

STUDY ON KEY COMPETENCES FOR THE IMPLEMENTATION OF INDUSTRY 4.0 SOLUTIONS

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Purpose: The latest studies in the literature on the subject discuss the topic of future competences in the industry sector. The purpose of this article is to indicate the key competences for the implementation of Industry 4.0 solutions. The presented results are part of wider research (Michna, Kmiecik, Kruszevska, 2021).

Design/methodology/approach: The research methods consist of a comprehensive literature review of the subject under study and the results of empirical research conducted in 2021 based on an anonymous online survey completed by employees from different levels of organization, operating in diverse industries and located in multiple locations.

Findings: Study presents competences with the highest importance for survey participants – problem solving, process understanding, efficiency in working with data; and with the lowest importance – leadership skills and coding skills.

Research limitations/implications: Competences were grouped according to literature study results, chosen group was not always natural for specific competence, which could lead to difficulties in research. The study group was anonymous, it consisted of random employees from multiple organizations, not selected in advance.

Practical implications: The study's results provide knowledge about general perception of competences in Industry 4.0 with a division of specific groups: technical, social, economic, political and environmental.

Originality/value: The study can help HR practitioners and Industry 4.0 specialists in analyzing human resources competences and planning the development of possible competence gaps.

Keywords: Competences, Industry 4.0.

Category of the paper: Empirical research results.

1. Introduction

Globalization, technological progress and knowledge-based economic development caused increase of nonmaterial values such as employee competences. It is essential from organization point view but also important for the functioning of employees in the changing labor market. In actuality, competences more often than not are subject to devaluation and require improvements (Sitko-Lutek, and Jakubiak, 2020). Additionally, in the modern economy, the competitiveness of enterprises is the ability to constantly improve, generate new ideas, introduce new or improved processes, products and services or organizational solutions. These activities require creative employees and transforming their ideas and knowledge into innovative solutions (Michna, 2017). Especially in the realities of Industry 4.0, where technological development requires changes in organizational and personal areas, the subject of competence is actually noticed by researchers and studied in multiple dimensions. In most of the reviewed literature employee competences are shown as barriers as well driving forces for Industry 4.0 Implementation (Michna, and Kruszewska, 2021). Barriers understood as inhibitors or named as challenges are mentioned by (Kiel et al., 2017; Vuksanović Herceg et al., 2020; Stentoft et al., 2019). Competences as a drivers or potentials, which I4.0 could deliver are noted among others as: (Müller et al., 2018; Vuksanović Herceg et al., 2020).

Differentiations of employee competences lead to creation of multiple competences models. One of them proposed by (Szwajca, 2021) relies on a base of 5 levels of needed competences – personal competences, competences related to data, social competences in enterprises, technical competences and competences for functional area of industrial sector. On top of those levels author mentioned management skills and job-specific requirements.

Erol et al. (2016) grouped future competences into the following categories: personal competences, which can be understood as the ability of a person to act in a reflective and autonomous way; social/interpersonal competences such as ability to communicate, cooperate, as well as establish social connections and structures with other individuals and groups; action-related competences, meaning the ability of a person to take individual or socially-constructed ideas and act on them; and domain-related competences, which refer to the ability to access and use domain knowledge for a job or a specific task.

A different point of view is presented in the works of Hecklau et al. (2016). On the basis of the identified challenges, grouped according to the PESTEL analysis: economic (i.e. ongoing globalization), social (i.e. increasing virtual work), technical (i.e. growth on technology and data use), environmental (i.e. resources scarcity) and political (i.e. standardization or data security), authors divided the competences into: technological, methodological, social and personal competences.

The model of future employee competences, proposed by Vrchota et al. (2020), relies on two axes. The first one contains groups of technical and personal competences, while the other axis consists in the classification into needs – “must have”, “should have” and “can have”.

Irrespective of the researcher or model, results in recent studies on the subject of personnel competences in Industry 4.0 are focused around technical and social skills. As mentioned by Vereycken et al. (2021) increased employee involvement would be significant in Industry 4.0. In results presented by authors, prepared on the basis of periodic surveys performed in European companies we could see confirmation of strong positive impact of employee involvement on the newest digital technologies. Researchers also confirm that Industry 4.0 will be related to changing skill requirements and job training practices. In the work of Grzybowska and Łupicka (2017) with results of survey conducted among selected experts in automotive and pharmaceutical industries within transnational companies we could see that entrepreneurial thinking, decision making, efficiency orientation and problem and conflict solving belongs to key competences for managerial staff in Industry 4.0. Deeper analysis of required managerial competences specifically in the quality area was performed by Sumitha et al. (2021). This particular researcher pointed out gaps in the technical, methodological, social and personal competences in Malaysian electronics manufacturer as an example. She investigated competences such as awareness of data security, ability to solve complex problems, increased virtual communication, effective knowledge orientation concerning engineering and management level of employees regardless of geographic location. Another research was performed by Rakowska and Juana-Espinosa (2021) in 2016 and 2019 afresh in Spain, Thailand and Poland, on the subject of major employability skills, competences and main demand trends for it. Study has been performed by researcher on the basis of panel experts from academic and business background. As a result, key employability skills have been identified in all those three countries. What is visible in that research, is that Polish and Thai experts were focused more on IT skills while Spanish experts on social skills development. “Novel and adaptive thinking” was a competence which was constantly perceived as highly relevant in all countries. At the same time, it is worth mentioning that “formal education” and “work experience” significantly lost their value as employability skills in all those countries during the study period.

