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ANALYSIS OF THE RESPONSES TO THE QUESTIONNAIRE SURVEY

WORKPLACE TRANSITION, DIGITALISATION AND AUTOMATION IN THE HUNGARIAN AUTOMOTIVE, AUTOMOTIVE PARTS AND METAL INDUSTRIES

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EXECUTIVE SUMMARY

In developed countries, the wave of innovation known as Industry 4.0 has triggered major restructuring processes in both industry and services, but has also significantly transformed consumer habits. The everyday activities of people working in production plants have been fundamentally transformed by robotisation, digitalisation and automation. A few years ago, literature began to address the phenomenon of job losses and the potential for employees who are unable to adapt and may be placed in extremely precarious situations.

Our study examined the situation of the Hungarian metal and automotive industry at the dawn of Industry 4.0 using questionnaire and company interview methods. Our results show that both company managers and employees are aware of the changes caused by digitalisation, but do not see either their company's competitiveness or their jobs at risk. At present, the pressure to adapt is not significant and orders can be fulfilled by building on existing assets, even if the machines are old, not modern and not efficient. The only development pressure is due to amortisation processes and (rarely) customer requirements. If the customer requires it, the company will carry out the necessary improvements; otherwise it will typically invest mainly in making up for amortisation.

At present, the domestic corporate sector is facing a severe labour shortage, and many of the developments are designed to alleviate this. If the shortage is alleviated, however, there may already be employees whose jobs will be displaced by automation/digitalisation. They are mostly low-skilled, mainly in jobs that rely on their physical ability. Among the more highly skilled, neither managers nor the employees themselves perceive a risk of digitalisation at the moment. Industry 4.0 is currently seen by respondents as simplifying work processes, with some tasks becoming simpler or even fully automated. This is also due to a misinterpretation of the situation, as the simplification of certain job tasks is not specifically a consequence of the introduction of Industry 4.0 processes, but rather the result of continuous improvements and modernisation. The respondents find it difficult to imagine that entire work processes will be eliminated. For example, the principle of propulsion of electric vehicles is completely different from the principle of propulsion of vehicles equipped with combustion-engines, so that with the spread of the former, some parts will not be needed at all and batteries will be made using a completely different technology. Similar processes are also taking place in manufacturing technology, but they are not yet massively present in the domestic industry.

According to the respondents, this is due to the commitment on the owners' behalf and a lack of professionals due to the inadequate education system. The state is intervening, but at the wrong place and with a delay, because it is much more difficult to train old, skilled employees. The correct teaching of the basics and the introduction of modern technologies (e.g. programming) into basic education is essential for the development of an approach that Industry 4.0 requires and that will be present in Hungary in a few years' time. Without this, our competitive advantage will continue to rely on cheap labour, which will conserve the Hungarian economy on an unsustainable path.

INTRODUCTION

It was not so long ago that the spread of information and communication technologies (ICT), including computerisation and the internet, brought profound changes to our lives. The current wave of technology, the fourth industrial revolution, more commonly known as Industry 4.0, which is rapidly gaining ground worldwide, has been made possible by the exponential increase in computing power and data storage capabilities as well as the rapid decline in the cost of software and hardware. Digital information or data has become a strategic resource. Collecting, analysing and storing data has become an activity that determines competitivity. Artificial intelligence (AI), fed by data collected and structured in a target-driven manner, has helped to create the process that will shape our future: *digital automation.*

The most important feature of digital automation is that it enables the reduction of the use of human labour in production while increasing the importance of machines by harnessing the power of networks and data. Historically, technological change has served to replace humans, in whole or in part, in the performance of certain tasks. ***Industrial automation was initially limited to manual tasks***—for example, the spread of machines in manufacturing has forced millions of manual workers out of production. The process of deindustrialisation in developed economies has been triggered in part by the greater use of automated forms of production.

Today, the development of computerisation is also laying the foundations for the automation of routine mental tasks, which is now threatening many jobs not only in industry but also in the service sector. Digital automation, driven by artificial intelligence, now has the potential to replace or supplement human activities that require adaptation and learning. "Intelligent" machines are able to imitate or even surpass human intelligence in certain tasks.
The new digital technologies promise to reduce the number of workers involved in the production process and could also lead to the disappearance of jobs previously thought immune to automation. But these technologies will also soon change the way we work.

In the framework of the **WorkTransitionCEE** project, our research group is trying to find out where this process is in Hungary, with respect to two processing industry sectors, the automotive and automotive parts industry as well as the metal industry, what employers and employees perceive from it and how they try to meet the challenges involved.

As the project was launched on the basis of the European Social Partners' Framework Agreement on Digitalisation[1], we have tried to follow its ideas, objectives and spirit in our work. According to the document, the Framework Agreement aims to:

- "Raise awareness and improve understanding of employers, workers and their representatives of the opportunities and challenges in the world of work resulting from the digital transformation;
- Provide an action-oriented framework to encourage, guide and assist employers, workers and their representatives in devising measures and actions aimed at reaping these opportunities and dealing with the challenges, whilst taking into account existing initiatives, practices and collective agreements;
- ösztönözze a munkaadók, munkavállalók és képviselőik közötti partneri szemléletet;
- Encourage a partnership approach between employers, workers and their representatives;
- Support development of a human-oriented approach to integration of digital technology in the world of work, to support/assist workers and enhance productivity."

To establish our empirical research, and to help us compile questionnaires with the most relevant content possible, we have studied a wide range of national and international literature on the topic. We will refrain from presenting a detailed review of these studies here, and, in the first part of our study, we will only present an assessment of the situation and the lessons and recommendations of a few works that worth taking into consideration in the Hungarian context.

We then report the results of our questionnaire surveys of employers and employees in two sectors of the Hungarian industry, in the automotive and automotive parts manufacturing and in the metal industry. After that we will use a novel approach ***(skillscape)*** to outline the relationship between employee skills and jobs, and draw conclusions about the impact of digitalisation on jobs. We conclude our analysis with company interviews, which take the results of the questionnaire survey further and provide a broad picture of the digitalisation situation in the country.

[1] https://www.etuc.org/system/files/document/file2020-06/Final%2022%2006%2020_Agreement%20on%20Digitalisation%202020.pdf

1. SOME FINDINGS AND RECOMMENDATIONS BASED ON THE EXTENSIVE LITERATURE ON THE SUBJECT

1.1. OECD analysis of the situation

In The impact of ***Artificial Intelligence on the labour market – What do we know so far?***[2], published a year ago, the OECD presents the results of its multiple-year research work, which has led to the formulation of a set of principles for governments of Member States on the development of Artificial Intelligence (AI), along which it expects governments to take concrete actions to prepare for the transformation of the labour market. These are:

- ***Ensuring that people have the knowledge*** **to interact with AI systems and benefit from the services they provide;**
- ***Retraining programmes*** **and new job opportunities must be provided for workers who lose their jobs as a result of the rise of AI;**
- **Encourage *the responsible use of AI* in the workplace, including safe working conditions and quality work opportunities, promoting entrepreneurship and increasing productivity. Ensure that the benefits of AI are shared as widely and fairly as possible.**

An important finding of the study is that AI should not be seen as a potential "killer" of certain occupations, as it's effects in transforming the nature of occupations are much more important. It is this lack of understanding that leads many to see the current phase of digitalisation and automation as a potential cause of mass unemployment. It is important to distinguish between a task and a job. With the rise of AI, the employee is relieved of certain tasks, while his or her job is not completely eliminated; only his or her tasks have to be thoroughly reorganised. Dismissal only occurs if the employee is not able to meet the new expectations, in which case the employer is forced to make a so-called quality replacement. This view was shared by the company managers we interviewed.

AI also generates new occupations. Some of them are related to AI itself, and are connected to its development and servicing. Another very important area is the occupations related to the training of employees and users in the use of AI, such as the "trainer–explainer–sustainer" trio, i.e. the professionals who

- **provide training and education for potential users;**
- **interpret the achievements of AI in a manner that is understandable for non-professionals, raise awareness of the new opportunities created by the new technology; and**
- **ensure the "feeding" of AI systems, i.e. the updating of the information stored in them and the continuous expansion of their scope.**

In addition to the new professions directly related to AI, there is a growing importance of professions that can be created and made massive by AI-supported services, such as the development of personalised education systems, which use AI to assess the current knowledge, skills and abilities of each student and adapt the curriculum to the student, which is then delivered to them by the teacher operating the system.

By combining the potential of AI and virtual reality in product development, today's researchers can take on some very exciting challenges.

[2]https://www.oecd-ilibrary.org/docserver/7c895724-en.pdf?expires=1632395471&id=id&accname=guest&checksum=470459627D49F74387266881EECD099C

In line with the opinions of several renowned researchers, OECD experts also predict that *the overall impact of Industry 4.0, including AI, will be employment-enhancing in the Member States.* Not to the same extent, of course. Those countries that are unable to embrace the idea of progress, cling to old structures and even try to develop their economies along these lines, will be at such a competitive disadvantage that they will be left behind.

1.2. McKinsey's recommendations for Hungarian decision-makers

McKinsey's Budapest office conducted a comprehensive study in Hungary based on the methodology of the McKinsey Global Institute[3], and summarised its findings, assessment and recommendations in a study entitled ***"Transforming workplaces: the impact of automation in Hungary"[4]***, published in May 2018. The recommendations of this study are presented below.

