Automation: Threat or Opportunity?

The Impact of Robotisation on the Hungarian Manufacturing Industry

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Abstract

Economists are divided over the potential impact of robotisation, especially when the effects on labour are considered. Several experts fear that the labour substitution effects will outpace the number of new jobs created, while others find that balancing forces will work this time as well. In this article, I focus on the impact of these processes on the Hungarian manufacturing industry, as Hungary is a good example of an FDI[1]-dependent, production-focused country. The analysis is based on several interviews with experts and managers, mostly from the automotive industry. The result of the discussions shows that there is a growing robotisation trend in Hungary, along with the other Visegrad Four countries. While this trend decreases the number of workers needed for a certain production volume, it does not pose a serious immediate threat as it is balanced by the tendency of a lack of workforce with the necessary skills.

Keywords: automation, robotisation, labour, manufacturing industry, cost-efficiency

JEL codes: A12, E24, F23, J01, O30

Introduction

Automation and robotisation[2] are increasing trends nowadays, therefore, researchers have recently started to focus on the possible effects they might have on the global economy and social relations.

1 Foreign direct investment

2 It is not easy to make a clear distinction between the two expression, in this article automation is more considered as a general process and under robotisation I mean the employment of physical, digital robots in factories.

DOI: https://doi.org/10.14267/RETP2023.02.05

Received: 27.01.2023 | **Accepted:** 11.03.2023 (2 revisions) | **Published:** 04.07.2023

The usual question with automation is the impact on jobs, that is, the extent to which automation can change people's working possibilities. A particularly interesting area is the manufacturing industry, where robotisation has a significant history[3]. Also, the manufacturing industry in itself has a growing significance[4]. It is an essential sector for long-term growth, has a high share of exports and has a positive influence on other sectors (Tassey, 2014).

Hungary is a good example when studying the effects of robotisation on the manufacturing industry. Together with the other Visegrad Four (V4) economies, these are often referred to as "FDI hosting, intermediate level factory economies" (Szalavetz, 2017).

Despite the fact that V4 countries are appropriate representations of manufacturing-focused economies, I found that the existing literature has not yet dedicated enough attention to scrutinising the effects of robotisation on them. Such analysis, however, is relevant, given that automation can have varying labour-related effects depending on the economic structure of a given state. This paper thus aims to contribute to the existing literature by analysing this particular context of robotisation in Hungary.

The paper is based on semi-structured interviews conducted during the second half of 2022 with managers and experts from the manufacturing industry. By applying data triangulation, the results of the interviews are matched against the relevant literature in the field, and they are to answer four interrelated research questions:

- What are the technology development trends in the Hungarian manufacturing industry?
- What are the impacts of robotisation on labour-related factors?
- To what extent is the situation in Hungary similar to other countries in the region?
- Does robotisation endanger or enable the Hungarian economy?

The structure of the paper is the following: first the relevant literature is reviewed; after that, applicable recent statistics are introduced, after which comes the methodology of the interviews, followed by the results of the discussions with the experts and the analysis, and it is closed by the conclusions and the recommendations section.

3 The first industrial robot, Unimate was installed in 1961. (Robots.ieee.org)

4 The share of the value added activities of manufacturing industry is 17% of the GDP (Worldbank, 2023)

1. Theoretical background

The primary automation-related concern is the impact on jobs. As some researchers warned, the current industrial revolution is different from the earlier ones, since the jobs lost might not be substituted with the same number of new jobs, and even full automation is conceivable in some sectors (Ford, 2015). His finding is not without precedent. Keynes made similar cautioning observations nearly a hundred years ago (Keynes, 1932). In line with Keynes's and Ford's predictions, Frey and Osborne (Frey et al., 2013) found that 47% of the jobs in the USA are at risk. According to them, the current technological development, the Industry 4.0[5] process, rather risks low-skilled jobs. In contrast, in the nineteenth and twentieth centuries, it was mostly skilled jobs that were replaced by machine-based productions. Hallward-Driemeier and Gaurav share this view: *"...what is different now is that the pace of change is accelerating, and the extent to which new technologies may be labor-saving could be unprecedented"* (Hallward-Driemeier et al., 2017). In this context, adaption to the changing environment is vital "for workers to win the race, however, they will have to acquire creative and social skills" (Frey et al., 2013, p. 45.).

The underlying economic theory to the above is the production function (Solow, 1957, Mankiv, 2009), which indirectly shows a competition between technological improvement and labour (Guraly, 2020). The production function (1) developed by Solow is as follows:

$$Q=F(K,L,t) \quad (1)$$

where "Q" represents output, "K" is capital, "L" is labour and "t" shows the technology change.

Following the same terminology of the production function, Fernald and his co-authors argue that the new automation technologies would enable computers and robots to substitute labour on a growing scale (Fernald et al., 2014). The impact of the technological effect can be considered not only as a possible future trend, but also as a tendency already having an impact in the past. When investigating the changes in the employee's income in developed countries, it was found that the share of income from employment within the GDP has decreased from 55% (1988) to 51% (2017). The main reasons for this reduction are technological development and global integration (Magas, 2018).

