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PILOT STUDY OF READINESS OF CZECH COMPANIES TO IMPLEMENT THE PRINCIPLES OF INDUSTRY 4.0

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ABSTRACT

This article describes results of the survey, which was conducted in the context of investigating the readiness of selected companies in the Czech Republic to implement the principles of Industry 4.0. The main objective of the survey was to analyze the level of a basic knowledge of this topic in enterprises, the existence of appropriate strategies, responsible persons, and the general awareness among employees.

KEYWORDS

Internet of things, industry 4.0, innovation, information and communication technology, cyber physical system.

Introduction

Long-term forecasts and trends of global development show that information and communication technology will continue to play a leading role among innovation technologies. Trends such as cloud computing, big data and Internet of Things are very important today, but it seems that they will remain very important over the next 10-15 years [1]. For example, the document Global trends 2030 [2] emphasizes ICT as one of four key technological areas:

- information and communication technology,
- technologies pertaining to the security of vital resources (food, water and energy needs),
- new health technologies,
- new manufacturing and automation technologies.

Manufacturing and automation technologies are crucial for the deployment of ICT and at the same time they also represent one of the key segments of the portfolio of the Czech economy with a strong influence on the Czech labor market.

Theoretical background

There is no doubt that ICT play a key role in the development of the whole of society. ICT will be shaping the global economy, social, and military developments as well as the world community's actions pertaining to the environment in the future. Information technology will provide global access and pervasive services; social media and cybersecurity will be large new markets.

Among the TOP 10 strategic technology trends according to the Gartner Group are [3]:

- The digital mesh
    - the device mesh,
    - ambient user experience,
    - 3D printing machines.
- Smart machines
    - information of everything,
    - advanced machine learning,
    - autonomous agents and things.
- The new IT reality
    - adaptive security architecture,
    - mesh app and service architecture,
    - IoT architecture and platforms.

Advanced system architecture and virtual reality are examples of symptoms of the new important wave of changes.

The current ICT trends do not only emphasize the social networking role of the internet. The internet is now also a platform for communication among machines and products. The internet offers a complete solution that goes beyond the potential and possibilities of traditional manufacturing industries.

All these changes are very significant and this new wave of changes is called the new, fourth industrial revolution. This revolution has started changes and movements that have never been experienced in society before.

To better understand the term 'fourth industrial revolution', the main principles of the previous three industrial revolutions should be remembered. The first industrial revolution was based on steam power and mechanization in industry. The second revolution was caused by electricity and mass production and connected with 'hard automation'. The third industrial revolution was based on computers and it was connected with 'flexible automation'.

Finally, the current fourth revolution is also based on ICT but is associated with 'cyber physical systems'.

Fields such as automation, robots or digitalization of everything are important, and again the internet plays a key role – in the form of the internet of things (IoT) or rather the internet of everything [4–7]. This is the reason why we sometimes call the changes of Industry 4.0, 'smart factory' [8] or 'factory 4.0' [9–11]. This designation is a continuation of the term 'digital factory' which has been used in previous years.

The basic principles of Industry 4.0 are therefore the connection of machines, work pieces and systems, and businesses are creating intelligent networks along the entire value chain that can control each other autonomously [12–14].

Industry 4.0 is a way to improve production processes, to increase the productivity for batch size equal to 1, to reflect individual demands and short term wishes. It helps to reduce lead time and time to market. It helps to reduce product development time ad-hoc networking within cyber-physical systems. It helps transparency in real time, to make faster and more flexible decision making, to archive global optimization in development and production.

Industry 4.0 means making important efforts not only at a technological but also at a national level. A good example has been set by the German government. The German Federal Ministry for Education and Research currently offers 183 different documents related to this topic. For example, there is a project of the future, 'Assembly 4.0' which was presented with the project of the month award in

2016. Industry 4.0 was also proposed and adopted as a part of the 'High-Tech Strategy 2020 Action Plan' of the German government. [15] The general expectation is a growth of Industry 4.0 in Germany until 2020 by about 1.7% each year – mainly in chemistry, manufacturing, ICT and farming.

Similar steps have been taken in other industrially developed countries like the USA (in the 'Industrial Internet' document [16] and China (in the 'Internet+' document [17] and in the ambitious plan 'Made in China 2025' [18]. The Chinese government declares here that the country is aiming at Industry 4.0 implementation.

It is very important to note that the Czech government also strongly supports the Industry 4.0 trends in the document 'The national strategy Industry 4.0' published in September 2015 [19]. It was prepared and guaranteed by the Czech Ministry for Industry and Trade. Not only technological trends are elaborated here, but the changes in the labor market are highlighted as well.

