Industry 4.0 and its impact on employees' age

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Abstract

Development of industrial environment and changes in technologies always brings negative influence on companies and employees, because of the fundamental skills and abilities. The main objective of the paper is to discover potential relations between the age of workers and (1) knowledge of 4.0 industry concept, (2) threats of new technologies and (3) future expectation of technology changes. There were defined three hypotheses, focused on connection between defined variables. To verify these hypotheses there was used questionnaire survey, distributed in engineering companies in Czech Republic, Germany and Canada. Gained data was put under statistical evaluation by Pearson's chi-square test of independence. According to processed data there was confirmed only one dependence between age of workers and foreknowledge of industry 4.0 (significance is 0,001, intensity of the dependence is 0,630).

Keywords: Industry 4.0, industrialization and automatization, unemployment, circular economy.

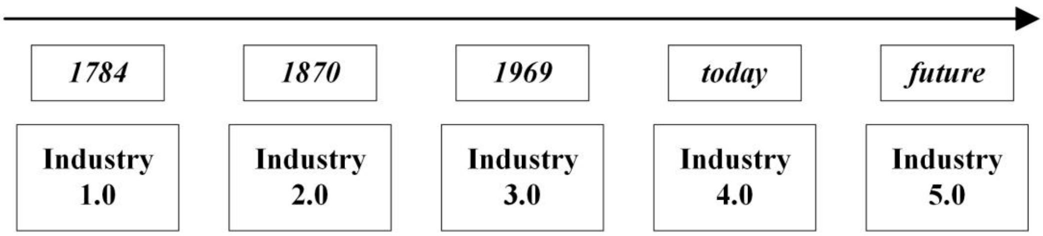
Introduction

Industrial environment and all including companies have to adapt their approaches, technologies, and strategies according to industrial changes, which are provided by industrial revolutions (IR) as a kind of answer to actual industrial production. In the present time, there is already concept Industry 4.0 which requires high digitalization of all processes in company and organization in connection to the implementation of automatization into production. All past IRs and IR 4.0 required changes in employees' minds because of the technology changes.

Cline (2017) mentioned, that one-third of companies plan to adapt their corporate environment components of IR 4.0 by process digitalization for effective production.

During the development of industry, there were four steps till now, how companies and industries adapted their production systems (see Pic. 1). IR 1.0 changed occasional production into mass production by the employment of machinery (approx. since 1784). IR 1.0 was established by finishing a steam machine and its production. As IR 0 there was applied only hand-made production within hand-tools. At the moment, when companies started with mass production and assembling lines, which replaced simple machinery, we can define IR 2.0 (approx. since 1870). Lean philosophy as Kanban production, Just-in-time transportation prepared the situation for IR 3.0 (since 1969). During IR 3.0 there were implemented computers, corporate networks, and internet as a kind of support of production on the way to digital transformation and outsourcing of specialized process and production. During all industrial stages, there were required skills, abilities and experiences of workers. IR 4.0 moves companies to massive digitalization and automatization of the production systems, which lead to clouding and virtual process (future IR 5.0).

Figure. 1: Industrial revolution in time



Source: Own work according to Cline (2017).

Concept IR 4.0 provides smart factory creation because of the requirements of the market. The basic essence of the smart factory is strong integration, automatization and continuous optimization of the working environment in linking to production facilities and equipment within cyber-space and cyber systems. Development of innovative solutions, followed by the implementation into corporate lines requires intensive investments, which help to stabilize time-consuming projects on the way of creation long-time competitiveness of Czech industrial companies. Producers of equipment, software, and industrial companies need a specific platform, which provide development, function verification and compatibility of new solutions in semi-industrial conditions and in interaction within actual technologies (Fettig et al., 2018; Ematinger, 2017; Koren, Shpitalni, 2010; Nayak, Dürr, Rothermel, 2015).