According to other economists, technological development is beneficial for the economy and society, and many middle-skilled jobs will still exist in the future (Autor, 2015). Holzer found that although some middle-skill job functions are disappearing in the USA, they are replaced by new jobs in a

5 The Fourth Industrial Revolution

similar category, and sometimes there are shortages of labour for certain jobs (Holzer, 2015). Atkinson does not doubt that some workers will lose their jobs due to robotisation. Still, he admits that due to increased cost-effectiveness, prices will be lower, making it possible for customers to purchase more, enabling the creation of new jobs (Atkinson, 2018).

Other scientists attempted to develop a balanced view on the issue. Acemoglu and his co-author think that the fears of immediate negative impacts of automation are excessive, but they also believe that in the long-term, the strength of workers will decline (Acemoglu et al., 2019).

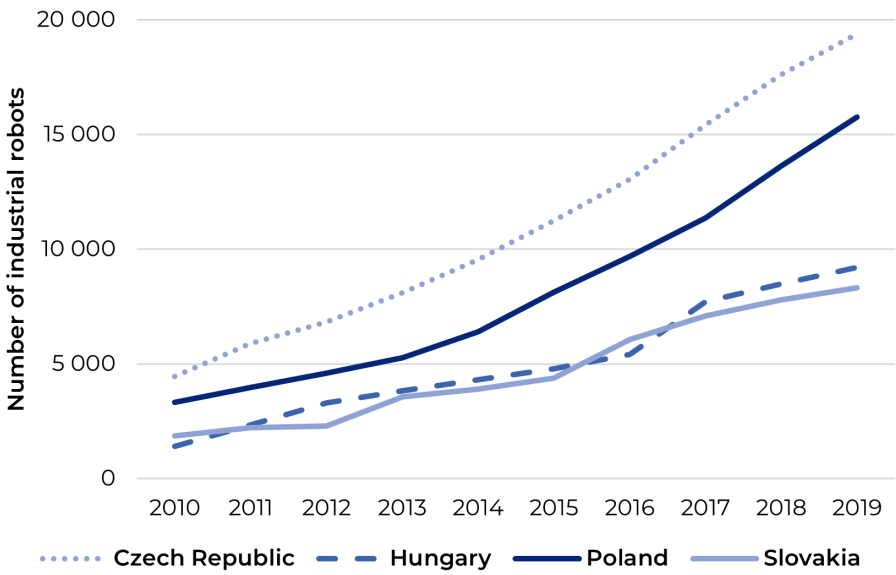
Other empirical analysis pointed out the correlation that "different robot densities across the world and the European economies clearly respond to the economic assumption: high labour costs are coupled with high robot densities while low wages are accompanied with low robot densities" (Cséfalvay, 2019, p. 1540-1541). According to the author, this relation can also be the reason for the finding that robotisation is higher in sectors with middle and high skills requirements and still low in sectors where employees would be easily replaceable by robots, e.g. in the textile, food and beverage sectors (Cséfalvay, 2019). Countries like India and Pakistan are good examples of such a situation; there is a strong focus on labour-intensive industries like textiles, the labour cost (India Briefing, 2019 and DTDA, 2022), and consequently, the rate of robotisation is still low (IFR, 2023). However, this finding should be handled attentively, as some developing countries, such as China, are among the frontrunners in robotisation (IFR, 2023) due to the extensive focus on manufacturing activities (Bratton, W, 2022).

2. Robotisation and labour-related tendencies in Hungary

Besides the ambiguous impact on jobs in general, automation also has geographically varying impacts. Some economists argue that developed countries are the forthcoming winners of the technological improvements. They have larger markets and capital supplies, and the availability of skilled workforce to utilise automation and the related tendencies is better (Lund et al., 2019). Therefore, it is particularly relevant to see the impact of robotisation on Central Eastern European countries, which are still in the process of reaching the development status of their Western European peers and can be labelled as "industry-oriented factory economies" (Hillebrand, 2022). Hungary, as a member of the V4, the most developed part of Central Eastern Europe, with a significant focus on the manufacturing industry, is a salient example for scrutinising these trends. The analysis can be conducted using three primary indicators: robotisation rate, availability and cost of labour, and the possible substitution effect of automation in the given country.

When considering the possible impact of robotisation in Hungary, the statistics on industrial robots seem to be a valid starting point. The International Federation of Robotics does yearly statistics on the number of industrial and service robots installed globally. Having a closer look at the V4 countries (Chart 1), the analysis shows that the operational stock of industrial robots has increased continuously in all the V4 countries, which is in line with global trends. The number of industrial robots used was 2,7 million in 2019[6] (IFR, 2023). What can be observed is that the pace of growth is different. It is relatively steady in the Czech Republic and Poland, while in Hungary and Slovakia, it is a bit slower. Regarding ranking, the Czech Republic is leading both in terms of absolute and relative (considering the population) values, while Hungary has the third position in both measurements. As benchmark data, the number of robots used in Germany is more than tenfold higher than the ones in operation in the Czech Republic: 223.000 in 2019 (IFR, 2023). Although, when considering the robotisation rate per capita, the German rate is only 45% higher than the Czech one (own calculation on the basis of IFR, 2023).

