THE DEVELOPMENT OF AUTOMATION AND HUMAN CAPITAL IN AUTOMOTIVE BUSINESSES IN THE AREA OF LIBEREC

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Abstract

The automation of manufacturing processes associated with the development of the concepts of Industry 4.0 affects all industrial businesses, including automotive businesses that play a significant role in the Czech economy. The introduction of digital technologies in manufacturing processes drives changes in traditional work systems and evokes new requirements on human capital of industrial businesses. The paper analysis the results of the authors' questionnaire survey on the development of automation and human capital in 10 medium-sized and large automotive businesses in the area of Liberec with the aim to answer how the automation affects their work systems and changes their requirements on human capital. The survey was carried out in spring 2020. The questionnaire used had two parts, one for technicians and one for HR specialists and line managers. The answers were obtained from 20 respondents, two from each business. The data analysis methods included the calculation of relative frequencies and the evaluation of the dependence of responses on the size of the business. The findings showed that surveyed businesses increase the automation of their processes, which leads to the replacement of low-skilled manual and routine jobs, but at the same time it increases the demand for technically educated workers.

Key words: automotive industry, Czech Republic, Industry 4.0, labor market

JEL Code: M10, M12, M 50

Introduction

The technological advancement associated with the development of the concepts of Industry 4.0 is characterized by a progressive application of digital technologies in manufacturing processes (Müller & Kiel, 2018), which brings new products and services to customers, but at the same time it causes significant changes in traditional business models (Botha, 2019). Through the application of digital technologies, the manufacturing processes are getting optimized, which helps to increase the productivity (Gera & Singh, 2019).

The application of digital technologies in manufacturing processes drives radical changes in traditional work systems and evokes new requirements on human capital of industrial businesses. Increasing digitization affect both the performance of work systems as well as the well-being of people working in and interacting with the work systems (Kadir & Broberg, 2020).

In the Czech Republic, as a traditional industrial country, the implementation of digital technologies is observed in many industrial businesses, however the fastest development of the concepts of Industry 4.0 can be observed in the automotive, electrotechnical, pharmaceutical, or chemical-technological industry (Adámek, 2018). In the automotive businesses, which play a significant role in the Czech economy, the automation of manufacturing processes is progressively increasing, which increases the productivity, but at the same time it increases the demand for high-skilled workers (Volek & Novotná, 2017). These consequences were observed by authors in selected automotive businesses in the area of Liberec.

1 Goal and method

The paper analysis the results of the authors' questionnaire survey on the development of automation and human capital in 10 medium-sized and large automotive businesses in the area of Liberec with the aim to answer how the automation affects their work systems and changes their requirements on human capital.

The authors' questionnaire survey was carried out in spring 2020. The questionnaire used had two parts, one for technicians and one for HR specialists and line managers. The answers were obtained from 20 respondents, two from each business. The questions for technicians were as follows: 1) What concepts of Industry 4.0 do you apply? 2) What concepts of Industry 4.0 are you going to implement? 3) What concepts of Industry 4.0 are key to your business? 4) What are the benefits of automation in your business? 5) What are the risks of automation in your business? The questions for HR specialists and line managers were as follows: 1) Has the introduction of automation led to the loss of some jobs in your business? 2) Do you plan to retrain employees whose jobs will be lost due to the automation in your business? 3) Do you face a shortage of technically educated workers with both secondary and higher education? 4) Do you cooperate with secondary schools or universities to recruit new talents? 5) Do you suppose that the Covid-19 pandemic will accelerate the introduction of automation in your business?

Automotive businesses located in the area of Liberec with more than 100 employees were selected for the survey. A total of 10 automotive businesses met this condition. The selected automotive businesses were divided into five medium-sized businesses (less than 500 employees) and five large businesses (500 and more employees). The average number of employees was 274 in medium-sized businesses and 1,412 in large businesses. The data analysis methods included the calculation of relative frequencies and the evaluation of the dependence of responses on the size of the business (medium-sized businesses with less than 500 employees and large businesses with 500 and more employees). Performing the Fisher's exact test, a hypothesis that the proportion of job losses due to the introduction of automation is higher among large businesses than among medium-sized businesses was tested.