To reap the benefits of automation, businesses and policymakers need to take action to educate and retrain the current and future workforce and create an innovation-friendly environment

1.2.1. Education that is started in time to improve technology skills and build adaptive capacity

Today, children as young as five are "digital natives", often more at ease with automated technologies than the adults looking after them. Hungary's ***school curricula should focus on developing two types of skills*** to take advantage of this phenomenon:

- **those related to the use and maintenance of automation and technology; and**
- **those that emphasise effective social skills.**

Children should learn skills such as programming, computer science, data analysis and other digital skills from primary school onwards, so they can communicate effectively with machines. In Estonia and the UK, for example, programming is taught from primary school, introducing basic concepts such as the knowledge of algorithms and technical skills such as debugging and writing simple programs. Acquiring these skills at an early age helps develop natural digital literacy and a workforce that is ready for future challenges.

As the jobs requiring "soft" skills that are not possessed by automated technologies will be filled by humans and not robots, it is important to develop the children's adaptive, creative, decision making, empathic and reasoning skills. Apart from being necessary for the teamwork that characterises today's organisations, these are increasingly important for creating a workforce of people practising in the changing professions.

[3] https://www.mckinsey.com/~/media/mckinsey/featured%20insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works-Full-report.ashx

4 https://www.mckinsey.com/~/media/McKinsey/Locations/Europe%20and%20Middle%20East/Hungary/Our%20Insights/Transforming%20our%20jobs%20automation%20in%20Hungary/Automation-report-on-Hungary-HU-May24.ashx

1.2.2. Adult education to develop the right skills

In adult education, there is a need for immediate and large-scale retraining programmes to help the current and soon-to-enter workforce adapt to a more automated economy.

Large corporates can play a central role in designing curricula and providing the theoretical and practical training that underpin the skills needed in the automated economy. Some companies in Hungary have already taken steps in this area. For example, Audi Hungária Zrt. supports a scholarship programme for engineering students at Széchenyi István University. Audi is involved in developing the curricula used in the university's five degree courses and offers training to suitable students. Similar cooperation programmes could be implemented throughout the country to increase the employable workforce. Measuring the results of individual adult training programmes (e.g. the proportion of workers who find a job after six months) and transparent monitoring of job opportunities after completion of each training course could also increase the efficiency of the training market.

As ***SMEs*** (small and medium-sized enterprises) are relatively under-resourced for training the employees, the government should offer them financial incentives and programmes to support SME consortia to develop innovative solutions in their sector, in cooperation with educational institutions, government and employment offices. As part of this cooperation, they can offer workplace courses and informal learning opportunities that are particularly relevant for SMEs.

Employment offices and chambers of commerce could help identify skills needed in specific sectors and skill gaps. Employment offices could also help connect jobseekers with independent training providers. They can also encourage training that is in line with business demand by assessing whether training providers are delivering training that leads to successful employment. For example, the Swiss government provides companies with a so-called "QualiCarte" to enable them to assess the quality of their trainings themselves and identify areas for improvement. Switzerland also requires training providers to obtain quality certification for their operations, and local authority inspectors monitor the quality of training through interviews with course participants and employers. Continuous monitoring of training programmes can help businesses, government agencies and employees to fine-tune their training programmes and adapt them to the rapidly changing needs of the labour market.

1.2.3. Government and private initiatives to stimulate technological innovation

The government could support private sector innovation through grants that provide financial incentives for research centres and SMEs to explore new opportunities and apply AI and other automation technologies and to expand the use of digitalisation. Incentivising automation technologies through targeted subsidies and tax incentives can help companies to make their deployment more cost-effective. As these subsidies can lead to redundancies, they could be made conditional on the need to retrain workers or create new jobs for them.

The government could also consider using financial incentives to absorb foreign investments that create innovation hubs that include automated technologies. Examples of innovation hubs include the Silicon Valley, Belgium or Israel, where local and multinational companies have built up collaborative networks with financial institutions, government agencies, research institutes and universities. This allows them to exploit synergies from access to labour and finance to take innovative ideas to the next level. Such an innovation hub could be created in Hungary by offering tax incentives to companies to launch technology-based R&D projects. It could also be important to make it easier for skilled professionals from outside the EU to obtain work and residence permits.

Policy makers could also consider model programmes that allow companies to test automation-oriented innovation ideas without the risk of possible fines for breaching existing legislation. One such initiative is the "Regulatory Sandbox", which the Magyar Nemzeti Bank (National Bank of Hungary) is trying to introduce to encourage testing in the financial technology sector. Another programme to support the development of automated products and processes is the test track near Zalaegerszeg, where self-driving vehicles are tested and their programming improved. In another programme, Facebook and Magyar Telekom are testing a new 5G wireless technology called Terragraph in Budapest. Programmes like this not only stimulate innovation, but also help policy makers to create legislation that encourages the uptake of these technologies.

To support all of these efforts, policy makers need to identify areas where legislation needs to be amended or new legislation needs to be created to regulate the specificities of automation ***technologies***[5]***.*** As automation technologies evolve these and other issues will arise and will require constant attention by policy makers. In order to demonstrate the benefits of automation and support its uptake in the private sector, the government needs to lead by example, by actively promoting digitalisation and automation in the public sector.

1.3 McKinsey's recommendations for business leaders

The McKinsey Global Institute's recommendations for Japan's business leaders published in the summer of 2020 in their study "The future of work in Japan: accelerating automation after COVID-19"[6] would be very important for the authorities to keep in mind in our country as well.
Experts say that to prepare for a more automated future, managers also have a lot to do. They need to focus on four key areas. These are:

➤ **Commitment to digital transformation is required at the top** – You cannot lead a revolution that you cannot understand!
Senior managers need to develop their own digital skills to be able to drive the changes from the top. This means they need to understand the impact that the achievements of digitalisation, machine learning and artificial intelligence can have on their business. It also means that they should learn about the latest technologies not only at conferences and workshops, but also in practice. They should visit companies, start-ups and development teams where they can see the tools and applications in action.

➤ ***"Business translators" should be hired, or possibly contracted,*** to act as a kind of mediator between developers, managers and employees. They are professionals with diverse education who can communicate with these people and are also aware of technological and market trends. They can see the bigger picture and act as project managers to lead the company's transition to a higher level of digitalisation and automation. As such professionals are hard to find on the labour market, experts recommend that companies train such "interpreters" from their own staff.

➤ ***Flexible working style models must be developed.*** During the pandemic, contact had to be kept to a minimum, transforming working conditions in ways that would otherwise have taken years to achieve. After the pandemic, organisations need to be flexible—both in where they work and when they work. This creates new opportunities for companies to recruit people who would not be able or willing to work for them under less flexible conditions. Examples include parents with young children, people living in other countries, and people who find it difficult to commit to a traditional job because of personal or professional priorities. Digital innovation can also increase flexibility by giving managers new tools to nurture company culture, manage teams and protect cybersecurity.

➤ ***Focus should be placed on retraining and upskilling the workforce.*** The increased competition for talents and the pressure to innovate have made training and retraining employees a major challenge. Few managers have sufficient resources to help employees adapt to rapidly changing technologies, especially in small and medium-sized enterprises. The companies could work with government agencies to create a more comprehensive approach that includes developing training programmes and matching graduates with employers.

[5]Például ha egy önvezető jármű balesetet okoz, ki a felelős? A tulajdonos, a gyártó, vagy az algoritmus tervezője?

[6]https://www.mckinsey.com/featured-insights/asia-pacific/the-future-of-work-in-japan-accelerating-automation-after-covid-19

2. PRESENTATION OF THE RESULTS OF THE FIELD RESEARCH

The questionnaires, compiled by the research team of Kopint-Tárki Konjunktúrakutató Zrt., in consultation with the representatives of the MGYOSZ (Confederation of Hungarian Employers and Industrialists) and the Vasas Hungarian Metalworkers' Federation and some relevant professional organisations, were available online between 15 February and 31 March 2022 for the employees and employers in the two sectors. One hundred and thirty employees and sixty employers honoured us by answering our questions. Below we present a picture of the current state of workplace transition, digitalisation and automation in the Hungarian automotive, automotive parts and metal industry sectors and their closely related sub-sectors.

2.1. Employee questionnaire

2.1.1. Composition of the sample

It's no coincidence that the overwhelming majority of our respondents, 95 per cent, were members of the Vasas Federation. Our sample was almost equally divided between women (51 per cent) and men (49 per cent). The distribution of our respondents by educational level is illustrated in the chart below:

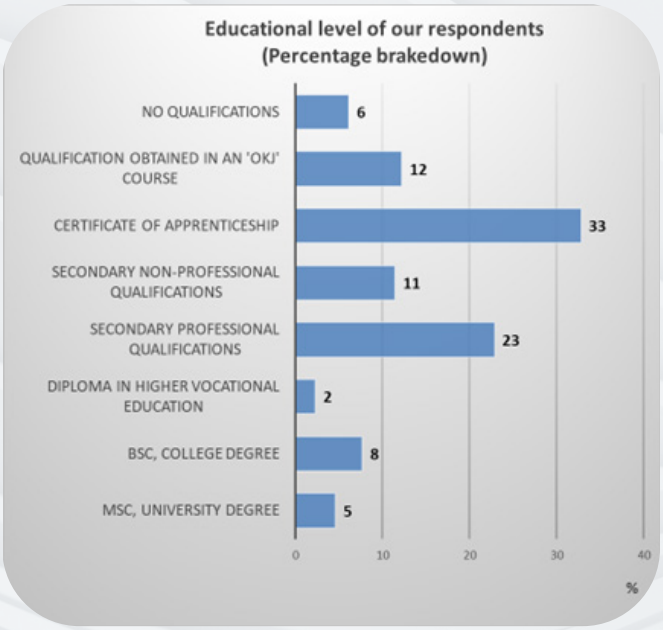

Figure 1: Distribution of respondents by education

A third of the workers who completed our questionnaire have a certificate of vocational qualification, and the second largest segment is made up of those with an intermediate vocational qualification. 15 per cent of our respondents have tertiary education.

