1 INTRODUCTION

The term “Industry 4.0”, whose synonym is ‘Industrie 4.0’, was proposed in 2011, in order to achieve technological innovation leadership of the German economy [1]. Since then, it becomes one of the most popular manufacturing topics among industry and academia, worldwide, however it may be named in different way, in various countries. Similar strategies were e.g. “Industrial Internet” in USA [2], “Internet plus” in China [3], ‘Future of Manufacturing’ in UK [4]. Moreover, that concept has been perceived as the fourth industrial revolution with extreme impact on future manufacturing [5].

Industry 4.0 may be considered from the perspective of the basic technologies, goals of the idea, and selected scenarios. [6, p. 3928]. In the paper, authors assumed that the Industry 4.0 is defined by the following key elements, including:

- Cyber-physical systems (CPS), with the feedback of cyber systems and physical one, resulting in new level of integration characterized by interaction and coordination of computational processes with physical processes [7, p.1] with use of sensors, actuators, control processing units and communication devices. [8, p.25],
- Internet of things (IoT) referred to everyday objects (physical) turning into so-called “smart things” by Internet connection [8, p. 28],
- Smart factory, built on the idea of a decentralized production system, where machines and equipment are improving processes through automation and self-optimization and human beings and machines communicate with each other as in a social network [6],
- Other technologies e.g. wearables, augmented reality applications, autonomous vehicles (incl. drones), or big data analytics [8, p.25].

To sum up, the concept of Industry 4.0 describes the future of manufacturing “affected” by IT, where processes are realized by networked human and machines on the basis of smart objects in order to perform required tasks and goals in the CPS environment with big amount of data and common digitalization.

According to results of literature review made on the Industry 4.0 in [9], authors claim that the awareness of the Industry 4.0 is still increasing, however the highest level was achieved by European countries, particularly Germany, although there can be observed great interest in Industry 4.0 in China and USA (Table 1).

**Table 1. Number of papers about Industry 4.0 per year and per country.**

<table>
<thead>
<tr>
<th>Database</th>
<th>Number of papers</th>
<th>Per Country (top 5)</th>
<th>Per Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCOPUS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>211</td>
<td>2017</td>
<td>57</td>
<td>437</td>
</tr>
<tr>
<td>China</td>
<td>31</td>
<td>2016</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>23</td>
<td>2015</td>
<td>106</td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>22</td>
<td>2014</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>21</td>
<td>2013</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Web of Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>115</td>
<td>2017</td>
<td>15</td>
<td>236</td>
</tr>
<tr>
<td>China</td>
<td>32</td>
<td>2016</td>
<td>143</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>11</td>
<td>2015</td>
<td>15</td>
<td>46</td>
</tr>
<tr>
<td>Austria</td>
<td>10</td>
<td>2014</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>10</td>
<td>2013</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Republic</td>
<td></td>
<td></td>
<td>2012</td>
<td>1</td>
</tr>
</tbody>
</table>

There were used two electronic databases, to collect academic research papers that: (1) contained one of identified terms: “Industry 4.0” or ‘Industrie 4.0’ in the title, (2) were published in journals, conference proceedings or book series; (3) were written in the English language, (4) were available at the date of 20.05.2017.

Data presented in the Table 1 confirmed, that Industry 4.0 is a young concept with only a five – years past, so far. The concept is well-examined by German researchers, who have...
the biggest contribution in the concept development, arising from many projects realized under that topic.

Considering high attraction to the concept of Industry 4.0 and many unknowns related to the short time of its existence, there are many emerging challenges. Authors claimed, that one of the most relevant challenge is related to the competences issue.

It was assumed, that the Industry 4.0 concept introduction into business activity requires changes, including the competences’ changes. Considering that, authors have adopted the results of German research conducted on the key competences, that the companies should master for development the Industry 4.0 concept.

The research questions are defined as:

RQ1: Which company’s competences relevant for Industry 4.0 development, are important in Polish companies?

RQ2: Which company’s competences relevant for Industry 4.0 development, should be developed in Polish companies?

In order to answer the questions, in the he first part of this paper there was served a background of the conducted research. In the second part there was described used methodology. Third section introduces 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

With reference to the literature review, authors claimed, that competences are frequently interchangeably called skills or know-how [9, 10]. It was assumed, that competences can be analyzed at individual, collective or company’s level [11, p.228; 12 p.1222-1224]. The individual competences are used for description of the people’s competences, collective competences are describing competences of a group of people, and finally company’s competences concern the organizational abilities of a company. In this paper, authors are focused on company’s competences.

In the paper, company’s competences were defined as the company’s ability to perform activities in order to achieve established goals with the use of owned resources (knowledge, abilities, skills and values) [12 p.1221; 13, p.605].