2 The impact of automation on the human capital development

The human capital of an organization consists of employees' knowledge, skills and abilities that the organization can use to achieve its goals (Ahmad & Seman, 2019). Employees use their knowledge, skills and abilities to perform their jobs. The enhancement of employees' knowledge, skills and abilities is supported by the human capital development.

The human capital development is the process of developing employees' knowledge, skills and abilities that the organization needs to achieve expected performance (Sima, Gheorghe, Subic, & Nancu, 2020). It can be done through different learning and development activities provided by the organization, the guidance, coaching and mentoring provided by line managers and HR specialists, or self-directed learning and development activities carried out by employees. The organization should provide an environment in which employees are encouraged to learn and develop, but the prime responsibility for learning and development rests with individual employees, who should be given the guidance and support of their line managers and HR specialists (Toszewska-Czerniej, 2018). The process of developing human capital should be performance-related and designed to help employees to acquire and develop knowledge, skills and abilities they need to perform agreed work and achieve desired results (Rodriguez & Orellana, 2020). The design of the process of developing human capital in the organization is affected by the business model, work system and individual jobs and their requirements for employees' knowledge, skills and abilities.

In a number of modern industrial businesses, the design of the process of developing human capital is affected by the automation of manufacturing processes that lead to the transformation of employment forms, work system and job profiles (Sima et al., 2020).

The automation of manufacturing processes brings less easy and repetitive but more advanced and complex activities (Marengo, 2019). The responsibilities are decentralized and the interactions between humans and machines are increased (Barata, Cunha, & Coyle, 2019). These new arrangements demand for technically educated and high-skilled people, which are creative, innovative and adaptable enough to apply different skills, work in different conditions and meet different requirements (Ahmad & Seman, 2019).

From the perspective of human capital development, the competition in recruiting and retaining technically educated and high-skilled people is the major challenge for many industrial businesses, which arises from a serious shortage of such people on the labor market (Košťálová & Bednaříková, 2019). The unsatisfied demand for technically educated and high-skilled people generally limits the introduction of automation in industrial businesses. Therefore, the industrial businesses should apply different training activities, such as job instruction, job rotation, coaching, mentoring, seminars or e-learning, to provide employees with the opportunity to acquire new knowledge, skills and abilities that they need for their jobs in connection with new conditions and requirements of the organization (Pardi, 2019).

3 Results of the authors' questionnaire survey

The authors' research results are presented in three parts: 1) the introduction of automation in selected automotive businesses; 2) the development of human capital in selected automotive businesses; and 3) the case study comparing the development of automation and human capital in the largest and smallest medium-sized automotive business.

3.1 The introduction of automation in selected automotive businesses

The introduction of automation in selected automotive businesses was surveyed based on the questions for technicians. Answers to five questions were received from 10 respondents, one from each business.

The first question asked about concepts of Industry 4.0 the businesses apply and the respondents stated new sensors (70%), digital modeling (60%), big data (40%), cooperating robots (40%) or autonomous robots (40%). The second question asked about concepts of Industry 4.0 the businesses are going to implement and the respondents stated cooperating robots (80%), new sensors (70%), digital modeling (60%), energy harvesting (50%) or autonomous robots (40%). The third question asked about concepts of Industry 4.0 that are key to the businesses and the respondent stated digital modeling (60%), cooperating

robots (60%), autonomous robots (60%) or new sensors (50%). These concepts correspond to concepts that businesses are already applying or are going to implement. Both large businesses and medium-sized businesses consider new sensors and cooperating or autonomous robots to be important (see tab. 1).