IR 4.0 consists of a mix of technologies, which help to make flexible production systems (e.g. robotic manipulation, cutting, additive production or smart conveyors. Due to both of flexible connections of universal production devices and sophisticated driving systems, there is possible to use the same equipment in different operations, which are planned in optimal ways according to specific needs. For the production of new products, there could be employed simulation processes and virtual environment, in which companies could eliminate potential threats as kind of optimization before starting new production line and launching a new product on the market. Whole simulation process provides a reduction of waste time and support cost-effectiveness before launching. A lot of companies use cloud services as a kind of support both of data collecting and data processing of whole production, which help to improve individual areas in company as quality management, equipment maintenance, usually marked as crucial part of industry 4.0 for modern and future production (Český institut informatiky, robotiky a kybernetiky, 2018).

The main essence of IR 4.0 is designed on the base of the German initiative, which was focused on the way of cooperation creation of academics and practitioners in companies in the production process as answer for performance claims (Bundesministerium für Wirtschaft und Energie, 2017). Czech Ministry of Industry and Trade (2015) implemented a philosophy of IR 4.0, which includes principles of the German initiative as well as Industrie du future (France), Fabrica Intelligente (Italy), Industrial Internet (USA). All of these concepts describe processes in the implementation of digital technologies into production equipment in connection within the internet. At the same time, there is required new thinking and mind setup of the staff because of their skills and abilities. From a general point of view, IR 4.0 combine both rational and irrational thinking of staff, who provides a specific value for building self-confidence of target customers as well as enquiring and more judicial to offering (Hecklau et al., 2016; Tomek, Vávrová, 2017, p.10-13).

Gatullo et al. (2019) describe IR 4.0 from point of view, how it influences different management approaches. These approaches are as follow:

1. Staff time capacity (time data collection in real time, providing fast reaction to potential falls and risks, and its connection to key documents because of real-time updates);
2. Orientation on services (orientation is assessed for a future base, how to create products, which meet customer's requirements, solving their problem in the combination of virtual space, humans, services, and internet offer product composition);
3. Virtual production (creation of virtual production environment support management of physical flows, using GPS systems and eliminate potential risks);
4. Decentralization (material's requirements in the company are decentralized to lower levels; if is make a failure, there is applied centralization to higher levels to help to solve the failure);
5. Modularity (modular approach maintains prompt reaction in case of changing product setup; production documentation must be modular to integrate new procedures, technologies, and other required items);

6. Interoperability (it provides communication between individual elements of a virtual world such as human, production units and systems which could be marked as crucial).

All of these elements reflect a strategy of the company, reacting to the current situation in different fields such specification of used business model, innovation's context, employment's needs or technology development.

Description of IR 4.0 implementation is usually sensed as a kind of challenge, what has to be reached in the context of corporate strategy, vision, and mission. In this way, it leads to corporate autonomy in production and supports the development of staff skills on the pathway to making opportunities, strengthening competitiveness and improve staff working-life balance (Fettig et al., 2018; Reischauer, Schober, Obermaier, 2016).

Due the virtualization as one of key part of IR 4.0 workers can find critical elements in production system and state product solution to prevent or minimize these critical elements, which leads to elimination of staff injuries and develop safety of working environment (Winge et al., 2019; Reissová, Šimsová, Hášová, 2017). As implementation of IR 4.0 is improved situation of staff safety and working environment advancement as key processes leading to higher productivity and satisfied employees (Lundberg, Rollenhagen, Hollnagel, 2009; Lindberg, Hansson, Rollenhagen, 2010; Reichel, De Schoenmakere, Gillabel, 2016).

All areas of IR 4.0 line up to staff opinion about the situation after implementation. This opinion is impacted by doubt of claim of a wide audience for eco-friendly production, reusing or repairing old technologies for new purposes. This approach is based in the so-called circular economy, which intensifies in corporate practices with no regards to industry or country.

Circular economy helps to discover new availing of used products, generated waste or used materials on the way of creating new products. Because of raw-material shortage, there is important to get a new form of source materials for the advancement of companies, industries, regions and of course whole countries (Benton, Hazell, Hill, 2015).

Circular economy brings in connection to industry 4.0 new potential values for all stakeholders' group on the way to connect them whit high responsibility for people, nature and other environments (Reichel, De Schoenmakere, Gillabel, 2016; Reike, Vermeulen, Witjes, 2018).