Chart 1: Changes in the number of industrial robots used in the V4 countries

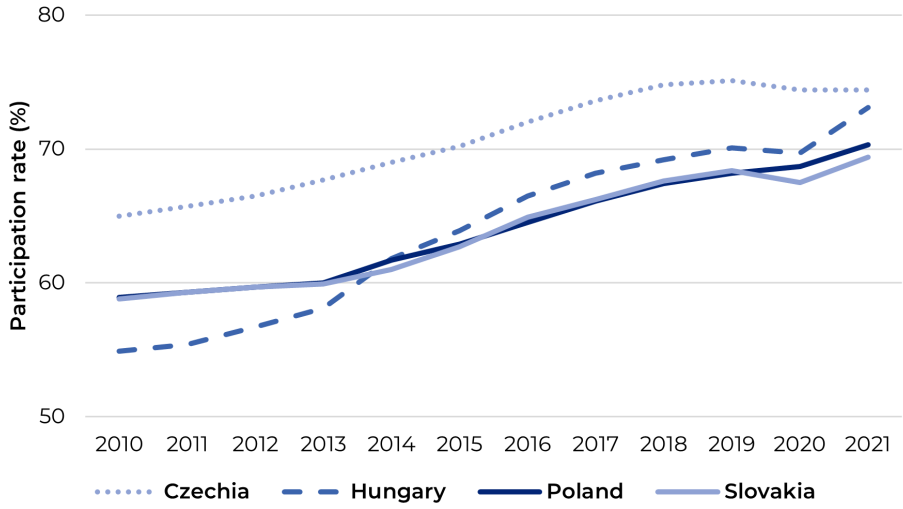


Edited by the author on the basis of IFR statistics

6 Robotisation has grown further, in 2021 the number of industrial robots in service was 3,5 million. The installations in 2021 exceeded 500 thousand, the highest number ever (IFR, 2022).

In terms of labour, one crucial aspect is the availability of workforce. There are similar trends in the V4: wages are increasing, and recently, there has been a growing labour shortage (Éltető, 2019). This trend is in line with the general trend in Europe[7] (HSCO, 2023a), and as shown in the chart below, the Czech Republic has the highest employment rate, with Hungary coming in second. The Hungarian employment rate rose substantially in 2021, and is converging with the Czech numbers (Chart 2).

Chart 2: The participation rate (%) of the V4 countries in the 15 – 64 years age group



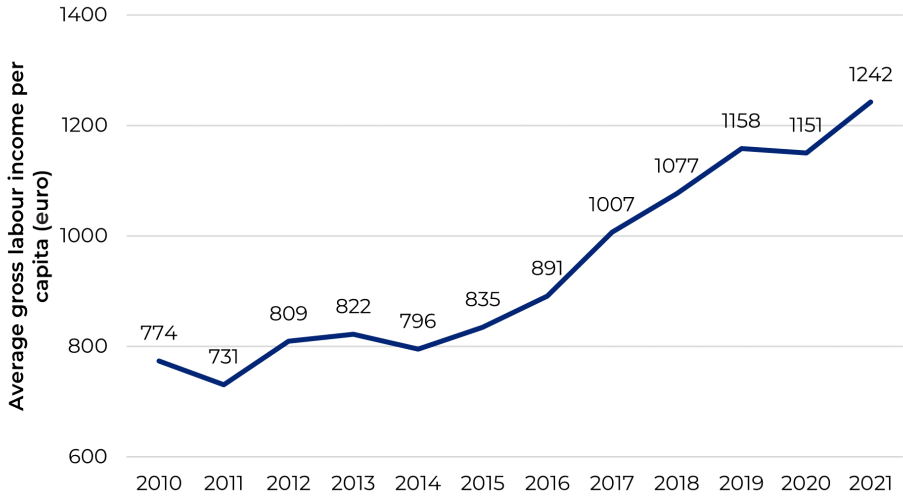
Edited by the author on the basis of HSCO data (HSCO, 2023)

In terms of salaries, the situation is ambiguous. On the one hand, the average annual salary in Hungary is the second lowest in Europe (Eurostat, 2022a). On the other hand, the gross labour income became larger by approximately 50% during the last decade, as shown in the table below[8] (Chart 3).

7 The employment rate (15-64 years age group) has grown from 61.2 % (2002) to 68.4 (2021). Source: HSCO, 2023

8 The gross income is converted to euro – mid-exchange rate on the end of the years - as the incomes in forint provide a misleading picture due to the EU average inflation rate. (Eurostat, 2022b)

Chart 3: Average Gross labour income in Hungary in euros per capita



Edited by the author on the basis of HSCO (HSCO, 2023) and MNB data

Studies are also available on the actual impacts of automation and robotisation on labour-related factors. Restrepo and Acemoglu calculated that the installation of one new robot per 1000 workers decreases employment to population ratio by 0.18-0.34 percentage points and wages by 0.25-0.5% (Restrepo et al., 2017). Regarding automation in general, following the earlier works in this field by Autor and Dorn (Autor et al., 2013) and Frey and Osborne (Frey et al., 2013), Josten and Lordan (Josten et al., 2019) did extensive research on patents to examine the extent to which different European economies are vulnerable to automation. They found that 47% of all jobs will become automatable in the next decade, which is in line with the findings of Frey and Osborne, as they estimated a 42% potential loss of jobs (Frey et al., 2013). Josten and her co-author differentiated between automatable and fully-automatable employment. The difference they found was dubbed "polarised" automation, a process where a new solution would still need human involvement to function properly. They found that 35% of European jobs can be fully automatable by 2030. However, not all countries are affected to the same extent. They analysed 25 European[9] countries and the EU itself, and the results show relatively large discrepancies: in Finland, only 20% of the jobs are automatable (15% fully automatable) whereas the same ratio is 57% for Greece (48% for fully automatable). Hungary is above the average in vulnerability[10], as shown in the table below, where besides the largest European economies, some of the Central European ones are represented (Table 1).