Tab. 1: Introduction of concepts of Industry 4.0 in selected automotive businesses

Concepts of Industry 4.0 in the businesses	Are already applied	Are going to be introduced	Are key to the business
Medium-sized businesses	– New sensors (100%) – Digital modeling (80%) – Big data (60%) – Cooperating robots (40%) – Autonomous robots (40%)	– New sensors (80%) – Digital modeling (80%) – Cooperating robots (80%) – Energy harvesting (80%)	– Digital modeling (100%) – Cooperating robots (80%) – Autonomous robots (80%) – New sensors (60%)
Large businesses	– New sensors (40%) – Digital modeling (40%) – Cooperating robots (40%) – Autonomous robots (40%)	– Cooperating robots (80%) – New sensors (60%) – Digital modeling (40%)	– New sensors (40%) – Cooperating robots (40%) – Autonomous robots (40%) – Digital modeling (20%)

Source: authors

The fourth question asked about benefits of automation in the businesses and the respondents stated addressing staff shortages (60%), making work easier (40%) or quality improvement (30%). Large businesses rely on addressing staff shortages (100%), while medium-sized businesses rely on making work easier (80%). The fifth question asked about the risks of automation in the businesses and the respondents stated a shortage of skilled workers (50%), device failures (30%) or high initial costs (20%). Large businesses are concerned about the shortage of skilled workers (80%), while medium-sized businesses are concerned about device failures (60%) or high initial costs (40%).

3.2 The development of human capital in selected automotive businesses

The development of human capital in selected automotive businesses was surveyed based on the questions for HR specialists and line managers. Answers to five questions were received from 10 respondents, one from each business.

In response to the first question, whether the introduction of automation has led to the loss of some jobs in the businesses, 80% of respondents stated yes (including 100% of large businesses and 60% of medium-sized businesses) and 20% of respondents stated no (including 0% of large businesses and 40% of medium-sized businesses). The jobs being lost

due to the automation include an assembly worker (70%) or a production operator (40%), which represents low-skilled manual and routine jobs. This corresponds to general trends associated with the development of the concepts of Industry 4.0. Performing the Fisher's exact test, the null hypothesis was tested that job losses due to the introduction of automation are equally likely among large and medium-sized businesses (see tab. 2). Since the total probability of observing data if the null hypothesis is true (p_i) was higher than the chosen level of significance (α), the null hypothesis was not rejected in favor of the alternative hypothesis that the proportion of job losses due to the introduction of automation is higher among large businesses than among medium-sized businesses.

Tab. 2: Job losses due to the automation in selected automotive businesses

	Yes	**No**	**∑**
Medium-sized businesses	3	2	**5**
Large businesses	5	0	**5**
∑	**8**	**2**	**10**

H_0: Job losses due to the introduction of automation are equally likely among large and medium-sized businesses. H_A: The proportion of job losses due to the introduction of automation is higher among large businesses than among medium-sized businesses.

Chosen level of significance: $\alpha = 0.05$

Total probability of observing data if the null hypothesis is true: $p_i = \sum \frac{(a+b)!\,(c+d)!\,(a+c)!\,(b+d)!}{n!\,a!\,b!\,c!\,d!} = 0.222$

Source: authors

In response to the second question, whether the businesses plan to retrain employees whose jobs will be lost due to the automation, 70% of respondents stated yes (including 60% of large businesses and 80% of medium-sized businesses) and 30% of respondents stated no (including 40% of large businesses and 20% of medium-sized businesses).

The third question asked whether the businesses face a shortage of technically educated workers with both secondary and higher education, in the case of technically educated workers with secondary education and 60% of respondents stated yes (including 60% of large businesses and 60% of medium-sized businesses) and 40% of respondents stated no (including 40% of large businesses and 40% of medium-sized businesses), and similarly in the case of technically educated workers with higher education, 30% of respondents stated yes (including 60% of large businesses and 0% of medium-sized businesses) and 70% of respondents stated no (including 40% of large businesses and 100% of medium-sized businesses). The results indicate that both large businesses and medium-sized businesses face more a shortage of technically educated workers with secondary education than with higher

education. In this context, the fourth question asked whether the businesses cooperate with secondary schools or universities to recruit new talents and 60% of respondents stated yes (including 80% of large businesses and 40% of medium-sized businesses) and 40% of respondents stated no (including 20% of large businesses and 60% of medium-sized businesses). The results indicate that the cooperation with secondary schools or universities is more intensive in large businesses than in medium-sized businesses, which may be because the large businesses have more resources and wider opportunities for such cooperation.