Another South African research of Industry 4.0 skills from manufacturing perspective has been introduced by Maisir and van Dyk (2021). Performed analysis confirms the importance of soft skills such as problem-solving, critical thinking, collaboration, communication, cross-cultural ability, teamwork, emotional intelligence, lifelong learning, and multiskilling in Industry 4.0.

Discussion related to competences could not be conducted without aspects such as: education, self-learning, knowledge management, skills development and trainings systems. All of the above are definitely connected with presented subject. Competence development could be accomplished by using different methods and techniques. In the research of Sitko-

Lutek and Jakubiak (2020) performed on 2,000 employees in 50 Polish enterprises, 80% of respondents declared learning during working – meaning on-job learning, 70% self-learning by using the internet. An interesting subject in the mentioned research was a fact that the higher the position in organizational hierarchy, the more frequent it is to seek information from professionals outside the workplace. Research also confirms that women more often than men seek competence development through participation in formal courses, training, studies and postgraduate studies. A different research made by Soniewicki and Paliszkiwicz (2019) in Poland on the basis of the above 1,200 questionnaires confirms that intensity of knowledge management process is higher for bigger companies, especially in relation to competitiveness of companies with 250 employees or more. “Enterprises that do not have an implemented knowledge management system are unable to properly respond to market knowledge”. Statement by Michna et al. (2020) also confirms results from above research studies as acquiring new knowledge and using it, is an element of building a competitive advantage. In small and medium sized enterprises, the key factor for knowledge management evaluated by Brzostek and Michna (2016) is to make use of employee latent information and skills.

2. Methods

The elements used in this study were part of a pilot study in the research of barriers and drivers for Industry 4.0 implementations and additionally in the research of usage level of this concept in the organizations from various localizations and within employees from different level of organization (Michna et al., 2021). The survey method was chosen to carry out the mentioned study. Study tools have been designed according to previously planned research (Michna, and Kruszewska, 2020). The survey has been conducted using internet tool available at www.surveymonkey.com. A link with the survey has been directly distributed to potential participants via online communicators available on business and employment-oriented online services. Data collection using an anonymous questionnaire was conducted between 13 and 21 of October 2021. During that time 125 surveys have been finalized. In total, the web page registered 327 visits which gives a 38% response rate. The survey has been prepared in two languages: English and Polish. The respondents had the opportunity to use the questionnaire in their selected language.

Items of the questionnaire were measured using five-point Likert scale, where 1 means definitely not, 2 – rather not, 3 – I have no opinion, 4 – rather yes, 5 – definitely yes. Both surveys contained the same set of questions: metrics and a fundamental group of questions developed on the basis of literature research.

General metrics include items directly related to survey participants: questions related to their country of origin (Poland, Germany, India etc.), role in the company (owner, manager,

engineer, employee etc.), working area (that is department like finance, manufacturing, logistic, quality, IT etc.). The other part of general metrics contained questions related to enterprise; country of operation (Poland, Germany etc.), years of enterprise's existence (0-2 years, 2-5 years, 5-10 years, 10-20 years and more), size of the enterprise: micro with 1-9 employees, small with 10-49 employees, medium with 50-249 employees, and large ones with more than 250 employees, sector of the activity (the following proposed general groups were available: manufacturing, service provider, information, and agriculture), and role of the enterprise in the Industry 4.0 with possible answers as a: provider (of I4.0 services, solutions, products), user (of I4.0 services, solutions, products), user and provider, none of the above.

Main part of the survey contained questions from literature sources such as: Michna and Kmiecik (2020), Müller and Voigt (2018), Vuksanović Herceg et al. (2020) which were arranged in order to support the stated objectives of the generic study: determining the usage of the concept of Industry 4.0 by employees at various levels; determining main barriers and drivers that enterprises might encounter in implementing Industry 4.0 technologies from an employee's point of view. For this detailed study authors decided to present results from section related to competences where the aim was to determine key competences for engineers and specialists in the Industry 4.0.