9 Under Europe the geographic Europe is meant as some non-EU members were also present in the analysis.

10 In this context vulnerability stands for the share of jobs endangered.

Table 1: The share of fully automatable jobs per country by 2030[11]

Country	Type	Jobs fully automatable
France	LE	31%
Germany	LE	36%
Italy	LE	13%
Spain	LE	47%
Croatia	CEE	47%
Czech Republic	CEE	38%
Hungary	CEE	41%
Slovakia	CEE	38%

Created based on Josten et al. (2019)

However, the threat forecasted by Josten and Lordan is not shared by everyone. As Cséfalvay points out, there is still a need for human involvement, even in the most robotised factories. That is why Central and Eastern European countries are still attractive to the corresponding foreign investors: they can supply skilled labour at a lower cost. He finds it is a "winning formula" for the global economies to establish production in Central and Eastern Europe: here, close to the markets of the products, they can use robots for routine work while employing humans with competitive salaries on additional activities (Cséfalvay, 2019).

3. Methodology

The study mostly relies on a qualitative analysis based on primary data from semi-structured interviews, meaning that I planned to follow a certain interview schedule, but the actual implementation of the interview was always adapted to the respondents (Willis, 2006), enabling them to talk more on items where they had more to say. The aim of the interviews was to obtain direct feedback on the ambiguous results in the literature: how do the managers of some of the primary manufacturing companies in Hungary, along with some related experts, see the impact of robotisation on Hungary?

The interviews took place in the autumn of 2022, when I talked to sixteen people altogether. Nine interviewees were managers, as listed in the table below (Table 2).

11 LE stands for Larger European economies and CEE for Central Eastern Europe.

Table 2: Type of companies and positions of the managers[12]

Analysis code	Type of company	Position of the interviewees
CAOEM1	Automotive OEM[13]	Production leader
CAOEM2	Automotive OEM	CEO[14]
CHOEM1	OEM in health care	Project manager
CASUP1	TIER – 1[15] automotive company, OEM in other fields	CEO
CASUP2	TIER – 1 automotive company, OEM in other fields	Group leader
CASUP3	TIER – 1 automotive company	2 Operations managers, 1 line manager
CVSUP1	TIER – 1 vehicle company	R&D Director

Source: own editing

Besides the company managers, I also talked to seven people who were experts in various fields (Table 3).

Table 3: Position of experts and their organisations' type[12]

Analysis code	Type of organisation	Position of the interviewees
EA1	Automotive networking organisation	Managers of the organisation
EIN1	Innovation network	Managers of the organisation
EIN2	Innovation management	Manager of the organisation
ER1	Research organisation	Researcher
EG1	Government agency	Investment promotion expert

Source: own editing

Most of the manufacturing companies represented by the managers are active in the automotive industry, some of them solely, some partially,

12 For reasons of anonymity, the analysis code is not indicated in the text in some cases
13 Original Equipment Manufacturer
14 Chief Executive Officer
15 Direct supplier of the final product

and they are either OEMs or TIER-1 suppliers. The focus on the automotive sector is relevant, as it is a dominant robot-absorbing sector in Europe: in 2015, half of the robots were employed in this industry (Cséfalvay, 2019). In Hungary, the sector is significant in many aspects. It accounts for approximately one-quarter of the total investment stock in the manufacturing industry. Furthermore, it generates more than 7% of GDP and employs 6% of total employees, the third largest number in the EU after Slovakia and the Czech Republic (novekedes.hu, 2022).

Although the topic of the discussions was similar, the questions raised were different for the *managers* and for the *experts*. For the experts, the question covered more of the macro spectrum and mainly focused on two areas:

- What are the technological advancement tendencies in Hungary nowadays, and how do they compare with the processes in the other three V4 countries?
- What impacts do you consider automation/robotisation has on the Hungarian economy? To what extent is it similar to the akin effects in the region?

The managers were asked more focused, micro-level questions, focusing either on their local company or the holding/GVC[16] they belong to:

Questions regarding the particular subsidiary:

- How do the changes in the production volume of a certain company relate to the changes in the production staff?
- Does the production/worker efficiency increase?

More general questions:

- Can you compare the processes of production/worker efficiency with other companies in the same multinational network/GVC or with other companies in the same industry?
- What do you think: is robotisation a threat or opportunity for Hungary?

The interviews were carried out mostly on a one-on-one basis. On two occasions, two people were interviewed from the same organisation at once, and in one factory, most parts of the interviews took place during walking through the production steps of the two related plants. In most cases, the interview started with an explanation of the study objectives, followed by the introduction of the organisation from the respondent. The questions were the same for all the participants in a certain group (experts and managers), but specific questions were left out if the topic was not relevant to the particular person. This was not an issue for the analysis, as the

16 Global Value Chain

paper focuses on the general trends, and does not try to quantify the different answers. The questions were dominantly open-end questions, and the last question (is robotisation a threat or an opportunity?) to the managers was "semi-closed". However, even for that question, usually, a reasoning was provided by the interviewees after their short YES/NO answers.