We received completed questionnaires from 12 counties and Budapest. The distribution of responses by county is shown in the figure below:

Figure 2: Territorial distribution of respondents

Unlike other surveys, this time it was not the Central Region that received the highest number of responses. On this occasion, the activity of the people in Veszprém County was outstanding, and we thank them for this. They are followed by Hajdú-Bihar, Zala and Vas counties on our “scoreboard”.

Our graph displaying the age of our respondents shows that the majority of workers were the most active. Nearly 30–30 per cent were in the 36–45 and 46–55 age groups, with the 26–35 age group only slightly behind. It is noteworthy that the 56–65 age group was also well represented, but it is regrettable that the under-25s were hardly represented at all.

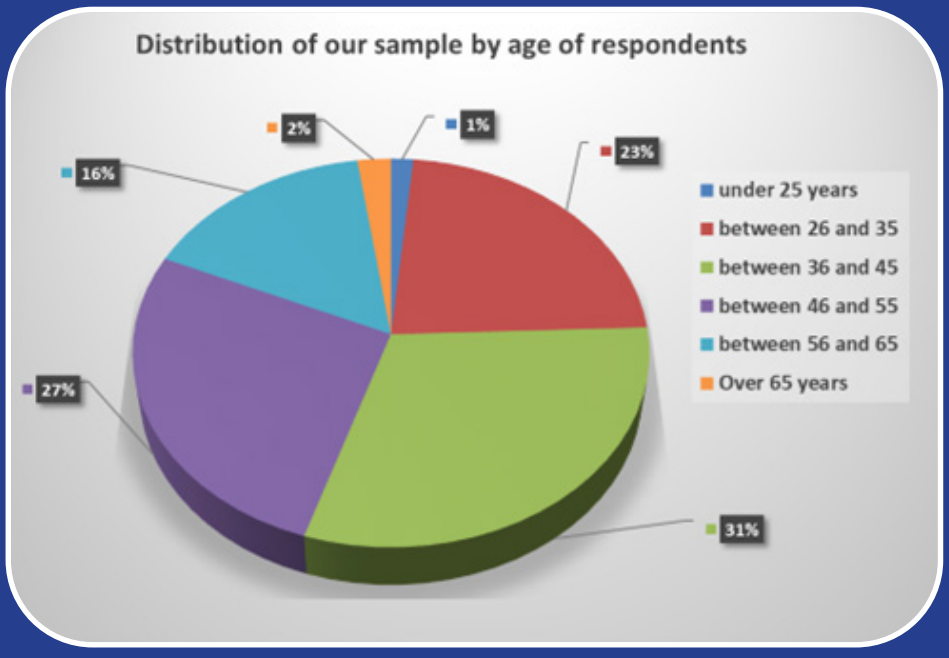

Figure 3:
Distribution of respondents by age

As far as the jobs of our respondents are concerned, our sample was dominated by operators, who were by far the most active with 38 per cent, followed closely by machine adjusters and middle or senior managers with the same score of 8 per cent each.

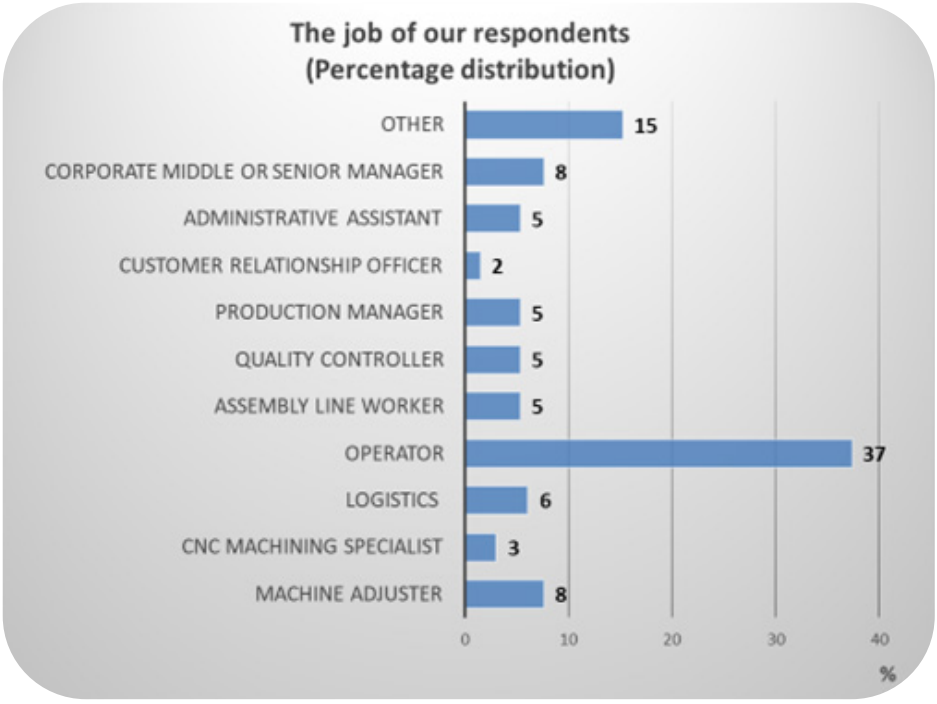

Figure 4: Distribution of respondents by job

Looking at the following chart, we can see that employees who are loyal to their jobs make up a large part of our sample. Only 18 per cent have been in their current job for less than 5 years and almost the same proportion have been with the same company for more than 25 years.

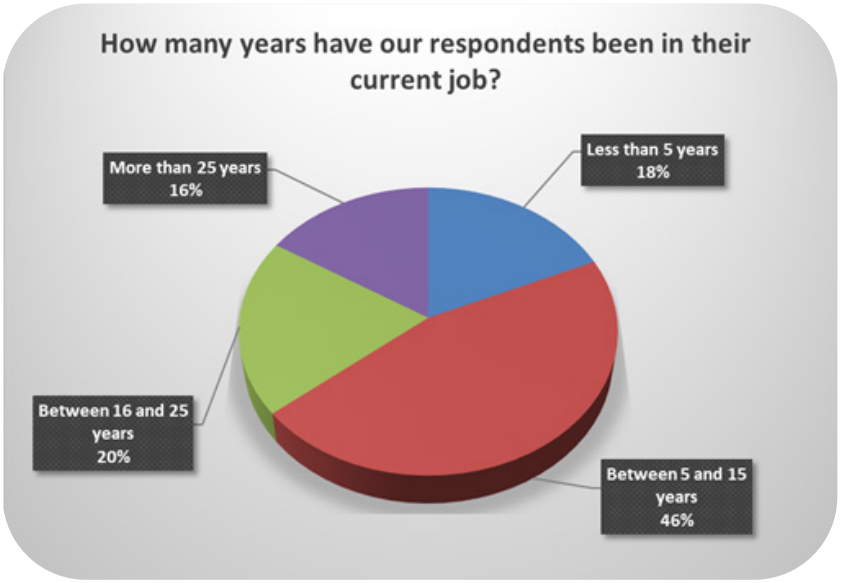

Figure 5: Distribution of respondents by time spent at their current workplace

From our list of the two major sectors surveyed, automotive and automotive parts and metal industry with it's subsectors, the respondents selected the sector of their workplace in the distribution shown in the following chart:

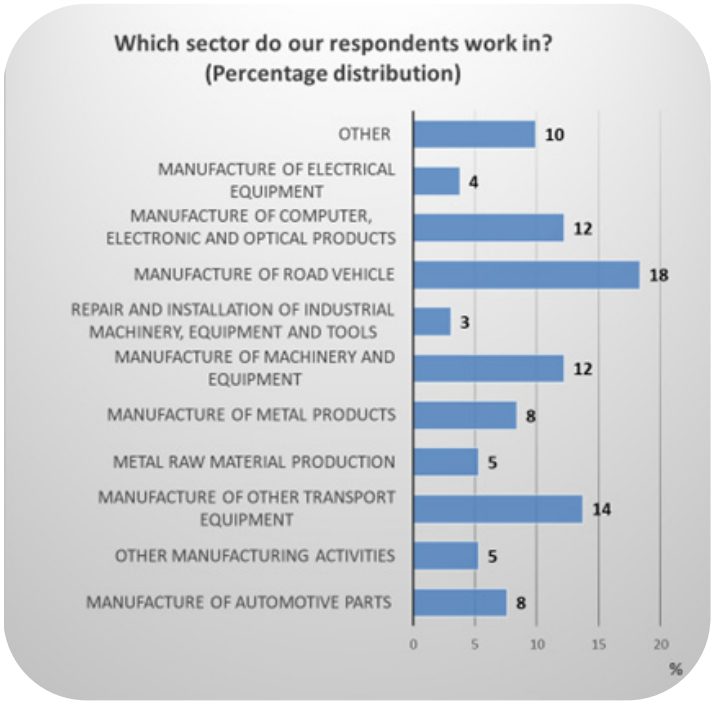

Figure 6: Distribution of respondents by sector

We can see that in addition to the manufacture of road vehicles and other vehicles, supplier sub-sectors such as computer, electronic and optical products (12 per cent), machinery and equipment (12 per cent) and automotive parts (8 per cent) are also quite prominent.