Statements related to competences have been used to create base for the above-mentioned competences model proposed by Hecklau et al. (2016). PESTEL method and available literature in the study subject have been used to group the studied answers. Survey participants were asked to choose competences for engineers and specialists in the era of Industry 4.0. Table 1 below presents questions with possible choices and their codes.

Table 1.
Questions related to competences

| Question | Item | Choices |
|--|------|--|
| TECHNOLOGICAL competences of engineers and specialists in Industry 4.0 | T1 | Technical skills |
| | T2 | Analytical skills |
| | T3 | Efficiency in working with data |
| | T4 | Coding skills |
| | T5 | Understanding IT security |
| | T6 | Virtual communication skills |
| | T7 | Process understanding |
| | T8 | Problem solving |
| SOCIAL competences of engineers and specialists in Industry 4.0 | S1 | Ability to transfer knowledge |
| | S2 | Accepting work-task rotation and work related change (ambiguity tolerance) |
| | S3 | Time and place flexibility |
| | S4 | Leadership skills |
| | S5 | Motivation to learn |
| | S6 | Decision making |
| | S7 | Communication skills |
| | S8 | Ability to work in a team |
| | S9 | Ability to be compromising and cooperative |
| | S10 | Conflict solving |

Cont. table 1.

| | | |
|--|-----|--|
| ECONOMICAL competences of engineers and specialists in Industry 4.0 | E1 | Intercultural skills |
| | E2 | Language skills |
| | E3 | Time flexibility |
| | E4 | Networking skills |
| | E5 | Entrepreneurial thinking |
| | E6 | Creativity |
| | E7 | Work under pressure |
| | E8 | State-of-the-art knowledge |
| | E9 | Research skills |
| LAW/POLITICAL competences of engineers and specialists in Industry 4.0 | LP1 | Understanding of IT security (Data and personal) |
| | LP2 | Understanding of compliance |
| | LP3 | Standardization |
| ENVIRONMENTAL competences of engineers and specialists in Industry 4.0 | EN1 | Sustainable mindset |
| | EN2 | Motivation to protect the environment |
| | EN3 | Creativity to develop new sustainable solutions |

3. Results

In the group of technological competences authors listed competences such as: technical and analytical skills, efficiency in working with data, coding skills, understanding IT security, virtual communication skills, process understanding and problem solving. Table 2 presents basic statistics for technological field of competences. In detail Table contains: mean value, StDev – standard deviation means average deviation from the mean value, median as an obtained middle value, mode – dominant, the most common value in the sample and lastly N for mode means number of responses for the dominant.

Table 2.

Basic statistic for technological competences

| Variable | Item | Mean | StDev | Median | Mode | N for Mode |
|---------------------------|------|------|-------|--------|------|------------|
| TECHNOLOGICAL competences | T1 | 4,26 | 0,75 | 4 | 4 | 58 |
| | T2 | 4,37 | 0,71 | 4 | 5 | 61 |
| | T3 | 4,43 | 0,69 | 5 | 5 | 66 |
| | T4 | 3,72 | 1,02 | 4 | 4 | 50 |
| | T5 | 4,20 | 0,84 | 4 | 5 | 54 |
| | T6 | 4,17 | 0,83 | 4 | 4 | 52 |
| | T7 | 4,44 | 0,70 | 5 | 5 | 67 |
| | T8 | 4,47 | 0,70 | 5 | 5 | 72 |

Note. StDev – Standard deviation.

Highest mean value 4,47 was achieved for T8 – problem solving. That competence was also the most common answer – 5. It was given 72 times. On the other hand – the lowest mean value was 3,72 for T4 – coding skills.

Table 3 presents similar results for social competences. That group contains such competences as: ability to transfer knowledge, ambiguity tolerance, time and place flexibility, leadership skills, motivation to learn, decision making, communication skills, ability to work in a team, ability to be compromising and cooperative and conflict solving.

Table 3.
Basic statistic for social competences

| Variable | Item | Mean | StDev | Median | Mode | N for Mode |
|--------------------|------|------|-------|--------|------|------------|
| SOCIAL competences | S1 | 4,13 | 0,80 | 4 | 4 | 61 |
| | S2 | 4,02 | 0,71 | 4 | 4 | 72 |
| | S3 | 4,06 | 0,79 | 4 | 4 | 65 |
| | S4 | 3,43 | 1,11 | 4 | 4 | 43 |
| | S5 | 4,30 | 0,74 | 4 | 4 | 60 |
| | S6 | 4,00 | 0,97 | 4 | 4 | 60 |
| | S7 | 4,22 | 0,86 | 4 | 5 | 54 |
| | S8 | 4,11 | 0,91 | 4 | 4 | 53 |
| | S9 | 4,06 | 0,83 | 4 | 4 | 64 |
| | S10 | 3,99 | 0,92 | 4 | 4 | 53 |

Note. StDev – Standard deviation.