2.2 Research background

The research carried out by the German researchers from Fraunhofer Institute for Factory Operations and Automation (IFF), on the development of competences for Industry 4.0 [14], made an important contribution to research results, presented in the paper.

Research about competences development carried out in Germany, were based on a non-representative online survey conducted among German companies, accompanied by interviews with science and industry experts. The survey questionnaire and interview guide referred to existing research (e.g. Deloitte [15] McKinsey&Company [16]). The purpose of the research was, to identify the set of competences that are required for companies, in order to implement Industry 4.0. In the result, there was identified a set of competences, whose development is key to the application of Industry 4.0 assumptions. The final list of company’s competences was presented in the Table 2, in distinction on category of orientation.

Table 2. Company’s competences required for introduction Industry 4.0 [14].

<table>
<thead>
<tr>
<th>Category of orientation</th>
<th>Competences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology/ data processing</td>
<td>- data evaluation and analysis, - IT systems safety, - artificial intelligence / algorithms, - user-support</td>
</tr>
<tr>
<td>Process/ customer</td>
<td>- process management, - customer relationship management (CRM), - business analysis IT, - e-commerce/online marketing</td>
</tr>
<tr>
<td>Infrastructure/ organization</td>
<td>- knowledge of specialized IT systems, - administration of networks and databases, - IT systems architecture, - privacy policy.</td>
</tr>
</tbody>
</table>

The list of competences developed in [14] and presented in Table 2, was the basis for solving research problems (RQ1, RQ2) referring to competences, which should be developed in Polish companies, in order to be able to implement Industry 4.0.

According to the research of German scientists, it was assumed in the present study, 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 research conducted by authors, there was used survey research method, which is a method of gathering information, in an organized manner, about the object of research, from a sample or all units of population [16, p. 1].

The survey was 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 middle-size companies and rest of them (23%) were from small companies.

With reference to the research question RQ1, respondents of the survey were asked to indicate importance of each competence (from Table 2) for the company, where she/he is employed.

4 RESEARCH RESULTS

Considering the analysis of the summary of the results, authors claimed that, not all competences for Industry 4.0 are equally important for companies (Fig. 1, Table 3).
Table 3. Competences for Industry 4.0 [5].

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Data evaluation and analysis</td>
</tr>
<tr>
<td>P2</td>
<td>Process management</td>
</tr>
<tr>
<td>P3</td>
<td>Customer relationship management (CRM)</td>
</tr>
<tr>
<td>P4</td>
<td>Knowledge of specialized IT systems</td>
</tr>
<tr>
<td>P5</td>
<td>IT systems architecture</td>
</tr>
<tr>
<td>P6</td>
<td>Privacy policy</td>
</tr>
<tr>
<td>P7</td>
<td>Business analysis IT</td>
</tr>
<tr>
<td>P8</td>
<td>IT systems safety</td>
</tr>
<tr>
<td>P9</td>
<td>Cloud storage</td>
</tr>
<tr>
<td>P10</td>
<td>User support</td>
</tr>
</tbody>
</table>

Half of the respondents, were pointed out five types of competences with a high importance level on the company, namely 67% respondents pointed out data evaluation and analysis and the same score was obtained by customer relationship management (CRM), process management was indicated by 63% of respondents, IT systems safety - 59% and administration of networks and databases 56% of the examined people.

The remaining competences were assessed as high important or low important, although the percentage share of those indications was similar. An interesting fact was that none of competences has been identified by most of the respondents as completely unimportant or without any importance.

According to a more detailed analysis of the obtained results, the indication of the manufacturing companies Employees, fit in with results obtained from all companies, without sector diversification (Fig.2). For manufacturing companies, Industry 4.0 competences with the highest importance were process management (78%), customer relationship management (CRM) (67%), data evaluation and analysis, IT systems safety (59%) and privacy policy (56% of indications).

4.1 Competences for Industry 4.0 with reference to type of business activity

According to the results of research in manufacturing companies, the most relevant competence for Industry 4.0 was process management (according to 78% of respondents). On the other hand, CRM was the most important (86%) in the trading companies, what was the result of the type of business.

For service companies the most important was the competence related to the data evaluation and analysis (69% of indications). The most surprising was that employees in from the public sector, indicated that competencies such as data evaluation and analysis and privacy policy were most important in their businesses (Fig. 2).
The results of carried out research were also analyzed in terms of the size of the enterprise. With reference to research result, for large enterprises, the most relevant competence for Industry 4.0, was administration of networks and databases (according to 76% of respondents). Authors claimed, that it could be an evidence of the high level of digitization implemented in these companies. On the other hand, in medium-sized companies, CRM was the most important competency (74% of indications). It might be a result of that, they primarily engage in customer-focused business. For small businesses, the competence of data evaluation and analysis had the highest importance level according to 69% of respondents (Fig. 3).