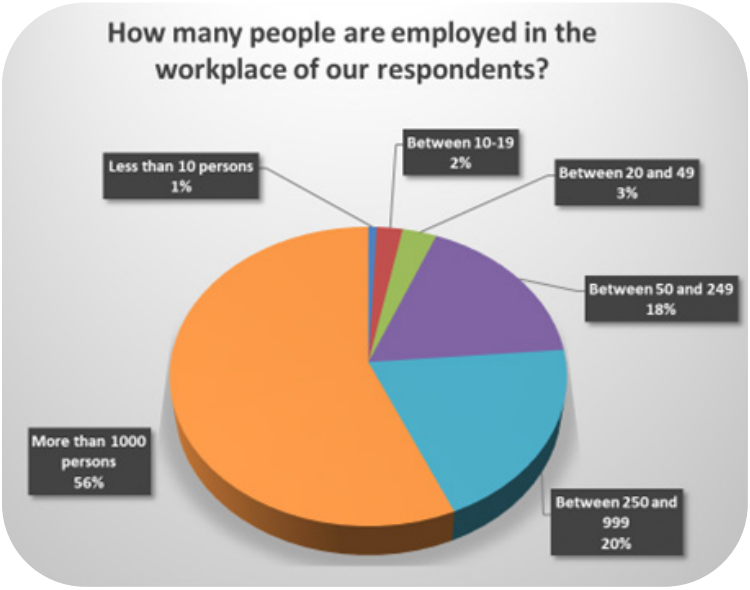

Figure 7: Distribution of respondents by company size

The vast majority of workers who completed our questionnaire work in large corporates. 56 per cent are employed in firms with more than 1,000 employees and a further 20 per cent in firms with between 250 and 999 employees. In particular, the activity of employees in micro-enterprises was very low. Presumably, this could be due to the very limited role of trade unions among them.

2.1.2. Analysis of the responses received

After the statistical block, we turned to the substantive issues in our questionnaire. Firstly, we wanted to find out how important our respondents consider each area of digital competence to be. We asked them to give marks from 1 to 5 (fail–(pass–satisfactory–good)–very good) for the competences in our table, as is customary in schools. The resulting "certificate" is illustrated in the following figure:

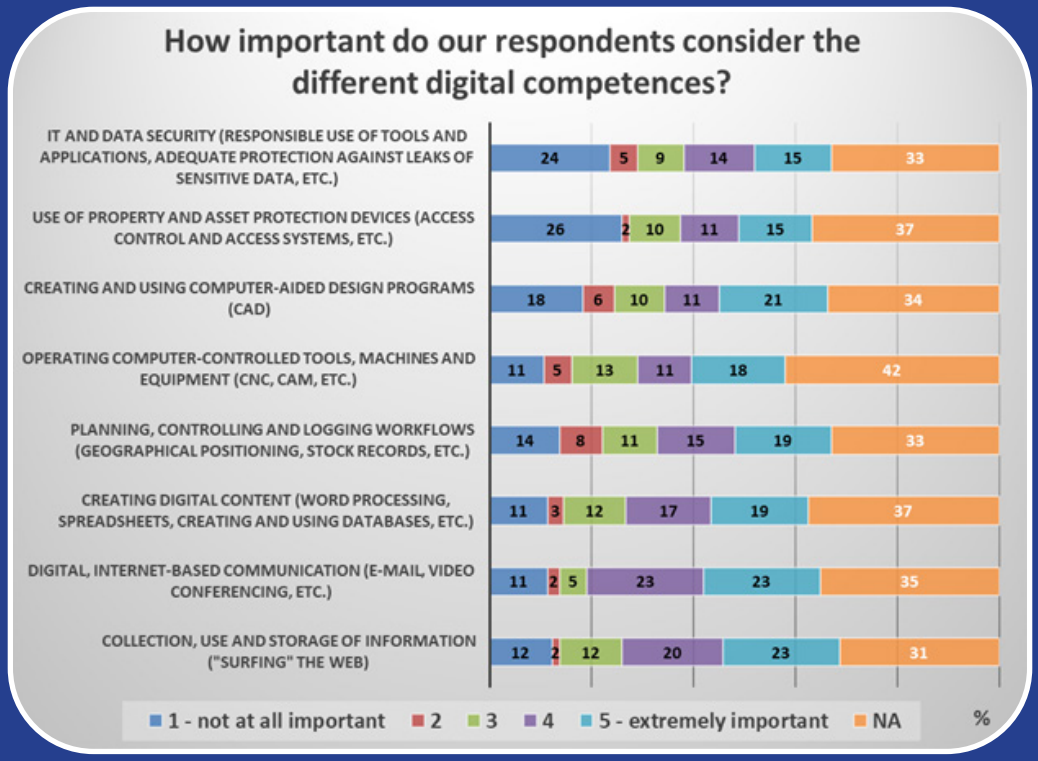

Figure 8: Perception of the importance of digital competences

The first thing that stands out in the figure is how high the weight of the NA option (i.e. the respondent could not judge the given aspect) is for each of the competences listed. In line with international practice, this indicates the weight in the sample of those who did not answer this question.

The two competences that received the highest marks, very good (5) and good (4), from the employees who took part in the grading were the two competences they are most likely to encounter in their private lives: **digital internet-based communication (i.e. email and video conferencing) and collecting, using and storing information (i.e. surfing the web).**

The third most very good (5) marks were awarded to a specifically professional competence, the creation and use of computer-aided design (CAD) programmes. 21 per cent of respondents gave a 5 for this competence. Planning, controlling and logging workflows, as well as word processing, spreadsheets and creating and managing databases also scored similarly well. 19 per cent gave a 5 for both.

It is quite devastating that IT and data security together received the highest number of fail (1) and pass (2) marks. 24 per cent of the employees gave them a 1 and 5 per cent a 2. The highest number of 5s (26 per cent) was for the use of property and asset protection tools.

It is interesting to note that the third most fail (1) grades were given to the same competency, the creation and use of computer aided design (CAD), as the third most very good (5) marks.

In addition to the high NA rate, it is also quite depressing that there was not a single competency that did not receive a fail (1) grade from at least 11 per cent of employees.

Interestingly, when asked how the development of digitalisation/automation has affected their perception of the labour market, the vast majority of employees answered positively. 45 per cent of respondents said "positively, because I have always tried to keep up with progress" and a further 29 per cent said "positively, because it has freed me from a lot of unnecessary work". 20 per cent said that although the transition was difficult at first, their colleagues were patient and waited for them to catch up. Five per cent were made feel that it was difficult to make the transition at their age, and only one per cent felt that they had to accept a transfer to a lower-paid job within the company because of a lack of skills.

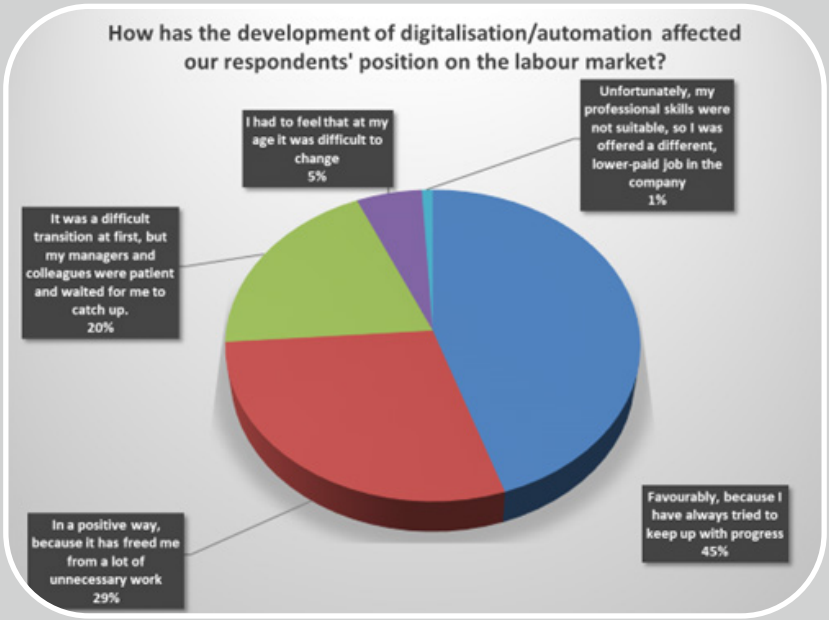

Figure 9: The impact of digitalisation on the employee

When asked if they have ever been in a situation where the development of digitalisation has made an activity they used to do at work redundant, 50 per cent of employees said no, and a further 31 per cent gave no answer. Most of the employees who found themselves in a difficult situation opted to improve their digital skills and some chose to learn another profession. There was an insignificant number of employees who resigned to their fate, opting for a change of job or field of work rather than learning.