In the social area of competences S5, which means motivation to learn, achieved the highest mean value – 4,3. The lowest mean was recorded for S4 – leadership. The most common answers “4” was observed for accepting work-task rotation and work related change (ambiguity tolerance). 72 participants gave such an answer.

Table 4 presents basic statistics for economical competences. That group contained such competences as: intercultural and language skills, time flexibility, networking skills, entrepreneurial thinking, creativity, work under pressure, state-of-the-art knowledge and research skills.

Table 4.
Basic statistic for economical competences

| Variable | Item | Mean | StDev | Median | Mode | N for Mode |
|------------------------|------|------|-------|--------|------|------------|
| ECONOMICAL competences | E1 | 3,90 | 0,94 | 4 | 4 | 58 |
| | E2 | 4,30 | 0,84 | 4 | 5 | 60 |
| | E3 | 3,89 | 0,94 | 4 | 4 | 57 |
| | E4 | 4,18 | 0,75 | 4 | 4 | 63 |
| | E5 | 4,00 | 0,84 | 4 | 4 | 55 |
| | E6 | 4,29 | 0,86 | 4 | 5 | 61 |
| | E7 | 3,95 | 0,98 | 4 | 4 | 49 |
| | E8 | 4,38 | 0,66 | 4 | 5 | 59 |
| | E9 | 3,91 | 0,93 | 4 | 4 | 55 |

Note. StDev – Standard deviation.

The highest obtained mean value – 4,38 for competence E8 – state-of-the-art knowledge, simultaneously with the highest possible modal value – 5 and the lowest value of standard deviation – 0,66 shows that the participants treat the latest knowledge in a given field as an important competence. On the other hand, the lowest mean value 3,89 has been attributed to E3 – time flexibility.

Table 5 presents data for law and political competences. In this area three such competences have been available: understanding of IT security (data and personal), understanding of compliance and standardization. Definite highest mean value of 4,3 was achieved by understanding IT security. Lowest – 4,14 by understanding of compliance.

Table 5.
Basic statistic for political and legal competences

| Variable | Item | Mean | StDev | Median | Mode | N for Mode |
|---------------------------|------|------|-------|--------|------|------------|
| LAW/POLITICAL competences | LP1 | 4,30 | 0,75 | 4 | 5 | 56 |
| | LP2 | 4,14 | 0,80 | 4 | 4 | 55 |
| | LP3 | 4,27 | 0,72 | 4 | 4 | 57 |

Note. StDev – Standard deviation.

The last table, Table 6, presents data and statistics for environmental competences: sustainable mindset, motivation to protect the environment and creativity to develop new sustainable solutions. Developing new sustainable solution got the highest score for mean value – 4,19 while the motivation to protect the environment the lowest – 3,94.

Table 6.
Basic statistic for environmental competences

| Variable | Item | Mean | StDev | Median | Mode | N for Mode |
|---------------------------|------|------|-------|--------|------|------------|
| ENVIRONMENTAL competences | EN1 | 3,99 | 0,86 | 4 | 4 | 60 |
| | EN2 | 3,94 | 1,01 | 4 | 4; 5 | 44 |
| | EN3 | 4,19 | 0,83 | 4 | 5 | 53 |

Note. StDev – Standard deviation.

Figure 1 below presents run chart with mean values for each of studied competences. Independently of the competences area, the lowest medium value has been observed for S4 – leadership while the highest value for T8 - problem solving. Similarly figure 2 presents data for N for mode value – that is the most common answers given by survey participants. Problem solving competence is also one of the most common answer. The same grade was obtained for competence – accepting work-task rotation and work related change – N for mode – 72, meaning 58% of participants consider them as essential. The lowest N for mode value received leadership competence – see Figure 2.

