, including: ability to work processes coordination (95.24%), problem solving (93.65%), interdisciplinary thinking and action (92.06%) and personal responsibility for decision-making (90.48%).

Authors have noticed an interesting situation with the competence ability to cooperate / interact with machines, for which the results spread almost evenly: for 36.51% of respondents it had high importance, for 33.33% - low importance, and for 30.15% it is not important. Interestingly, no competence was identified by most of surveyed, as irrelevant or without importance.

Moreover authors have checked the answers in distinction of the conducted business activity. The results were shown in Figure 3.

In the result, of the more detailed analysis presented in the Fig.3, it was stated that indications of the employees of the different types of companies are broadly covered. The most frequently identified competences for the Industry 4.0 staff are: problem solving and ability to work processes coordination (in three cases the rating is 100%, which may imply the importance of so called hard skills), interdisciplinary thinking and action, and personal responsibility for decision-making (all four indications are over 90%, what may be spoken in favor for high importance of soft skills). The lowest values were given to two types of skills: social skills and communication (average value was 75%) and ability to cooperate / interact with machines (on average 72%). In authors opinion, the fact that manufacturing companies received significantly lower indication of the importance of specific Employees’ competences for Industry 4.0 – on average 10-20%, it may be worrisome.

In the consequence, results for manufacturing companies were analyzed in details in further research, particularly because the idea of Industry 4.0 is related to the cost reduction, efficiency improvement, higher speed and scale of the production, and better products and services.

A summary of the results of research for manufacturing companies was presented in the Figure 4.

Considering the results of research obtained for manufacturing enterprises (Fig 4.), the following competences of Employees for Industry 4.0 are the most relevant, namely: problem solving (74.07%) and the ability to work processes coordination (62.96%). Both competences are crucial for a manufacturing company. Moreover, in authors opinion it is disturbing, that for the three Employees’ competences it was pointed out by respondents, that the sum of negative responses was a quarter of all answers. These were: participation in innovative processes (25.93% of indications were with lack of importance or completely unimportant), leadership
(25.92%) and ability to cooperate / interact with machines (25.93%).

Another point of view of conducted research inilded the perspective of the company’s size. Results were presented in Fig.5.

For small companies, three Employees’ competences have received maximum values (100% of indications), including: problem solving, personal responsibility for decision making, and the ability to work processes coordination. On the other hand, for large companies, three Employees’ competences have received maximum values (100% of indications), including: problem solving, personal responsibility for decision making, and the ability to work processes coordination, all for 96% of indications. For medium-sized companies, the most relevant were: interdisciplinary thinking and acting, process’s knowledge growth, problem solving, and the ability to work processes coordination.

The obtained results of the research, were also analyzed from the perspective of the job position, including two types, namely: managerial and executive position. Effect of that analysis was presented in the Fig. 6.

The chart presented in the Fig 6, clearly shows the difference in the perceived importance of workers’ competences for Industry 4.0. Managers are more aware of the importance of their competences, than those who work in executive positions, and the difference in responses was as high as 20-25%. Three competences have been rated the highest (100%), namely: problem solving, leadership, and the ability to work processes coordination. Authors claimed that those were related to the soft skills. The same group of respondents, pointed that the lowest importance level is related to hard skills: process’s knowledge growth and the ability to cooperate / interact with machines (63.64%). In the opinion of Employees, the most important are skills: interdisciplinary thinking and acting, problem solving problem solving and optimization skills and the ability to coordinate work processes (91,30%), and least importantly: ability to cooperate / interact with machines (69,57%). According to the executive workers opinion, the most important competences were: interdisciplinary thinking and action, problem solving problem solving and the ability to work processes coordination (91,30%), while the lowest

Figure 4. Importance of Employees competences for Industry 4.0 in polish manufacturing companies.

Figure 5. Importance of Employees competences for Industry 4.0 in polish companies according to the company’s size.

Figure 6. Importance of Employees competences for Industry 4.0 in polish companies according to the job position of the Employee.
level of importance was recognized in the case of the ability to cooperate / interact with machines (69.57%).

5 COMPETENCES REQUIREMENTS OF EMPLOYEES FOR INDUSTRY 4.0 IN POLAND

New technology areas, related to the idea of Industry 4.0, require new competences from the Employees. The most important are the professional competences (technological), which in today's production company is many. Among the new technological areas can be mentioned those directly related to the requirements of Industry 4.0, i.e. such aspects as cybernetic systems integration, advanced production management systems, advanced robotics, complex production data analysis systems, and artificial intelligence applications in the production space. Although there are new technological areas, the list of required competences of the Employee is much broader. What is more, the relevance of so-called soft skills is increasing.