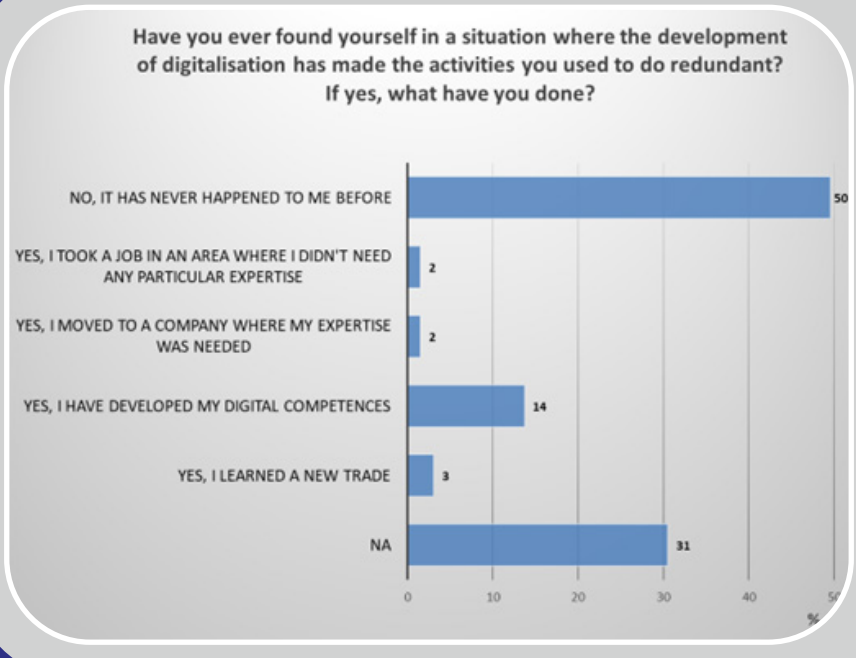

Figure 10: Employee responses to digitalisation challenges

In the next question, we asked for their opinions, not their own experiences. We asked the employees to rate, using the grades they were used to in school, how typical they thought it was that those who were displaced from their jobs by automation would choose the options we had identified.

The option “move to a company where their skills are still needed” received the most five and four marks, and the second best certificate was given to the option “move to a job in a field where no specific skills are needed”.

Each of the two options related to learning received a five from 6 per cent of the employees and a four from 17 per cent.

The least popular option was to become a private entrepreneur within the sector. 25 per cent of the employees gave it a one and 21 per cent a two.á.

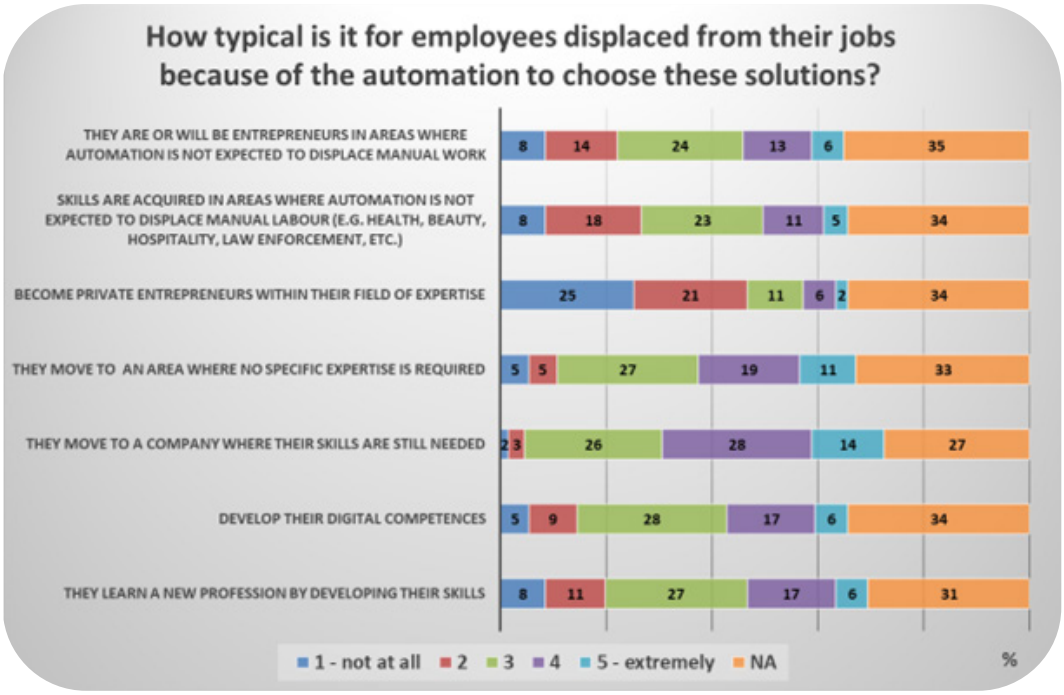

Figure 11: Responses from companies concerning the employees

Our last thematic question asked about the chances of losing their job due to digitalisation/automation in five years. The vast majority of our respondents are optimistic about the future, with 60 per cent choosing the option “possible, but not likely”. Only 3 per cent think it is sure it will happen and 10 per cent think there is a good chance that it will.

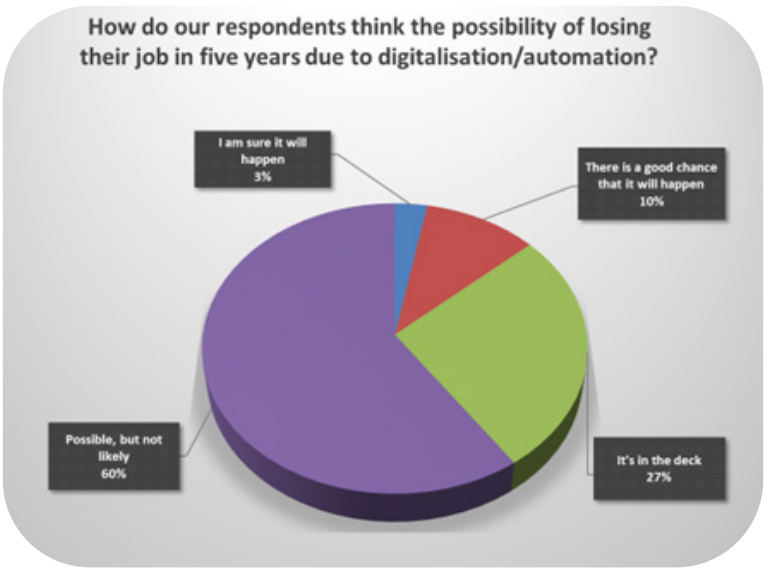

Figure 12: Employees and digital vulnerability

2.2. Employer questionnaire

2.2.1. Composition of the sample

While the representation of metal industry workers was very low among the respondents to our questionnaire for employees, it was the representatives of these sectors who were over-represented among the employers. The manufacture of metal processing products was represented by 47 per cent of our respondents and the manufacture of basic metals by 18 per cent. The automotive industry was mainly represented by the sectors that are suppliers.

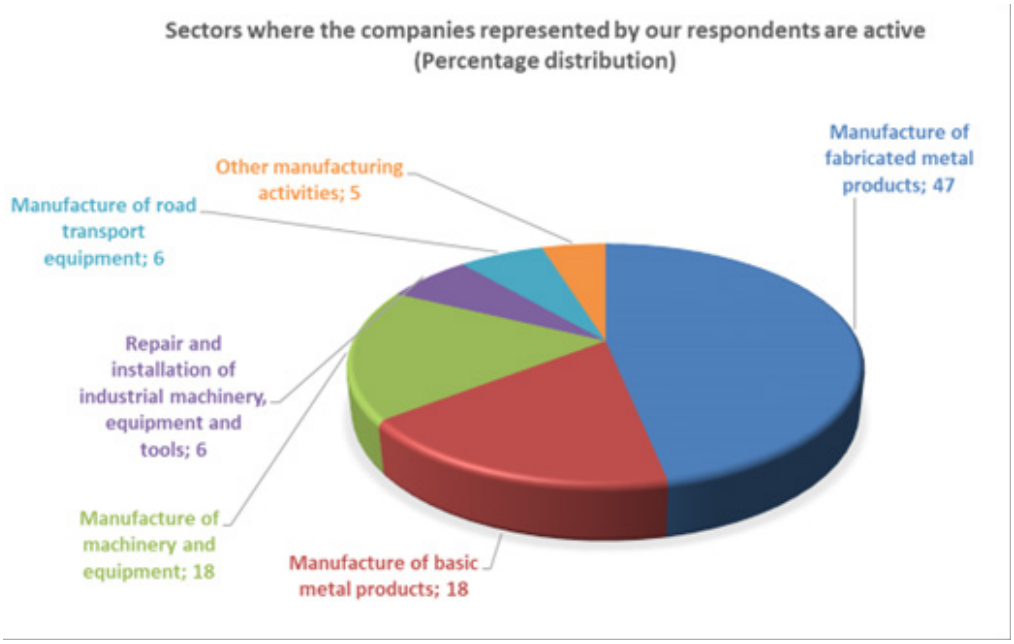

Figure 13: Sectoral breakdown of responding companies

The geographical distribution of our sample is also very different from that of the employees. The most active were the representatives of companies in Bács-Kiskun county. They account for 19 per cent of our sample, with Komárom-Esztergom (10 per cent), Borsod-Abaúj-Zemplén (10 per cent), Veszprém (8 per cent) and Pest (8 per cent) counties also having a significant representation.