Although the questions raised to the managers were dominantly focused on their particular company, the answers were well generalisable. Therefore, the feedback of the experts and the managers is presented together below, along with the main research questions of the study.

Despite the efforts to choose the interviewees carefully, there is always a degree of subjectivity in qualitative research, especially when the number of respondents is relatively low. To balance this, I used data triangulation (Bhandari, 2023), e.g. I cross-checked my findings with earlier research in the field.

4. Results

In this section, first the answers to the question on the general automation tendencies in Hungary are shown, then the impacts of robotisation on workers are inspected, followed by a sub-section contrasting the Hungarian situation with other Central Eastern Europeans. Finally, the responses to the "*threat or opportunity*" question are summarised.

4.1. Technological development and general automation trends in the Hungarian manufacturing industry

According to one of the interviewed experts (EIN1), the number of industrial robots is increasing globally and in the V4 region as well. In Hungary, there is a commercial robot production company (KUKA), and in many universities, robots are used for research and training purposes. However, the energy crises might alter the cost-effectiveness calculation of certain robots. This is because traditionally, robots have a high investment cost but a low operation cost, but the current higher energy prices might change this premise.

Another interviewed expert described the different landscape for Hungarian-owned smaller and middle-sized SMEs. They usually automate if they get financial support from the state to innovate. Generally, there is a lack of company-wide automation in these companies, they rather automate certain sub-fields within the organisation (referring to the interview with the EIN2 expert).

One of the reasons for the increase in robotisation is that production targets are constantly being raised. A manager of a TIER-1 supplier highlighted that production is always according to the demand of the customer. In their case, the biggest challenge is the low stock of raw materials and spare parts, as the company follows a JIT[17] methodology. The stock on some parts is only four hours and as the company follows a 24-hour operation in three shifts, keeping the production sustainable is really challenging. Any problems with the assembly line should be solved in maximum of three hours even in the middle of the night. Another strict requirement is that the transportation should go to the neighbouring OEM factory exactly every 88 minutes.

The changes in the share of direct, production-related and indirect, usually higher-skilled jobs are also important. In line with the process of robotisation, the number of direct jobs is decreasing, while the number of indirect jobs is increasing. Accordingly, those countries can utilise robotisation better, where there is a high-quality technical education.

A related aspect raised by some experts is that for Hungary, it is not sustainable in the long term to focus on simple jobs with low labour costs to gain a competitive advantage. Human work at the assembly line can remain beneficial in case of tasks where automation would be too difficult and costly. Cost-effectiveness can also stand for complex, engineering type of work. Here, the difference is less than in the case of direct workers, only one to two compared to German salaries, but it is still a significant advantage. Accordingly, even after the larger robotisation wave in the Hungarian manufacturing companies, the relative cost-effectiveness of salaries still remained, although to a lesser extent than before. According to the managers and the experts, there is a need for a more effective technical and vocational education to stay competitive. Having the appropriate, local human competencies is key to the success of any industrial investment (referring to EA1, EIN1, ER1, EG1, CAOEM1, CAOEM2, CASUP1, CASUP2, CVSUP1 interviews).

Another noteworthy aspect raised by an expert (EIN1) is that the whole production philosophy should be changed globally for sustainability reasons. There are not enough resources to maintain the current production volumes. Therefore, there will be more attention on producing durable goods and focusing more on repair, maintenance and recycling. Investing in the increase of production capacity is a blind alley: it generates profit in the short term, but it cannot be maintained in the long term. Consequently, in order to be resilient, smart automation is the key: buy into intelligent, mobile and multifunction robots and automation systems.

17 Just in time

According to another manager (CAOEM1), the important question is *why* do we do automation? The two reasons are: to make the process more economical and to support workers. As the costs of manpower are higher in Germany, it is easier to make an economically viable decision for automation. On the other hand, automation itself has a cost. It is an investment with depreciation costs, and it can create extra maintenance costs. Therefore, the decision should always be made on a case-by-case basis.

The same manager also added that it would be an exaggeration to say that automation in headquarters alone creates a threat for lower cost subsidiaries, since the verdict for establishing, keeping or closing a firm is a result of a complex decision-making process with a "checklist" including approximately 60-80 factors. These factors include: the market environment, the existence/non-existence of customs, the availability of an educated workforce, the supply chain situation, the role of trade unions, logistical, political, and demographic aspects, etc. As a result, the level of automation alone is not a decisive factor in the future of a company.

What is a more important factor nowadays is the availability of workers. As respondents said, government officials may want to increase investments in Hungary, but Hungary is close to being a full-employment economy. So according to them, it would be pivotal to ensure the availability of educated workforce in Hungary for the longer term (EA1, CAOEM1, CAOEM2, CASUP1, CASUP2, CVSUP1 interviewees).

4.2. The relation of robotisation rate and labour input-related efficiency

As mentioned before, companies claim that it is very difficult for them to find workers for different positions. Besides, the human-related costs are the highest among the production-related ones. Also, the level of fluctuation in certain positions is relatively high. Therefore, automation and robotisation offer a solution, they help companies solve the issue of lack of personnel.