Considering the results of research conducted by authors, it was stated that there is awareness of the importance of the Employees’ competences required for the Industry 4.0 development as well as of the needs for competences in order to ensure introduction of the Industry 4.0 policy into practice.

Authors have attempted to develop perspectives for the development of Employees’ competences for Industry 4.0. Moreover, there was assessed the willingness of Polish workers to undertake the fourth industrial revolution and there were indicated Employees competence which should be developed. It was related to the second research problem stated in the Introduction (RQ2).

Authors claimed, that Industry 4.0 introduction will force Employees to change their competences. Mechanical, repetitive activities will increasingly be performed by machines or robots, and educated people should develop competences related to their creative competences.

In the report of one of biggest Polish companies, which delivers automation solution for industry [12] there was presented the idea of Engineer 3.0 (hereafter: E 3.0) and Engineer 4.0 (hereafter: E 4.0), what was considered in the Table 2, from the perspective of the specific features of those two engineers types.

<table>
<thead>
<tr>
<th>Feature</th>
<th>E 3.0</th>
<th>E 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific person’s features</td>
<td>Logical, analytical, well-organized, predictable, attentive and methodical</td>
<td>Open for changes and diversity, active, perfectionist, communicative</td>
</tr>
<tr>
<td>Approach to procedures and rules</td>
<td>they define actions</td>
<td>they are considered</td>
</tr>
<tr>
<td>Object on concentration</td>
<td>task</td>
<td>people</td>
</tr>
<tr>
<td>Contact with people</td>
<td>Good but only including well-known working team</td>
<td>Very good, good information transfer, for listeners</td>
</tr>
<tr>
<td>Approach to changes/challenges</td>
<td>negative</td>
<td>positive</td>
</tr>
<tr>
<td>The way of work</td>
<td>Calm, from the beginning to the positive end</td>
<td>Perfection with consideration of all details</td>
</tr>
</tbody>
</table>

To summarize, the key soft skills of employees in a modern enterprise, will be primarily concerned with understanding issues and concepts from other disciplines and being open to change and novelty. Authors claimed, that communication skills also intercultural, often with the use of virtual tools will be more important.

The authority of the Engineer 4.0 will still be based primarily on hard, technological knowledge, but the importance of soft skills will be continued, to grow.

6 CONCLUSIONS

To sum up, the partial results of preliminary research on the development of Industry 4.0 in Poland, it was stated, that the perspective on the Employees’ competences is optimistic.

In the authors’ opinion, what was confirmed by research conducted in Polish companies, all competences which should be characterize the Engineer 4.0, are important.

Authors claimed, that those competences should be developed, of the forth revolution enters the Polish business Authors believed, that the Polish Employee is ready for this change, from the perspective of competences. Considering the results of previous research conducted by authors, on the issue of the core competences of enterprise, crucial for the development of Industry 4.0, it was claimed that perspective for Poland is optimistic. However, authors have perceived the problem elsewhere. In their opinion, in order to introduce the industry 4.0 into a business reality, a combination of three following components is required: (1). Enterprise’s Competences, (2) Engineer 4.0 (3) Infrastructure.

While the first two elements can be considered as a chance for the development of Industry 4.0 in Poland, the Infrastructure becomes a clear threat. As it was confirmed in research conducted by MillwardBrown’s [29], only half of Polish companies are manufacturing with the use of robotic production lines, 3% are fully robotic equipped, and 53% of companies are not considering robots in their processes.

On this basis, it can be argued that in Poland, the development of the concept of Industry 4.0 is possible from the perspective of Workers’ competences, but it will not take place without the investment of industry in the infrastructure towards its automation and robotics. Authors of the paper have identified one more threat related to the Industry 4.0 concept introduction, namely untapped potential of Polish Engineers 4.0 and their outflow from the Polish industry. It may lead to the collapse of the 4.0 industry in Poland due to lack of appropriate staff.

To sum up, it was stated, that Polish Employees are ready for the Industry 4.0, in terms of their competences, however there is lack of required infrastructure. Perhaps the awareness of Polish companies will be improved as a result of actions taken by the Polish government in the second quarter of 2017 towards industrial growth based on Industry 4.0. Considering all presented research result, authors believe that they have to conduct in-depth research on the development of the 4.0 Industry in Poland and to continue them for the coming years by seeking factors that favor and inhibit the development of the digital revolution in companies diversified in the context of their size.
7 REFERENCES