The fifth question asked whether the Covid-19 pandemic will accelerate the introduction of automation in the business and 40% of respondents stated yes (including 80% of large businesses and 0% of medium-sized businesses) and 60% of respondents stated no (including 20% of large businesses and 100% of medium-sized businesses). The results indicate that the Covid-19 pandemic will accelerate the introduction of automation in large rather than medium-sized businesses, which again may be due to more resources and wider opportunities in large businesses.

3.3 The largest versus smallest medium-sized automotive business

To demonstrate how the automation affects work systems and changes requirements on human capital in selected automotive businesses in the area of Liberec, a case study comparing the development of automation and human capital in the largest and smallest medium-sized automotive business (in terms of number of employees) was created. The largest business (business L) has 1,400 employees, the smallest medium-sized business (business S) has 100 employees. Both businesses produce similar products (plastic components) using the same manufacturing process (injection molding).

When it comes to the concepts of Industry 4.0 the businesses have applied, the business L has applied new sensors and cooperating robots, while the business S has applied only new sensors, however, it plans to introduce cooperating robots within two years. Both businesses consider new sensors and cooperating robots as key concepts of Industry 4.0. The business L also plans to introduce digital modeling or autonomous robots withing five years. The introduction of the concepts of Industry 4.0 naturally affects work systems and changes requirements on human capital in both businesses. Making work easier is seen as a benefit of automation in both businesses, however, the business L also relies on addressing staff shortages. When it comes to the potential risks of automation in the businesses, the business L is concerned about a shortage of skilled workers, while the business S is concerned about device failures and high operation costs. The introduction of automation has

led to the loss of jobs only in the business L and the jobs being lost due to the automation have included an assembly worker or a production operator, which represents typical low-skilled manual and routine jobs. The business S has not yet faced this situation. In addition, the business L, unlike the business S, plans to retrain employees whose jobs will be lost due to the automation. The retraining methods used include job instruction (employees learn under the guidance of an experienced colleague) or mentoring (employees learn under the guidance of an experienced mentor). The business L faces a shortage of technically educated workers with both secondary and higher education, while the business S faces a shortage of technically educated workers with secondary, not higher education. The business L, unlike the business S, cooperates with secondary schools or universities to recruit new talents.

These findings related to the largest and smallest medium-sized automotive business (see tab. 3) correspond to the findings related to the selected automotive businesses in the area of Liberec presented above. The development of automation and human capital is more intensive in large businesses than in medium-sized businesses.

Tab. 3: The largest versus smallest medium-sized automotive business

	The largest business (L)	**The smallest business (S)**
Number of employees	1,400	100
Products / manufacturing process	Plastic components / injection molding	Plastic components / injection molding
Introduction of the concepts of Industry 4.0	Yes	Yes
Benefits of automation	Making work easier and addressing staff shortages	Making work easier
Risks of automation	Shortage of skilled workers	Device failures and high operation costs
Job losses due to the automation	Yes	No
Employee retraining due to the automation	Yes	No
Cooperation with secondary schools or universities to recruit new talents	Yes	No

Source: authors

Conclusion

The results of the authors' questionnaire survey show that the development of automation and human capital in selected medium-sized and large automotive businesses in the area of Liberec corresponds to general trends associated with the development of the concepts of Industry 4.0. The businesses have introduced concepts of Industry 4.0 including digital

modeling, big data, cooperating robots, autonomous robots or energy harvesting with the aim to increase productivity, improve quality, address staff shortages or make work easier. These tendences naturally affect their work systems and changes their requirements on human capital. The developing automation of manufacturing processes leads to the replacement of low-skilled manual and routine jobs of assembly workers or production operators, but at the same time it increases the demand for technically educated workers. Most of the businesses face a shortage of technically educated workers with both secondary and higher education, which may be partially solved by the retraining of employees or by the cooperation with secondary schools and universities. Such practices are a challenge for both medium-sized and large businesses, if they want to remain competitive in a world of developing digitization, automation or robotization. The focus on automotive businesses in a specific area as well as the relatively low number of respondents limit general conclusions. However, the current results can be the starting point for the further research on the development of digitization, automation or robotization in different industries and businesses with the aim to observe its impact on different business models and work systems.

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