According to a respondent, the improvements in the production efficiency/worker is a "sensitive topic." There is some decrease in the number of direct workers, but the situation is more complex. The primary goal is always to achieve overall cost-effectiveness and not to decrease the headcount. To make the process more effective, there is a need for transformation: that is why usually at first the simple, repetitive tasks are automated. Robotisation is not primarily about saving workers' salaries, but there is a scarcity of workers and automation can help fill these gaps. For example, there is a constant demand for forklift operators, while there is also a high rotation among them. Moreover, faulty products and production stops can

be avoided, and energy can be saved through the optimization of production. On the other hand, automation has a significant maintenance requirement, with an emphasis on preventive maintenance. For that, there is a need for a higher number of indirect workers, skilled workers and engineers particularly, resulting in a decreasing staff in one segment and an increasing one in another.

The manager of a factory of a different OEM mentioned that they implemented a heavy cost reduction recently. In their case, there was a more direct relation between the intention to increase efficiency and the desire to reduce staff. In their factory, the number of indirect workers, particularly the office workers, was drastically reduced.

At this point it is noteworthy to add that the higher decrease of indirect workers relative to direct workers is rather the exception than the rule among the interviewees' companies. This is because the general trend is that both the production volume and the productivity are growing continuously. As automation is carried out better, there is a need to employ more experts who are planning and implementing the automation itself.

The varying nature of the dynamics between automation and labour structures came to the fore in another factory (CHOEM1), which is designed for assembling and packaging simple cosmetics and healthcare products. The number of employees of the company is continuously growing, however, the structure of the staff is shifting in the process, the number of outsourced (contractual) employees is decreasing. In their case, robotisation is driven more by the interest in quality upgrades than cost-efficiency. Human workers make a lot of mistakes that can be avoided with a more automatised production line.

In a car OEM factory, the manager (CAOEM1) gave a more theoretical explanation to the reasoning behind robotisation. According to the answer, the number of direct workers depends on the technological set-up of the company's business model. This setup defines the production time, and the production time establishes the number of workers needed to produce one car. The company is continuously trying to make the process more efficient in terms of cost between products, updates, and production cycles. Ideally, it would mean a reduction of costs or, in some other cases, at least keeping it at a constant level. The reason behind this is the ever-increasing product costs, which cannot always be passed on to the customers. These types of expenses include: energy prices, cost of raw materials, wage costs etc. Even if these costs constantly drive the product's price to rise, this growth is not at the same rate as the costs. This propelling for a cost-effective production defines the drive for trying to decrease the direct headcount in production.

My research observed a similar effect on the indirect workers in other cases, but the relation is not always as straightforward as with the manufacturing workers. Although every plant aspires to decrease the number of indirect workers, there are certain job functions independent from these reduction models. For example, when it comes to the issues of digitalisation, the main drive is to utilise resources better in the future. This could create working environments where there are fewer jobs which are purely mechanical and create less added value. On the other hand, however, the human resources spared by digitalisation can be utilised when creating future job functions in other areas, such as big data analysis, artificial intelligence and other development projects.

In the case of a TIER-1 supplier the Budapest-based subsidiary of the company experiences the highest levels of robotisation. The reason being that this is the city where it is the most difficult to hire new employees and the circumstance also produces higher salaries here.

Their production lines are either fully automated (only one supervisor per shift is needed) or they are highly automated, where a few tasks are still carried out by workers whose functions cannot be easily automated. Sometimes, they build their own lines from collaborative robots. The respondent underlines that the main drive for robotisation is not to increase the efficiency of the production process but the lack of a workforce to rely on, adding that difficulties in finding new workers started in 2014-2015. In other words, even if the rates of robotisation were lower, there would still be a headcount reduction due to labour shortage (based on the interview with CASUP1).

Currently, the above-mentioned TIER-1 supplier operates 125 robots in the Budapest factory in a four-shift[18] work schedule, so in conclusion, with these robots they can spare 500 workers. Although the production volume is growing, the number of direct workers is not increasing according to the growth of the production volume. The new, smaller and simpler robots changed the situation significantly. They are not necessarily collaborative, but their costs are much lower than it was earlier. The larger industrial robots' capacities were not fully utilised and they were usually too complex for the certain task they were used to. The earlier, larger robots were in the range of 100 thousand euros, but the new smaller ones are available for approximately 15 – 30 thousand euros. Nowadays, for the one-year cost of a worker, e.g. for approximately 20 thousand euros, a robot can be obtained, and their lifespan is at least three years long. Additionally, a robot can work in four shifts, not only in one, so it works four times more

18 Four shifts are defined in terms of number of teams of workers, the hours are calculated on a weekly basis: 168 hours/4=42.

than a human worker. Altogether, the different kind of savings add up to a 1:12 cost-sparing compared to a human worker.

It should also be mentioned that the above facts are not valid for all companies. There are suppliers with rigid assembly lines. In their case, the assembly line remains basically unchanged during its lifespan, which is six-seven years. As the production line usually brings back the initial investment in two to three years, the line is generating profit during the remaining time. In their case, innovation and further robotisation can come when the next assembly line is put into operation.

Another discrepancy exists due to the different nature of the industry domain. For example, in the commercial and railway vehicle sectors, the number of units produced is much lower than in the car industry. There are many unique products in both brands, generating the need for higher human worker involvement. In these sectors, Western European factories might be competitive either due to their higher robotisation levels or because of the higher complexity of their products. Hungary is halfway between India and Germany in terms of competency levels, which generally increase as one moves from East to West. Therefore, the flow of production shows a certain pattern: the most complex products are manufactured in Germany, then later, they are moved to Hungary, and the least complex or well-established products are produced in India. The decision on where to produce a certain product is also very reliant on the availability of local suppliers.