5 PERSPECTIVES OF INDUSTRY 4.0 CONCEPT DEVELOPMENT IN POLAND

In the result of connection of (1) results of German researches showing the set of company’s competences for development of Industry 4.0 with (2) results of research conducted by authors of the paper on the importance of these competences in Polish companies, there was made an attempt for determination a perspective for the development of Industry 4.0 in Poland. Moreover, authors have assessed the willingness of Polish companies for the digital revolution and there were indicated competences which should be developed in Polish companies towards a new age. In the result, the second research problem (RQ2) was solved.

With reference to the aggregated data, it should be stated that all competences for the Industry 4.0 development are important for Polish enterprises, where only in 5 cases, the significance of which has been assessed as large, and the others as minor. However, authors believed that there are conditions for the Industry 4.0 development, in Poland.

Authors claimed, that the competence, that should be developed in particular is artificial Intelligence/algorithms, because it was indicated as important only in 56% of the all indications. By analogy, there were made the same conclusions after analysis of answers Employees from manufacturing companies.

With reference to the results of research carried out on companies, according to their size, it was stated that there is a positive perspective of the Industry 4.0 development in Polish companies. An interesting fact is that, the most ready for the next stage of the industrial revolution are medium – sized and small enterprises. It is a result of that, the entire population of the medium-sized companies, covered by the survey, indicated the following competences: data estimation and analysis and CRM, as important. In the case of small companies, there was similar situation with the competence of administration of networks and databases. However, in large companies, none of those competences was pointed as important in 100%. Considering that, authors stated that, it may be an evidence of seeking the area where small companies could be competitive with large one, e.g. by using modern, innovative technology solutions that are part of Industry 4.0 concept.

To sum up, authors of the paper assessed the perspectives for the Industry 4.0 development, according to the result of conducted research, as moderate optimistic.

However, company’s competences required for the Industry 4.0 development, are important for Polish enterprises, unfortunately only in part this importance level has been assessed as high. In order to confirm that conclusion, there should be noticed that none of the competences was rated by the majority of the respondents as without any importance.

With reference to the RQ2, there were determined recommendations for manufacturing companies, depending on the company’s size, including the following recommendation according to the competences, presented in the Table 4. Recommendations include:

- DF - definitely develop;
- M - maintain the importance level;
- SD- successively develop the importance level.

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1 It was assumed, that division on large, medium-sized and small companies refers to the number of Employees: large enterprises employ 250 or more employees, medium – sized have less than 250 employees and more than 50, small company employs less than 50 employees.
about the development of the 4.0 Industry in Poland, which are convinced, that there is a need for in-depth research towards industrial growth based on Industry 4.0.

by the Polish government in the second quarter of 2017 companies may be improved in the result of actions taken technologies. Authors believes that, the awareness of Polish concept or its identification only with innovative assessment may be a result of the misunderstanding of new Industry 4.0 in terms of competences, but critical self-companies have the potential for the development of by authors of the paper, it should be concluded, that Polish

3.0 stage, and only 6% think they are at the stage of Industry entrepreneurs believe that their company is at the Industry table 4.0 in companies of all sizes.

CONCLUSIONS
To sum up the partial results of preliminary research on the development of Industry 4.0 in Poland, it should be noted that the perspective is moderately optimistic. Companies' competences for the Industry 4.0 development are important for majority of Polish companies, however in authors' opinion, they should be developed.

However, it should be remembered that the concept of Industry 4.0 becomes to be promoted and for many entrepreneurs it is still unknown and/or incomprehensible. It may be provided results of other research e.g. Astor company [18], where it was indicated that 40% of Polish entrepreneurs believe that their company is at the Industry 3.0 stage, and only 6% think they are at the stage of Industry 4.0.

Considering that with the result of research conducted by authors of the paper, it should be concluded, that Polish companies have the potential for the development of Industry 4.0 in terms of competences, but critical self-assessment may be a result of the misunderstanding of new concept or its identification only with innovative technologies. Authors believes that, the awareness of Polish companies may be improved in the result of actions taken by the Polish government in the second quarter of 2017 towards industrial growth based on Industry 4.0.

Taking all presented conclusions into account, authors are convinced, that there is a need for in-depth research about the development of the 4.0 Industry in Poland, which should be continued next years in order to find out factors that favor and inhibit the development of the digital revolution in companies of all sizes.

Summarizing the presented recommendation, it should be stated, that in Poland, in small companies the greatest number of competences require giving the highest importance level. In the consequence, small companies are faced to the greatest challenges in the field of the digital industrial revolution of the 21st century.

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