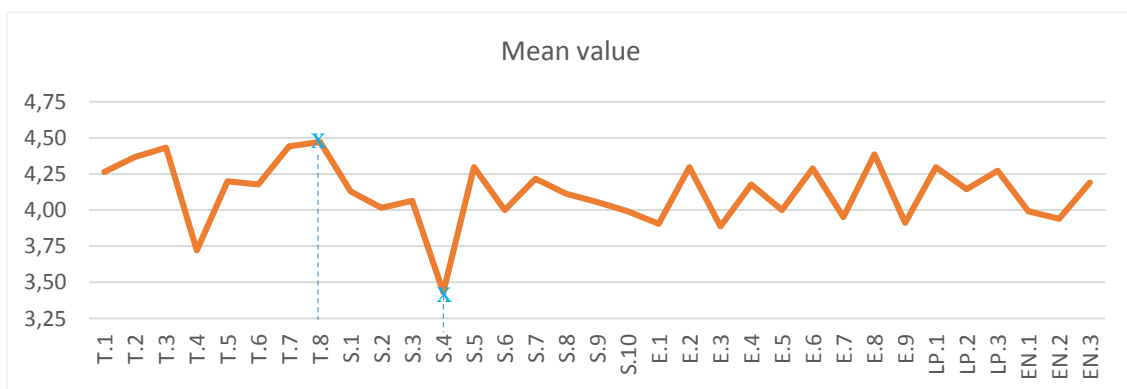


Figure 1. Run chart – mean value.

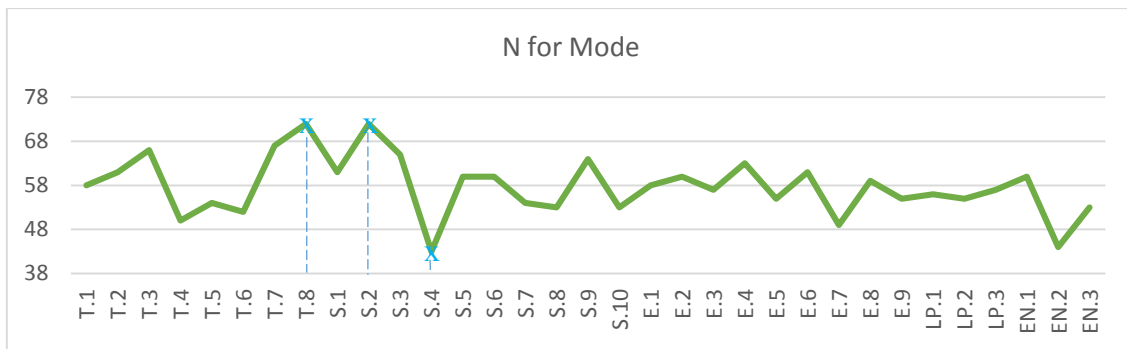


Figure 2. Run chart – N for Mode.

Another way to identify competences with the highest importance for the participants was the sum of positive confirmations of the tested statement. In fact, the answers; 4 – rather yes and 5 – definitely yes, were summed up. During the next step, the % of all results was calculated. Table 7 shows the results in this respect.

Table 7.

% of positive (4 and 5) answers for statements. Data stacked from highest to lowest value

| Item | % | Item | % | Item | % | Item | % |
|------|------|------|------|------|------|------|------|
| T3 | 92 | LP3 | 87,2 | S9 | 81,6 | S10 | 75,2 |
| T7 | 92 | LP1 | 87,2 | T5 | 80,8 | E5 | 74,4 |
| E8 | 92 | E6 | 86,4 | S2 | 80,8 | E1 | 73,6 |
| T8 | 91,2 | E4 | 85,6 | S8 | 80,8 | E7 | 72,8 |
| S5 | 90,4 | S7 | 84,8 | LP2 | 80,8 | E3 | 72,8 |
| T2 | 89,6 | S1 | 83,2 | S6 | 80 | E9 | 72,8 |
| T1 | 88 | T6 | 81,6 | EN3 | 80 | EN2 | 70,4 |
| E2 | 88 | S3 | 81,6 | EN1 | 76,8 | T4 | 64 |
| | | | | | | S4 | 52,8 |

The largest group of people confirmed great importance of T3 – Efficiency in working with data, T7 – Process understanding and E8 – State-of-the-art knowledge. On the opposite side we have EN2 – Motivation to protect environment, T4 – Coding skills, S4 – Leadership skills.

Depending on the methods the most important and the least important competences have been presented in Table 8. Independently of statistics, leadership competence has been chosen as a competence with the lowest importance. Understanding processes and ability to solve the issues together with the latest state-of-the art knowledge reveal themselves as the most important competences for all survey participants.

Table 8.

Summary of importance by basic statistics metrics

| Competences | Acc. to mean value | Acc to mode value | Acc to % of positive answers |
|---------------------|----------------------|-------------------|---|
| The most important | T8 Problem Solving | | T3 Efficiency in working with data T7 Process understanding E8 State-of-the-art knowledge |
| The least important | S4 Leadership skills | | |

Analysis by control variables

For deeper analysis control variables have been used: size of enterprise and its sector. In research with 125 participants, 83 of them were working in large companies, 32 in medium and small ones while 10 were working in micro organizations. 93 organizations represented industry sector while 32 service. Due to this uneven distribution of data, results by control variables were used primarily for illustrative purposes and preliminary analysis. First part of data below represents results by size of enterprise, second one – company sectors.