As a final remark for this subsection, there were similar complaints made by several managers: that lately, it became quite uneasy to find workers for the type of work with several shifts schedule in Hungary (based on the interviews with CAOEM1, CASUP1, CASUP2, CVSUP1). As one of them said, Hungarian society had “grown lazy”, free time means more now than the extra perks for a night shift. This raises questions about the sustainability of economic development in the country, as Hungary is still quite dominantly reliant on the manufacturing industry, and if there will be no workers for the night and weekend work, how will the production facilities be maintained? The same manager also brought up the question of what proportion of Hungary's 4.7 million workers is limited to performing simple manufacturing-related tasks only. This stratum is not suitable for being employed in complex jobs, e.g. shared service centres, etc.

4.3. Regional comparison

In terms of regional outlook, it was said by experts (EA1, ER1) that multinational companies dominate the automotive sector; therefore, the tech-

nology advancement level and the process for design and development in the V4 region are quite similar in this domain.

Robotisation in the manufacturing industry might decrease the labour intensity in certain sectors, but despite that, Hungary and the other V4 countries remain competitive due to the substantially higher Western-European wages, even though the technological upgrading progress is rapid, and it tries to follow the rise of labour costs. One of the experts quoted a CEO of an American company investing into the region: “now the salaries have increased by twenty percent, but to balance that we will decrease the headcount also by twenty percent in five years with the help of robotisation”.

When comparing the position of Hungary regionally, it should be noted that there is competition in the region between Polish, Slovakian, Hungarian and Romanian companies, which encompasses automation trends as well. The interviewees' opinions on this topic were virtually identical, indicating that Hungary's situation is comparable to that of the other Visegrad Four nations in terms of lower production costs and, consequently, a lower rate of automation. The Czech Republic is the leader in the V4 in this sense, as the Czech manufacturing industry is embedded into the German one historically, so it is not useful to compare Hungary with it. In Slovakia, there are also several OEMs present, whereas in Poland, there is a different company structure, and according to a respondent, the automotive industry is not a high priority. Regarding robotisation in SMEs, Poland is stronger, while Slovakia and Hungary are lagging behind (based on the interviews with EA1, ER1, CAOEM1, CASUP1, CASUP2, CVSUP1).

One manager mentioned that it is not easy to compare Hungary with the other V4 countries, as Hungary is within the “Balkan region” (albeit usually phrased differently) in terms of regional classification for many multinational companies. When comparing Hungary with countries to the South, Hungary seems to be less industrialised than Slovenia, but more so than Romania.

4.4. Robotisation: a threat or an opportunity for Hungary?

The company managers unanimously agreed that robotisation is a positive opportunity for the Hungarian economy. Some of the benefits mentioned include: it offers a secured, cost- and time-efficient production process, and supports the processing of heavy items. In sectors where there are repetitive tasks, automation is beneficial. They are not afraid that Hungarian SMEs would lag behind: according to them, there is a substantial program for SMEs (benefits, cheap credits) in Hungary that can support investment into robotisation.

According to a manager (CAOEM1), automation is an evidently positive opportunity for Hungarian companies. A train which goes towards the future can only be a chance. If the competencies are not developed, then the production system gets outdated. This chance is to be utilised, and nobody should fear automation. We should not be afraid of losing workplaces as it is the role of the management to find new jobs for the workers who lost their tasks due to automation. The human resources which become available due to automation can be integrated into similar or higher job functions.

That being said, they also raised a warning: the cost of the workforce should grow in line with the increase of the added value. It is not a useful combination if Hungary does not have enough skilled workforce, but it grows more and more expensive simultaneously. In a pessimistic scenario, this might prompt OEM companies to leave the country. The problem in Hungary is not the lack of workforce in general, but the lack of qualified workers. If non-qualified workers would like to earn a lot, it would not match the intent of multinational companies, and they will move to other places where the same work can be done more cost-effectively with more talented workers.

On the other hand, they also mentioned: anything that is a danger is a possibility at the same time. The world is changing, and Hungary should react to these challenges in a smart manner. As one manager said, for example, in research and development, the good strategy is a forward escape.

5. Theory and Statistics versus Field Research Results

When comparing the theoretical studies with the findings of the interviews, a number of conclusions can be established.

First, when analysing the impact of robotisation on jobs, the examples in the Hungarian manufacturing sector underline the deduction from the production function: indeed, there is competition between robots and workers. In other words, the more robots are utilised, the fewer production workers are necessary to prepare a certain product. This, however, still does not look dangerous for the Hungarian economy, as this process seems to be in line with the availability and cost of the workforce. It appears that, at least for now, the Hungarian case supports Autor (Autor, 2015) rather than Ford (Ford, 2015), in the sense that robotisation and worker substitution are ongoing in Hungary, but at the same time, it does not increase the level of unemployment. Using a more theoretical expression: there is an equilibrium between various driving forces. The combined impact of the workforce's declining availability and rising costs, on the one hand, and the level of robotisation, on the other hand, balance each other out.