Circular economy considers all kinds of waste such ground to reuse and redesign these wastes. Specific vigilance interrogates long-term products, for which have to find new alternate usage against to landfilling or burning. By potential utilization of waste instead of new sources, there is increasing requirements on relevant workers and their knowledge, abilities and other skills in connection to their profession (Kiørboe, Sramkova, Krarup, 2015; Ingebrigtsen, Jakobsen, 2007).

Methods and Data

The main objective of the paper is to discover potential relations between the age of workers and (1) knowledge of 4.0 industry concept, (2) threats of new technologies and (3) future expectation of technology changes.

There was realized questionnaire survey between workers in engineering companies in the Czech Republic and Germany. These companies operate in Brno and Stuttgart. The purpose of the research was to verify if workers have awareness of industry 4.0 and potential changes in this industry revolution. For this survey, there were asked 350 workers, from which decided to participate 110 workers from engineering companies (return rate was 31,43%). To processing, there were used only 95 questionnaires forms, which were completely fulfilled.

Gained data were processed by IBM SPSS Statistics 25. Then, there was applied calculation of dependency between two nominal variables by means of contingency tables and Pearson's chi-squared test. Pearson's chi-square test for independence of variables provides a basic view on the relationship between variables and help to show the specific intensity of the dependency.

Results

There was employed Pearson's chi-square test of independence between chosen variables, which afford to define potential influence. During analysis, there was an applied test of dependency with the paucity of external influence. On the base of the described theory, there is an assigned hypothesis, which had to be transformed into a statistical hypothesis. These statistical hypotheses are designed of the null form (as follow). In case of acceptation of the alternative hypothesis, there is a change in explanation from "there is no dependence" to "there exists dependence", which could be considered as statistical hypotheses (and could be put under statistical evaluation):

- $H1_0$: age of workers does not influence the foreknowledge of industry 4.0;
- $H2_0$: age of workers does not provoke potential future threat in 10 years;
- $H3_0$: age of workers does not impact new technology implementation of industry 4.0.

The main problem of Industry 4.0 concept is that it is still unknown by the industrial environment, managers of manufacturing companies and as well by appropriate employees. In case they know this concept, they usually have a kind of myth in their minds. Therefore, authors want to answer if working experiences, theoretical knowledge can impress potential acceptation of the concept in individual corporate fields (with no reference to the kind of industry).

There were participated 95 employees, which are employed in three locations, in German (Stuttgart area) and in the Czech Republic (Brno area) and in Canada (Windsor area, Ontario). These locations were chosen on connection to their focus in the heavy-machinery industry. For the purpose of the research were asked their employees, from which coincide to participate and deliver fulfill questionnaire only 95 persons. Their answers were categorized and put under evaluation by chosen statistical methods.

Table 1 shows relations between factors of threat expectation in the future and consciousness of industry 4.0 as a concept. It is obvious that employees consider their working positions as substantial for the company and they don't feel any potential threat because of the implementing of automatization.

Tab. 1: Pivot table of variables in linkage to the age of the workers

			20-29	30-39	40-49	50-59	60-70	Total	
H1	foreknowledge of industry 4.0	nothing important / naturalness	8	3	10	4	1	26	95
		no impact on my person	1	4	1	3	2	11	
		changes in employment	7	10	5	6	5	33	
		changes with possible adaptation	6	6	6	4	3	25	
H2	New technologies	threat	4	5	7	6	8	30	95
		opportunity	18	18	15	11	3	65	
H3	comprehension of industry 4.0	fiction	1	2	2	3	0	8	95
		behind us	1	2	2	1	1	7	
		computer coming	1	6	1	3	6	17	
		robots	5	3	5	1	2	16	
		digitalization	14	10	12	9	2	47	
Total			22	23	22	17	11		

Source: Own work by authors.

According to premises, there is a kind of limitation because some cells have zero value, which usually requires merging of separated answers. All of these values were put into a determination of proposed affinities and evaluation by Pearson's chi-square test for variable independence.