Figure 14: Regional distribution of responding companies

We also asked about the owners of the companies represented by the respondents. The chart below shows that domestically owned firms predominate in our sample (82 per cent). Foreign-owned firms represent 15 per cent of our respondents. It is noteworthy that our questionnaire was filled in on behalf some state-owned or municipal companies.

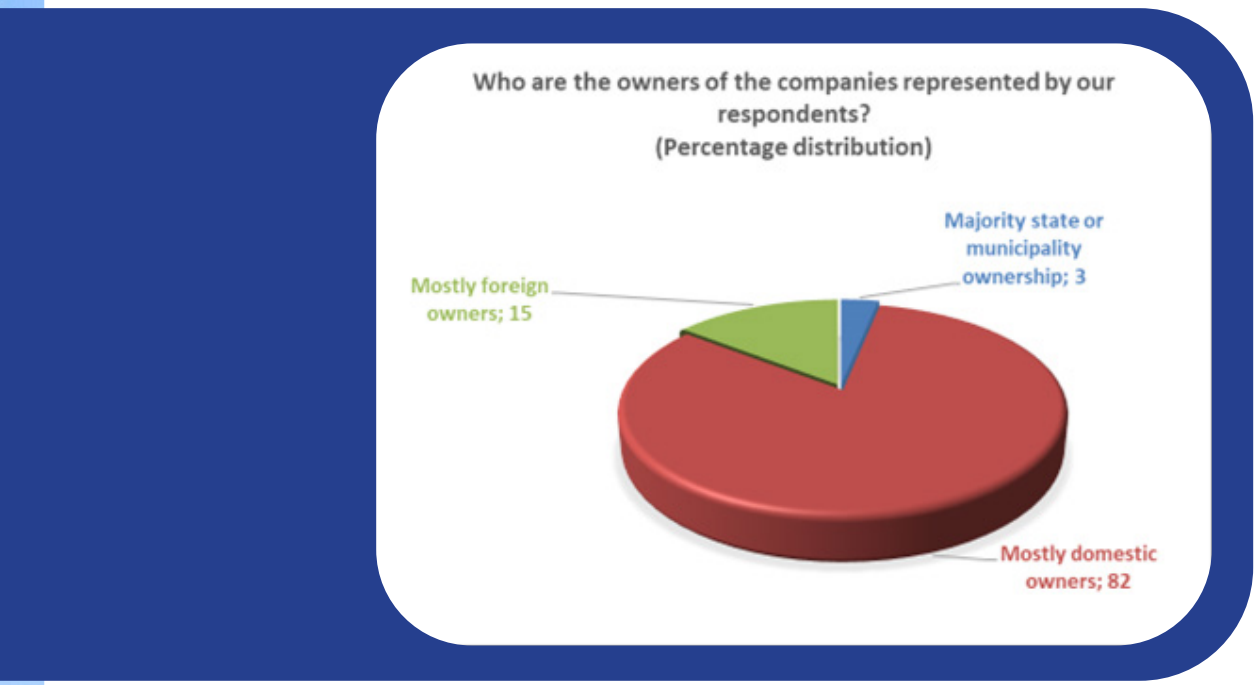

Figure 15: Breakdown of responding companies by ownership structure

While the majority of employee questionnaires were filled in by workers in large corporates, in the case of the employers, the respondents were overwhelmingly dominated by micro-enterprises. Firms with more than fifty employees were represented only by 26 per cent of our respondents.

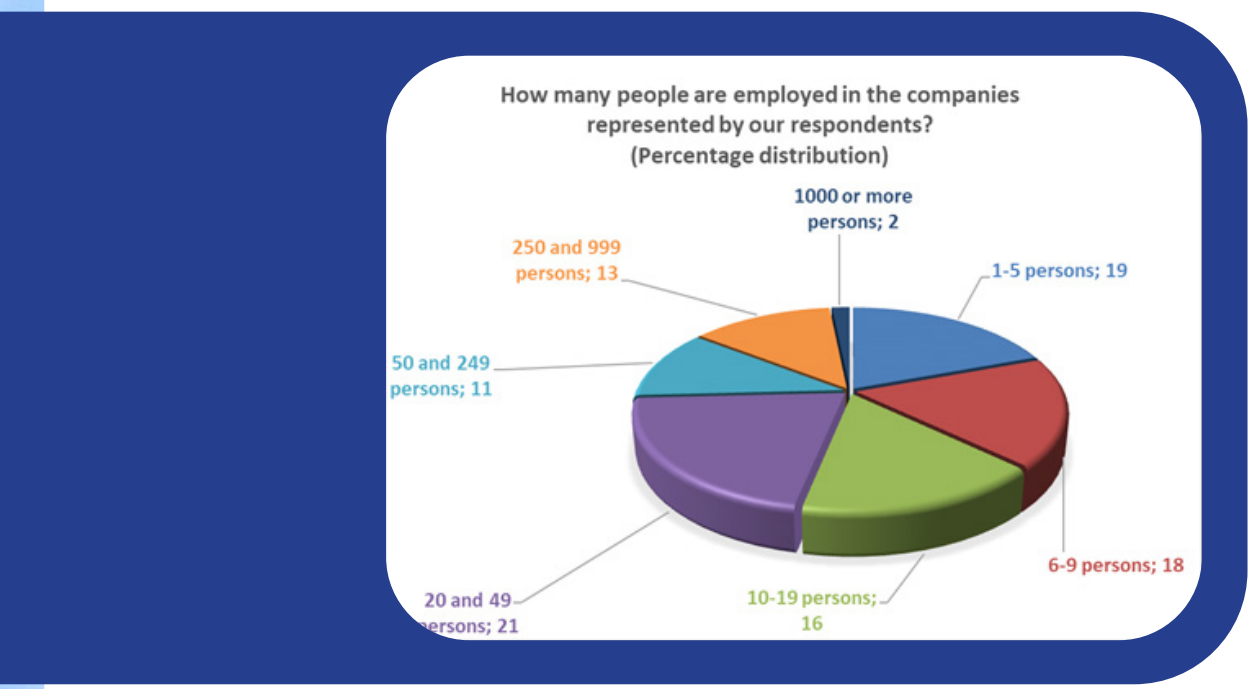

Figure 16: Distribution of responding companies by size

We also asked about the job title of the person completing our questionnaire. The answers showed that more than three quarters of them are number-one leaders, i.e. managing directors or CEOs. The second largest segment, with 10 per cent, is technical directors.

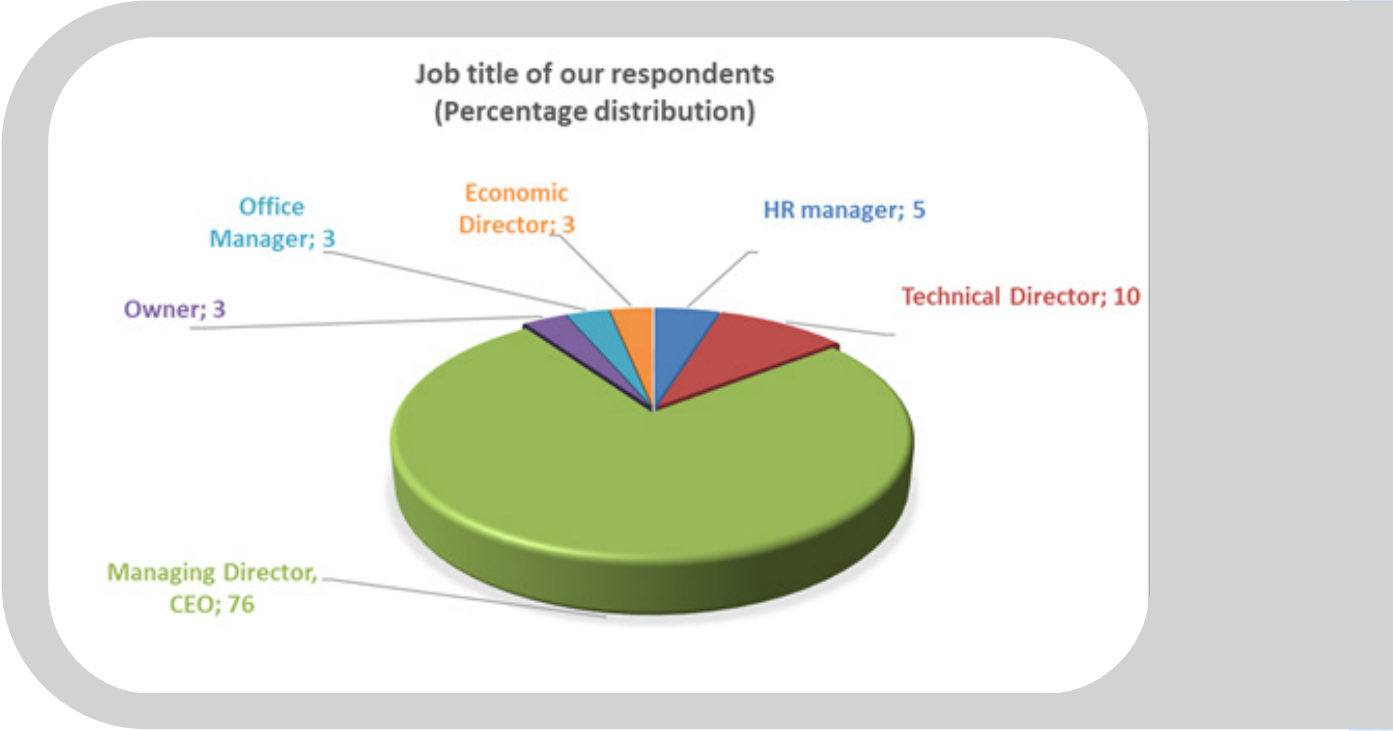

Figure 17: Position of respondents (company questionnaire)

We also asked about the approximate percentage of the company's workforce employed in production and other areas. The answers showed that our sample is dominated by manufacturing firms, with 50 per cent of them employing more than 80 per cent of their workforce in manufacturing.