Second, the assumption that robotisation is higher where the salaries are higher (Cséfalvay, 2019) was partially underlined both by some related statistics and by some opinions of managers. As robotisation is an investment, it is more profitable when the return is higher, e.g., the factor (labour) to be substituted is more expensive. However, it is important to note that this general finding is valid only with limitations. According to the feedback, other factors are also playing a role in a robotisation decision, and specific statistics augment the macro landscape. For example, the robotisation rate in the Czech Republic (per capita numbers) outpaces several leading industrial European countries and shows a catching-up trend to the German numbers (IFR, 2023). This trend is taking place despite the differences in wages (Eurostat, 2022a).

Third, in a regional comparison, it was found that the tendencies are comparably similar in all the V4 countries, at least when the subsidiaries of the multinationals are considered. However, as mentioned by experts and managers, the Czech Republic is more advanced in terms of domestic-owned companies and SMEs in general, so that might be one of the reasons for the higher robotisation rate.

Fourth, the contradiction in the Hungarian labour market, e.g., relatively low salaries but high employment rate at the same time (own calculation on the basis of HSCO, 2023a), has an effect on the Hungarian automation tendencies: it seems that in Hungary, the main drive for robotisation is not the aim to decrease the high labour costs, but to compensate the lack of sufficient labour.

Finally, although the strong prophecies by Josten and Lordan target the end of the current decade (Josten et al, 2019), so it is too early to draw conclusions about whether they were right or wrong, based on the interviews, we can admit that so far in the Hungarian manufacturing industry there are no signs for such a massive replacement effect of workers by robots. The statistics also support that the sum of total workers in the Hungarian manufacturing industry did not decrease during the last five years. In fact, there was a slight increase (HSCO, 2023b).

Conclusions

When comparing the technological development between “manufacturing-focused” countries in Western Europe (e.g. Germany) and the V4 countries (Hungary, for example) it was found that the automation and robotisation rate is generally significantly higher in Western Europe. The reason behind this is simple economics: automation is an investment, and as such, it is more economical where the factor to be substituted (e.g. labour) is more expensive. Nevertheless, robotisation also happens in Hungary, and

the main driving forces are the motivation to increase cost-efficiency, find solutions for the scarcity of qualified workers, and increase the quality of production. The possible threat of robotisation on jobs in Hungary on a large scale might become a reality in the future, but so far, there are no signs of that. This is in line with the findings of the authors investigating the labour market in the USA: "it should also be noted that even under the most aggressive scenario, we are talking about a relatively small fraction of employment in the US economy being affected by robots. There is nothing here to support the view that new technologies will make most jobs disappear and humans largely redundant (Restrepo et al., 2017)"

The summary of the main finding for each research question can be found in the table below (Table 4):

Table 4: Summary of main findings

Research question	Main relevant findings
What are the technology development trends in the Hungarian manufacturing industry?	• Significant robotisation is happening mainly in the subsidiaries of large multinational companies. • The main drivers are increasing cost-efficiency, supporting workers, increasing production quality and solving the worker scarcity issue.
What are the impacts of robotisation on labour-related factors?	• The relative share of direct workers is decreasing while the share of indirect workers (administration, IT, research and development, etc.) is increasing. • The impact is overall not negative for the economy as the trend balances the growing unavailability of sufficient workers.
To what extent is the situation in Hungary similar to other countries in the region?	• The overall trends are mostly homogeneous in the V4 due to the presence of similar companies. • What can be observed is the leading role of the Czech Republic in many aspects.
Does robotisation endanger or enable the Hungarian economy?	• According to the company managers, robotisation is ultimately advantageous for Hungary. • A much more realistic threat is the scarcity of workers with the necessary skills.

Source: own editing

Recommendations and Policy Implications

This section will be discussed in two subgroups: Possibilities for future research, and policy implications for decision-makers.

In terms of the possible continuation of the study, there are two major directions: one is to deepen the research, and the other is to move towards policy recommendations.

Regarding the further research, what can be a possible further work is to extend the study to neighbouring countries by cross-checking the findings with interviews in other V4 countries. A second option would be to bring forward the results of the interviews by analysing the possible effects of automation tendencies on foreign direct investment levels in Hungary and how these investments lead to upgrading in global value chains. In terms of policy recommendations, an extension of the study could work on the findings listed below. This could include examining the related global trends in detail, how the adaption to automation is carried out in leading developed countries, and what are the likely forthcoming trends, both at the macro and at company level. By building on these findings, a proposal for Hungarian decision-makers could be formed, including the necessary steps to be made in order to be prepared for the necessary changes.

The two most important policy recommendations related conclusions are the following:

- Public authorities and agencies should support robotisation across various sectors of the economy, as the benefit it creates is much higher than the related costs or the perceived threats to the labour market.
- The related parts of the Hungarian education policy should be changed in order to be able to supply the changing nature of the needs of the industry. Future workers should be given access to appropriate vocational training as well as other tools to ensure their flexible skill set, because automation has made lifelong learning more crucial than ever.

Acknowledgements

I am grateful to Prof. István Magas, Andrea Szalavetz and Attila Dabis for their support in writing the article. Also, I would like to thank the interviewees for their contributions; the following is a list of the identified respondents: Róbert Heffner (HIPA), Attila Lantos and Zoltán Volenszki (Duvenbeck Immo Logisztikai Kft.), István Szammer and Nikolett Szammer (Autopro), Bálint Rehák (Bosch Rexroth Kft.), Zalán Klauda, Zoltán Széles and Zoltán Székely.

The provision of robotisation statistics by the International Federation of Robotics was a useful contribution to my work.

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