From the realized test of independence, there was employed Pearson's chi-square test for independence. Due to the processing of the data, there was important to reach the significance level of 95%. This level could be described as the situation, in which exist 5% fault in case of choosing an alternative hypothesis. This error value is recall as significance, regarded as a level of reliability. If the value of significance is less than 0,05 than is possible to accept the alternate hypothesis and is possible to conclude the existence of dependence between chosen variables.

In Table 2 there are situated results of the Pearson chi-square test of independence, which are connected to defined hypotheses H1-H3. From these results, there is found just one dependence on 95% significance level (it is given by significance value under 0,05). According to previous note there, only one dependence was found: Age of workers and foreknowledge of industry 4.0 (H1), where significance is 0,001. The power of the dependence is given by the contingency coefficient, which circulates in range ⟨0; 1⟩. Values by zero are considered as weak, Vice versa, values close to 1 represent strong power. The intensity of observed dependence reaches the value 0,630, which is quite strong. Therefore, hypothesis $H1_0$ is declined and is chosen alternate hypothesis $H1_1$.

Hypotheses H2 and H3 have high significance values, which provide no statistical validation of dependence between variables. For H2 was significance at 0,873; for H3 significance value was 0,284.

Tab. 2: Gained values of the processed test of independence

	Pearson value	Significance	Intensity
H1: Age of workers and foreknowledge of industry 4.0	44,655	0,001	0,630
H2: Age of workers and new technologies	1,231	0,873	0,136
H3: Age of workers and comprehension of industry 4.0	18,704	0,284	0,467

Source: Own work by authors.

The main problem of the industry 4.0 concept is that a lot of managers and employees don't know the specification and relevant definition, which help them to improve their work setup and single work. From the point of view of the country of the company, it is obvious that industry 4.0 would be well known mainly in Europe. Arntz, Gregory, and Zierahn (2016) mention that workers in OECD countries fear of the automatization, which replaces them in production. Therefore, it is necessary to rebut apprehension and destroy myths, connected to industry 4.0. This situation confirms the work of Krzywdzinski, Jürgens, and Pfeiffer (2015).

Discussion

The main objective of the paper is to discover potential relations between the age of workers and (1) knowledge of 4.0 industry concept, (2) threats of new technologies and (3) future expectation of technology changes. These relationships significantly support the future development of the company in the context of IR 4.0 implementation. By this development, there is a strengthening of realized business activities as a process of producing all requested product solution (both tangible and intangible). For that, there is important to have professional knowledge about industrial environment and fields such engineering, electrotechnology, building industry, or chemistry, which held a specific quantity of employees (Černíková, 2018; Ambrozová, Koleňák, Pokorný, 2016).

Technology development attacks on staff minds, where appear fear of job loss. This fear is usually the due implementation of smart factory concept, including phases such as automatization, robotization and digitalization, and their adoption by production system in the company and all other affinitive fields. In case of implementation claim of IR 4.0 concept into a company, there is providing a lot of suitable amount of information, how IR 4.0works, what it needs for quick and regular adaptation into production, technical aspects, and potential of technological progress (Rojko, 2017).

Regardless of the fear and low complex knowledge, companies esteem concept IR 4.0 as a huge opportunity for own development. Because of IR 4.0 knowledge broadcast among managers, they already see the necessity of staff education and increasing their qualification, especially in working professions. That necessity leads to threats of staff dismiss (Malý, 2017; Telukdarie et al., 2018).

Conclusion

There exist a huge problem in companies in the implementation process of new technologies and requirements' changes for staff qualification. In both business and marketing activities, there will be work variations, when is revolve reduction of pre-set business offers, and all staff will start with creative work (Malý, 2017). From point of HR view, all potential changes will not be radical, because companies still must care about their employees, train them, support their motivation and stimulate them (Malý, 2017; Armstrong, 2007). By this long-time care would be reached positive influence of staff expectations about planned changes (Kohnová, Papula, Salajová, 2019).

According to the defined objective, there were stated three hypotheses. These hypotheses were evaluated by Pearson's chi-square test of independence. In results, there was found only one dependence between the age of workers and foreknowledge of industry 4.0 (H1), where significance reaches 0.001 and intensity is 0.630. Other hypotheses (H2, H3) did not match significance value and there is not possible to declare statistical dependence.

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