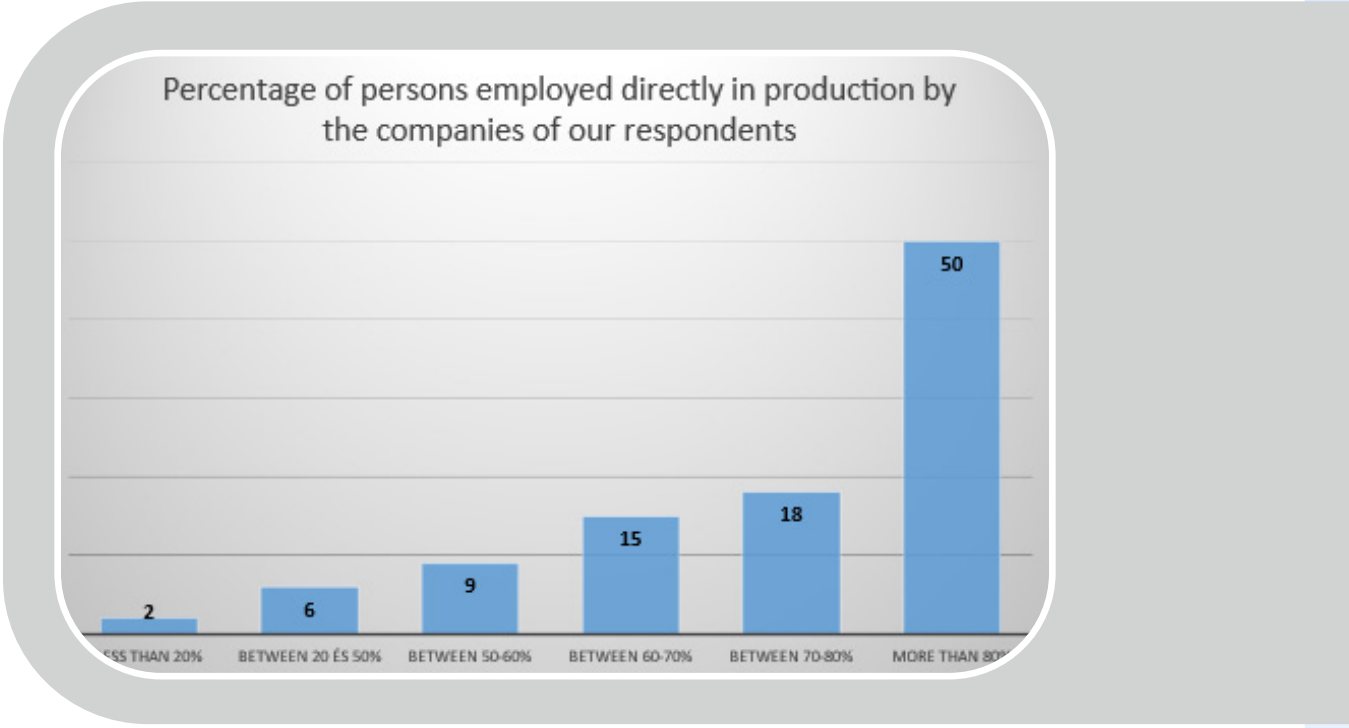

Figure 18: Percentage of persons employed directly in production in the company

2.2.2. Analysis of the responses received

Our first question following the statistical block asked how important they consider the achievements of digitalisation/automation in the various activities of their company. Here again, we asked them to rate the importance of digitalisation/automation in each area using the usual school marks.

Unfortunately, the high non-response rate for employees was also reflected in the employers' responses. Their non-response was mainly due to the composition of our sample, i.e. the fact that SMEs, and in particular micro-enterprises, were very well represented and that the areas listed in our questionnaire could hardly be interpreted as separate activities in their case.

The chart below shows that respondents who gave a meaningful answer almost exclusively consider digitisation/automation to be important. 1 and 2 marks are only rarely found. The highest number of fail (1) or pass (2) grades was given to HR and logistics, which is remarkable because international experience shows that these are the areas where the most dynamic development has taken place in recent years.

In line with global trends, development received the most very good (5) marks. 30 per cent of our respondents gave a 5 in this area and a further 25 per cent gave a 4. Sales received 28 per cent 5 grades, customer relations and production both received 27 per cent.

Marketing received the fewest 5 and 4 marks, which is probably due to the fact that our respondents are not in contact with consumers or end users, and therefore they feel less need to use modern marketing tools.

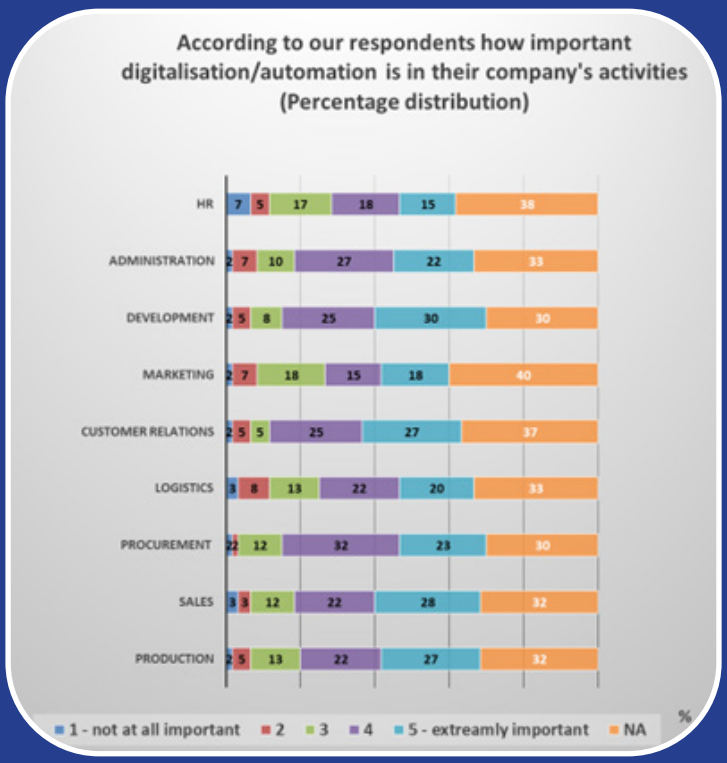

Figure 19: The importance of digitalisation for different departments

Then we asked: In general, how did workers respond to the digital transformation of their usual work processes? The employers were asked to select up to three typical responses from those we listed. The results are illustrated in the chart below:

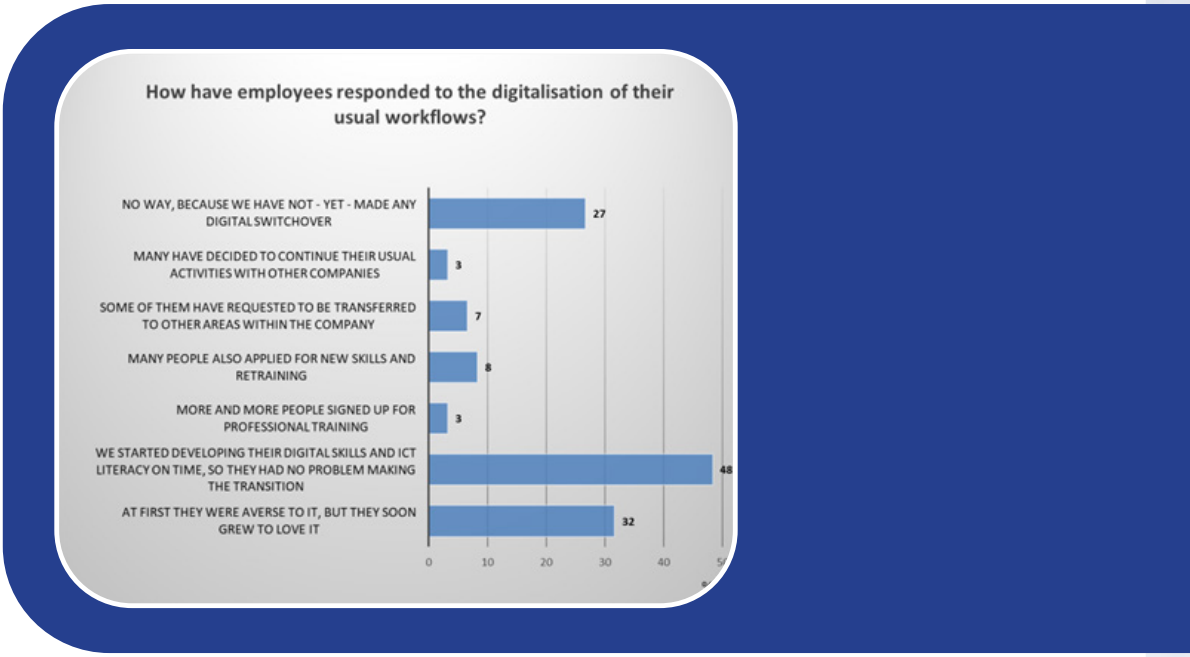

Figure 20: The impact of digitalisation on workflows

If it does not reflect an effort to give the "right" answer, it is both remarkable and reassuring that the most votes were cast for "We started developing their digital skills and ICT literacy on time, so they had no problem making the transition". 32 per cent of our respondents selected "At first they were averse to it, but they soon grew to love it" and 27 per cent "No way, because we have not—yet—made any digital switchover".