Table 9 presents basic statistics for competences with highest mean value by company size.

Table 9.

Basic statistics for competences with highest medium value by organization size

| Organization size | Competence | N | Mean | StDev | Median | Mode | N for Mode |
|------------------------------|------------|----|------|-------|--------|------|------------|
| Micro enterprises | S8 | 10 | 4,70 | 0,68 | 5 | 5 | 8 |
| | S7 | 10 | 4,60 | 0,70 | 5 | 5 | 7 |
| | S9 | 10 | 4,60 | 0,70 | 5 | 5 | 7 |
| Small and medium enterprises | T3 | 32 | 4,47 | 0,51 | 4 | 4 | 17 |
| | T7 | 32 | 4,41 | 0,56 | 4 | 4 | 17 |
| | T8 | 32 | 4,41 | 0,71 | 4,5 | 5 | 16 |
| Large enterprises | T7 | 83 | 4,52 | 0,61 | 5 | 5 | 48 |
| | T8 | 83 | 4,52 | 0,67 | 5 | 5 | 50 |
| | T3 | 83 | 4,49 | 0,63 | 5 | 5 | 47 |

Note. StDev – Standard deviation.

For micro organizations the highest mean values were S7 – Communication skills, S8 – Ability to work in a team and S9 – Ability to be compromising and cooperative, while highest scores in small and medium sized enterprises (SME) as well as in large companies were T3 – Efficiency in working with data, T7 – Process understanding and T8 – Problem solving received the highest mean values.

Table 10 presents competences by organization size with the lowest medium value calculation based on participants' grades.

Table 10.

Basic statistics for competences with lowest medium value by organization size

| Organization size | Competence | N | Mean | StDev | Median | Mode | N for Mode |
|------------------------------|------------|----|------|-------|--------|------|------------|
| Micro enterprises | T3 | 10 | 3,80 | 1,23 | 4 | 5 | 4 |
| | E7 | 10 | 3,80 | 1,23 | 4 | 4 | 4 |
| | T4 | 10 | 3,70 | 1,06 | 3,5 | 3 | 4 |
| Small and medium enterprises | EN2 | 32 | 3,53 | 1,05 | 4 | 4 | 14 |
| | E9 | 32 | 3,50 | 0,92 | 4 | 4 | 13 |
| | S4 | 32 | 3,22 | 1,13 | 3 | 4 | 11 |
| Large enterprises | E1 | 83 | 3,88 | 0,94 | 4 | 4 | 38 |
| | T4 | 83 | 3,66 | 1,05 | 4 | 4 | 35 |
| | S4 | 83 | 3,40 | 1,06 | 4 | 4 | 31 |

Note. StDev – Standard deviation.

For micro organizations competences with lowest scores are: T4 – coding skills, E7 – work under pressure and T3 – efficiency in working with data, for SME organizations – S4 – leadership and E9 – research skills, as well as EN2 – motivation to protect the environment received the lowest values. Participants working in large companies pointed out leadership as a less important issue too, but additionally considered T4 – coding and E1 – intercultural skills as less important.

Table 11 shows competences with the highest N-mode value. The presented competences are those which were predominant among the answers. Data from table 12, on the other hand, presents answers with the lowest N-mode values.

Table 11.

Basic statistics for competences with the largest number of the most common answers by organization size

| Organization size | Competence | N | Mean | StDev | Median | Mode | N for Mode |
|------------------------------|------------|----|------|-------|--------|------|------------|
| Micro enterprises | S8 | 10 | 4,70 | 0,68 | 5 | 5 | 8 |
| Small and medium enterprises | S9 | 32 | 3,91 | 0,73 | 4 | 4 | 21 |
| Large enterprises | T8 | 83 | 4,52 | 0,67 | 5 | 5 | 50 |

Note. StDev – Standard deviation.

Table 12.

Basic statistics for competences with the lowest number of the most common answers by organization size

| Organization size | Competence | N | Mean | StDev | Median | Mode | N for Mode |
|------------------------------|------------|----|------|-------|--------|------|------------|
| Micro enterprises | T4 | 10 | 3,70 | 1,06 | 3,5 | 3 | 4 |
| Small and medium enterprises | S4 | 32 | 3,22 | 1,13 | 3 | 4 | 11 |
| Large enterprises | S4 | 83 | 3,40 | 1,06 | 4 | 4 | 31 |

Note. StDev – Standard deviation.

Large enterprises pointed out problem solving, SME – ability to be compromising and cooperative while micro organizations ability to work in a team most often as the important competences. Large and SME marked leadership skills as less important while for micro organizations considered coding skills the least important.

Next verification was based on summary percentage results of answers 4 and 5. The highest values presented in table 13 confirm significance of studied abilities and the lowest summary percentage presented in table 14 could lead to the conclusion that the studied competences are less important for surveyed companies.