Last but not least the new study programs specialized on Industry 4.0 are available now for students to study at universities in many countries. The Czech Republic or Poland are good examples.

Methodology – formulation of the aim and research questions

The motivation for this survey were not only the current technological trends but the published manufacturing studies oriented towards Industry 4.0 penetration – on the global level [20] and on the national level in Germany [21–23].

The first of these surveys was the most significant. It was done by the Infosys – a leader in consulting, technology, outsourcing and next-generation services and by the Institute for Industrial Management at the University of Aachen in Germany. The survey analyzed more than 400 companies in industrially highly developed countries – China, France, Germany, the United Kingdom and the United States. It shows the level of maturity of Industry 4.0 and the key findings of this study are as follows [20]:

- 85% of manufacturing companies globally are aware of the potential of technologies for increasing asset efficiency,
- however, only 15% of enterprises surveyed have so far implemented dedicated strategies to this end by analyzing data from their machines,
- the research revealed that the largest improvements planned over the next five years are in the areas of information interoperability, data standardization and advanced analytics,

- it is interesting that one fifth of companies believe that by 2020 will achieve anything beyond recognizing the potential of the Industry 4.0 concept.

The results of the survey declare that from all the five analyzed countries (China, France, Germany, the UK and the US); China is the leading innovator and has the highest percentage of early adopters (57%). Germany is in fourth place with only 21% of early adopters. The German attitude and its wide support of Industry 4.0 is a big inspiration for the Czech economy and companies. There are many German investors and owners of companies in the Czech Republic and there is also close business cooperation between both countries, with a large volume of mutual exports.

Sample description and data collection

This paper deals with a survey of the penetration of Industry 4.0 principles in Czech companies and general preparation of Czech companies for this new trend.

The main research questions in this survey are as follows:

1. Does a company attempts to implement the principles of Industry 4.0?
2. If a company does not apply the principle of Industry 4.0, which of factors represents the main reason?
3. Which of factors motivate a company to implement Industry 4.0?
4. Does a company have any strategy for Industry 4.0?

To be able to answer the research questions, a special questionnaire form was created which was made available for the companies on the website.

Data collection was carried out by completing the web form in June/July 2016. Overall, 161 companies were addressed and 25 of them have fully answered the entire questionnaire, which makes for 15.5% response rate.

For a better understanding of the results, it is important to get familiar with basic characteristics of the respondents, both in terms of sectors of their main action, size, and ownership.

Respondents that answered the questions consisted mainly of companies operating in the automotive (28%) and engineering (24%) creating thus a half of the respondent's sample. The category "other application sectors" included areas such as the furniture industry, the manufacturing of electric motors and plastics, or statistics and consulting services.

Business Sector	Ratio
● Automotive	28.0 %
● Electrical	4 %
● Aviation and defense	4 %
● Construction	8 %
● Engineering	24 %
● Manufacturing	12 %
● Other:	20 %

Companies that completed the questionnaire may be divided by size (by the number of employees) as follows:

Number of employees	Ratio
● 1 - 9	0 %
● 10 – 49	8 %
● 50 – 249	24 %
● 250 and more	68 %

Two-thirds of the respondents are represented by large companies with the number of employees reaching over 250 and only one-third of the sample is represented by small and medium-sized enterprises. Interesting is the composition of the sample by the share of foreign participation. Companies with foreign participation form 44% of the participating companies and the remaining respondents were from domestic companies.

Results presented in this paper should be analyzed also with regard to who completed the questionnaire on the behalf of the company. The following table shows a high proportion of senior managers – from the ranks of top management, directors and board members – who participated in this survey.

The significant portion of high positions of respondents in the sample is also very important in terms of the obtained data reflecting the importance the business attribute of the topic of Industry 4.0. A smaller proportion of IT specialists and managers may be caused by the perception of Industry 4.0 not only as a technological issue but also as a comprehensive and strategic matter.

Respondent´s position in the company	Ratio
● CEO, owner or a board member	32 %
● Middle management	12 %
● IT management	4 %
● Office worker	4 %
● Top management	44 %
● Lower-level management	0 %
● IT specialist	0 %
● Other position:	4 %

Research results

In the survey, the respondents were asked for readiness and the level of penetration of Industry 4.0 principles into their business. Annotated summary of selected answers is provided further in this paper. For completeness, it should be added that companies were further questioned on key software applications, and also on future plans related to this concept of Industry 4.0, i.e. what areas, instruments, and procedures enterprises plan to implement within 2 and 5 years period. With regard to the extent of this paper, these additional answers are not included in this paper.