Table 13.

Highest % of positive (4 and 5) answers for statements by company size.

| Organization size | Competence | 1 | 2 | 3 | 4 | 5 | 4and5 |
|------------------------------|------------|-------|-------|--------|--------|--------|---------|
| Micro enterprises | S1 | 0,00% | 0,00% | 10,00% | 50,00% | 40,00% | 90,00% |
| | S10 | 0,00% | 0,00% | 10,00% | 50,00% | 40,00% | 90,00% |
| | S8 | 0,00% | 0,00% | 10,00% | 10,00% | 80,00% | 90,00% |
| Small and medium enterprises | T3 | 0,00% | 0,00% | 0,00% | 53,13% | 46,88% | 100,00% |
| | T7 | 0,00% | 0,00% | 3,13% | 53,13% | 43,75% | 96,88% |
| | T8 | 0,00% | 3,13% | 3,13% | 43,75% | 50,00% | 93,75% |
| Large enterprises | T7 | 0,00% | 0,00% | 6,02% | 36,14% | 57,83% | 93,98% |
| | E8 | 0,00% | 1,20% | 4,82% | 44,58% | 49,40% | 93,98% |
| | T2 | 0,00% | 1,20% | 6,02% | 43,37% | 49,40% | 92,77% |

Table 14.

Lowest % of positive (4 and 5) answers for statements by company size

| Organization size | Competence | 1 | 2 | 3 | 4 | 5 | 4and5 |
|------------------------------|------------|--------|--------|--------|--------|--------|--------|
| Micro enterprises | T4 | 0,00% | 10,00% | 40,00% | 20,00% | 30,00% | 50,00% |
| | T7 | 10,00% | 0,00% | 30,00% | 10,00% | 50,00% | 60,00% |
| | T2 | 0,00% | 0,00% | 40,00% | 0,00% | 60,00% | 60,00% |
| Small and medium enterprises | S4 | 3,13% | 31,25% | 18,75% | 34,38% | 12,5% | 46,88% |
| | E9 | 0,00% | 15,63% | 31,25% | 40,63% | 12,50% | 53,13% |
| | EN2 | 3,13% | 15,63% | 21,88% | 43,75% | 15,63% | 59,38% |
| Large enterprises | S4 | 2,41% | 21,69% | 24,10% | 37,35% | 14,46% | 51,81% |
| | T4 | 2,41% | 14,46% | 19,28% | 42,17% | 21,69% | 63,86% |

The highest % of positive confirmations for micro organizations can be seen for competences such as: ability to transfer knowledge, conflict solving and ability to work in team. For SME the highest score was achieved in: efficiency in working with data, process understanding and problem solving. Large companies also confirm the importance of process understanding but additionally pointed out state-of-the-art knowledge and analytical skills. For competences with the lowest values of % with answers 4 and 5 we have: coding skills, process understanding and analytical skills for micro organizations, leadership, research skills and motivation to protect the environment for SME and coding and leadership skills for large companies.

Table 15.

Summary of importance by organization size

| Competences | Organization size | Acc. to mean value | Acc to mode value | Acc to % of positive answers |
|---------------------|------------------------------|------------------------------------|---|------------------------------------|
| The most important | Micro enterprises | S7 Communication skills | S8 Ability to work in a team | |
| | Small and medium enterprises | T3 Efficiency in working with data | S9 Ability to be compromising and cooperative | T3 Efficiency in working with data |
| | Large enterprises | T7 Process understanding | T8 Problem solving | T7 Process understanding |
| The least important | Micro enterprises | T4 Coding skills | | |
| | Small and medium enterprises | S4 Leadership skills | | |
| | Large enterprises | | | |

Independently of statistic types, the less important competences were coding skills and leadership. Technical competences such as: process understanding, problem solving but also communication skills, being compromising and cooperative, ability to work in a team and with data were definitely important for the surveyed companies.

Analysis of mean values by company sector have been presented in table 16 – containing the highest values, and in the table 17, containing the lowest value.

Table 16.

Basic statistics for competences with highest medium value by sector

| Organization sector | Competence | N | Mean | StDev | Median | Mode | N for Mode |
|---------------------|------------|----|------|-------|--------|------|------------|
| Industry | T8 | 93 | 4,54 | 0,64 | 5 | 5 | 56 |
| Service | E2 | 32 | 4,53 | 0,72 | 5 | 5 | 20 |

Note. StDev – Standard deviation.

Table 17.

Basic statistics for competences with lowest medium value by sector

| Organization sector | Competence | N | Mean | StDev | Median | Mode | N for Mode |
|---------------------|------------|----|------|-------|--------|------|------------|
| Industry | T4 | 93 | 3,30 | 1,09 | 4 | 4 | 35 |
| Service | T4 | 32 | 3,81 | 1,09 | 4 | 5 | 11 |

Note. StDev – Standard deviation.

Results verified by the control variable – sector, present similar results as previous analysis. Problem solving competence is important for the industry sector. For service companies language skills obtained the highest mean. Leadership skills received the lowest results, independently of organization type. Exactly the same competences got the same results in case of analysis by N for mode statistics. Problem solving and language skills received the highest values, leadership the lowest.

Language skills importance has been confirm also by analysis of % positive answers. Data presents table 18. Additionally, process understanding received 94,62% of positive answers. Analysis also confirms the lowest importance for leadership skills with 59,38% in service companies and 50,54% in Industry sector – table 19.

Table 18.

Highest % of positive (4 and 5) answers for statements by company sector

| Organization sector | Competence | N | Mean | StDev | Median | Mode | N for Mode |
|---------------------|------------|-------|-------|-------|--------|--------|------------|
| Industry | T7 | 0,00% | 0,00% | 5,38% | 37,63% | 56,99% | 94,62% |
| Service | E2 | 0,00% | 3,13% | 3,13% | 31,25% | 62,50% | 93,75% |

Note. StDev – Standard deviation.

Table 19.

Lowest % of positive (4 and 5) answers for statements by company sector

| Organization sector | Competence | N | Mean | StDev | Median | Mode | N for Mode |
|---------------------|------------|-------|--------|--------|--------|--------|------------|
| Industry | S4 | 3,13% | 6,25% | 31,25% | 25,00% | 34,38% | 59,38% |
| Service | S4 | 2,15% | 29,03% | 18,28% | 37,63% | 12,90% | 50,54% |

Note. StDev – Standard deviation.

Table 20 presents summary data for all types of analysis: by mean value, by N for mode, and % of positive answers. Based on those data, it can be concluded that for industry sector process understanding and problem solving are the key competences, while service companies rely on language skills. Leadership skills for both types of companies are definitely less important in the Industry 4.0 reality than other competences.

Table 20.
Summary of importance by company sector

| Competences | Organization sector | Acc. to mean value | Acc to mode value | Acc to % of positive answers |
|---------------------|---------------------|----------------------|-------------------|------------------------------|
| The most important | Industry | T8 Problem solving | | T7 Process understanding |
| | Service | E2 Language skills | | |
| The least important | Industry | S4 Leadership skills | | |
| | Service | | | |

4. Discussion and conclusion

The aim of this article was to present the latest research results related to Industry 4.0 and the competences that the research group indicates as important for the era of new technologies. The conducted analysis of the anonymous questionnaires provided general information on the perception of the subjected aspects. Basic statistics were used to analyze the data. The authors, based on the average value, the number of the most common answers, i.e. the "N for mode" value and the percentage of positive responses, obtained the results on the perception of competences in the era of industry 4.0.

Problem solving competence has been pointed by multiple participants. On the basis of statistics, this competence is important mostly for large companies and the industry sector. Together with competences such as efficiency to work with data, process understanding and the state-of-the-art knowledge it is clear that in large enterprises, especially from industry area, those competences are needed on a daily basis. In small and medium sized enterprises, the ability to be compromising and cooperative was also important. As companies were multiple task must be performed using limited resources, being able to compromise and the ability to cooperate are easily understandable needs. Similarities have been found in micro companies as well. Ability to work in a team and communication skills have been found to be important for those types of organizations. In relation to service companies, it was not surprising to see that language skills and ability to communicate, which are the main "tool" for business continuity, were considered the most significant. On the other hand, leadership competence turned out to be the least important for the survey participants. Despite the statistics used and control variables leadership received the lowest results.

This research was not free from limitations. Competences were grouped according to literature study results. This meant that a chosen group was not always natural for specific competence, which could lead to difficulties in research. The study group was anonymous. The survey was taken by random employees from multiple organizations, who were not selected in advance and who sometimes did not even have any general knowledge about Industry 4.0 basics. Uneven data distribution by sector and size companies meant that presented results could be used mostly for illustrative purposes and preliminary analysis. Moreover, it is recommended to investigate presented subject in specific company sector and for a chosen employee level to obtain even data and more representative conclusions.

5. Summary

The study investigated the subject of competences in Industry 4.0. On the basis of anonymous survey via online tool, participants representing manufacturing industries and service companies identified key competences in the new era of technology development. Study results reveal that aside from technical skills, the crucial role in Industry 4.0 is played by soft skills such as ability to work in team, problem solving, communications skills and ability to work with data. It is worth adding, that based on the results, leadership skills became less important for survey participants than other studied competences.

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