The results of the survey here are presented in a simple manner. Each question that was included in the questionnaire is accompanied by a table summarizing the percentage of responses to each option followed by a brief commentary.

Question 1: Does your company attempts to implement the principles of Industry 4.0?

	Ratio
● We have been dealing with the topic of Industry 4.0 for more than one year	40 %
● We are trying to implement Industry 4.0 in our company at this moment	20 %
● We know the term Industry 4.0 but we have not considered its implementation so far	20 %
● We have already met the term Industry 4.0 but we have no idea what exactly the topic covers.	8 %
● We have not yet heard about Industry 4.0	12 %

Based on the data obtained from the survey, the Pareto rule could be applied. The fifth of the respondents indicated that they have never come across the notion of Industry 4.0 or that they do not know what exactly the term means. We may thus conclude that the average knowledge about this topic is very good. The majority of respondents (80%) stated that they are familiar with the Industry 4.0 concept. Within this group, only one-fifth of the total number of companies stated that they do not consider implementing this concept even though they know its principles.

Question 2: If your enterprise does not apply the principles of Industry 4.0, which of the following factors represent the main reason?

	Ratio
● Little awareness of the topic Industry 4.0	75 %
● High cost of Industry 4.0 solutions	37.5 %
● The absence of government regulations	0 %
● Lack of leading companies in Industry 4.0	0 %
● Insufficient skills and training	12.5 %
● Lack of trust in the security of some of the areas of Industry 4.0	12.5 %
● Unclear business benefits originating from the implementation of Industry 4.0 solutions	37.5 %
● The absence of government incentives	12.5 %
● Lack of methodological support	12.5 %
● Low application rate of Industry 4.0	25 %

Answers to the question, what influences the non-application of the principles of Industry 4.0, reported predominantly low awareness (75%), the high costs associated with the implementation of Industry 4.0 (37.5%), and unclear business benefits (37.5%), followed by low degree of application of the industry 4.0 solutions in practice (25%).

Question 3: Which of the following factors motivate you to implement Industry 4.0 in your company?

Conversely, the implementation of Industry 4.0 is supported in particular by the company's vision (60%), followed by pressure from the customers (56%), economic reasons related to cost reductions (48%), the activities of competitors (48%), market requirements (48%), and by effort and creativity of own employees (48%).

	Ratio
● Activities of the competition	48 %
● Market demands	48 %
● Product and marketing strategy	28.0 %
● Pressure from the customers	56.0 %
● Pressure from the suppliers	12 %
● Economic reasons – lowering the costs of the company	48 %
● Company strategy focusing on the development of Industry 4.0	12 %
● Industrial associations	8 %
● Government regulations	4 %
● Government incentives	12 %
● Global economic crisis	0 %
● Pressure on sustainable development	32 %
● Best practices	20 %
● Trends in the IT market	24 %
● Enterprises that implement Industry 4.0 are perceived positively	28.0 %
● Company vision	60 %
● Effort and creativity of the own employees	48 %

Question 4: If you are currently dealing with the topic Industry 4.0 in your company, do you have any strategy that describes future plans?

	Ratio
● We don´t have any strategy for Industry 4.0	39.1 %
● We don´t have any strategy but we are preparing one	30.4 %
● We have such a strategy and it is part of the company strategy	17.4 %
● We have such a strategy but it is not part of the company strategy	8.7 %
● We have such strategy and also many complex analyses and drafts of model process that could be implemented within the concept Industry 4.0	4.3 %

For the implementation of the principles of Industry 4.0 having an existing strategy is crucial. How-

ever, many of the companies do not have strategies containing enough details or do not have any strategy at all. In addition, according to the obtained answers, companies does not have so far even assigned a responsible person (40%), although some of them consider it (20%). Only a fifth of the companies said that such a person has already been assigned.

Conclusion

Generally, the information gained from the selected enterprises shows that Czech companies have a quite high awareness of the existence of a trend known as Industry 4.0. This readiness manifests itself the most at upper-level management rather than on the average employee level. Companies still lack own Industry 4.0 strategy and they don't have assigned responsible persons who would take care of further deepening of principles of Industry 4.0.

Higher penetration of the principles of Industry 4.0 into companies is so far inhibited by unclear benefits and in many cases the high costs associated with the application of Industry 4.0 solutions. Industry 4.0 also belong among the topics that are being strategically initiated and supported by top management in his visions, motivated by the customer demands and is expected to bring lower costs.

Finally, the investigation has shown that there is a large space for improvement in terms of delivery of available information on Industry 4.0 to the employees. Most companies (56%) stated that their employees are not yet aware of what this new trend means. Only about 8% of companies reported that Industry 4.0 is already part of the motivation of their employees.

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