It is thought-provoking that very few employers indicated that their employees would seek to meet digital challenges through retraining or further training.

When we asked "What are the jobs that have been eliminated in your company as a result of digitalisation and/or automation in the last five years?" strikingly few respondents gave an answer, and almost all of them said that they had not experienced any such job losses. A total of three reported that they had lost administrative jobs and one company had been forced to lay off a warehouse worker.

So, obviously, we could not get a meaningful answer to our question "Please specify in general what happened to workers who lost their jobs due to digitalisation/automation" either.

Then we asked: "Apart from all other factors, how has the introduction of digitalisation and automation affected the number of employees?" 48 per cent of the employers said they did not see a significant change in their workforce, 10 per cent said there was a qualitative change in the number of less skilled workers and 3 per cent reported a reduction in the number of office workers. At the same time, 3 per cent of respondents reported an increase in the number of employees due to a recovery in demand for their products and services.

Figure 21: The impact of digitalisation on the number of employees

In terms of plans for the future, it is interesting that when looking at the substantive responses, there were only three areas where there were more yes than no answers. Most employers, 33 per cent, plan to make digital improvements in production, 27 per cent in logistics and 22 per cent in finance. These are the three areas where the percentage of those not planning to upgrade does not exceed the percentage of those who intend to.

More than 20 per cent of respondents to our questionnaire do not plan to make digital improvements in any area over the next three years, with the exception of production. The proportion of respondents who do not intend to make developments is 28 per cent in marketing and 25 per cent in customer relations.

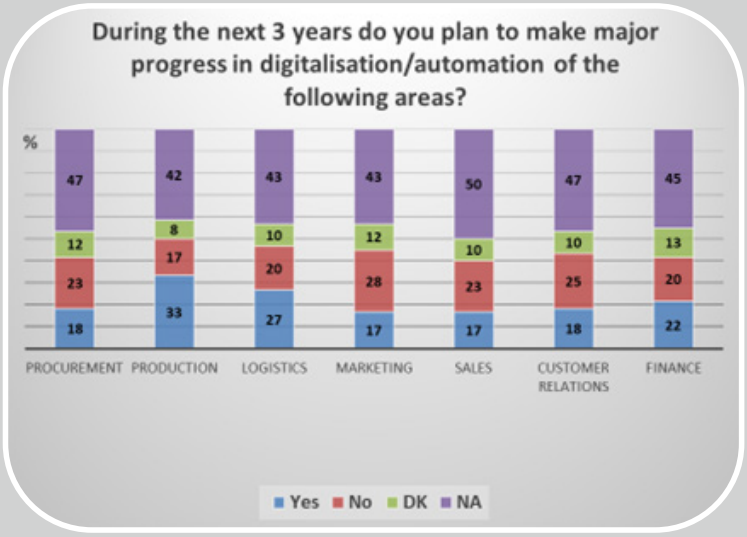

Figure 22: Plans in the area of digitalisation

When asked about the impact of the coronavirus outbreak on their company's digital strategy, a fifth of employers said they had not changed their strategy. 22 per cent responded to the pandemic by enabling home office working. The global impact of the pandemic, which is boosting digitalisation, was also cited by 15 per cent of our respondents. In particular, they are looking to extend digitisation/automation into new areas and accelerate their digital transformation already underway.

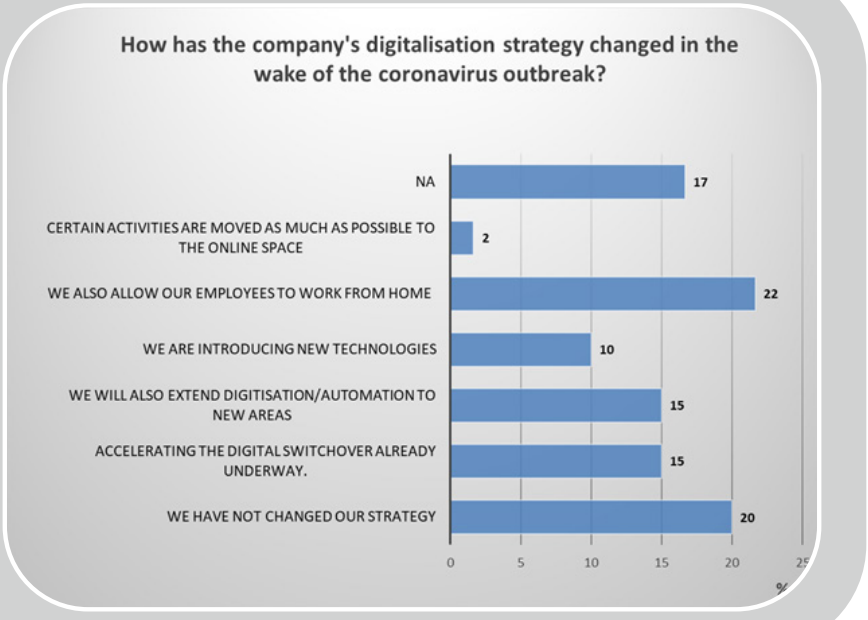

Figure 23: The link between the coronavirus epidemic and enterprise digitalisation

It is a sad fact for the digital development of the sectors we surveyed that the senior managers who completed our questionnaire are not able to judge how well their staff will be able to meet the digital challenges of the future. The chart below shows that there are only three areas—production, purchasing and finance—where 40 per cent or a little more had the courage to make a meaningful statement on this issue.

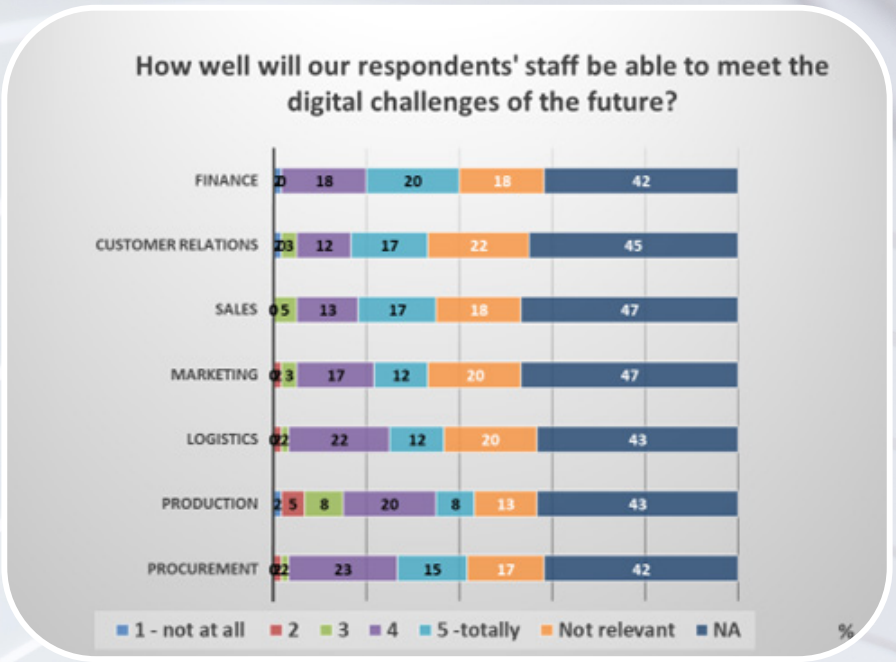

Figure 24: Meeting the digitalisation challenges by department

Production was the area where the usual school grades were awarded in full, but it was also the area where the workers received the least very good (5) marks. Only 8 per cent of the employers believe that their production staff will be able to fully meet the challenges.
The most 5 marks from their bosses were given to those working in finance (20 per cent), customer relations (17 per cent), sales (17 per cent) and purchasing (15 per cent).

Next, we asked what companies are doing to ensure they have the workforce to meet the challenges of the future. They could tick as many of the options we listed as they wished. In terms of measures, we wanted to know what they had done recently, what they were doing now and what they planned to do in the future.

Most votes were for the current practice of "trying to find the right workers on the labour market". The second place went to a practice that has been in place for the last three years, namely "we ensure continuous professional development of our staff within the company". Unfortunately, this latter practice, as well as "we help our workers to learn new skills", is becoming less and less relevant as time goes by. The latter was the least voted for in the list of measures to be taken over the next three years.

On the other hand, a positive trend can be seen in the growing popularity of the "we sign study contracts and offer scholarships to our future staff" option, which received the most votes of all the measures planned. The second most popular future measure, "we cooperate with educational institutions on the training of our future workforce", is also welcomed.

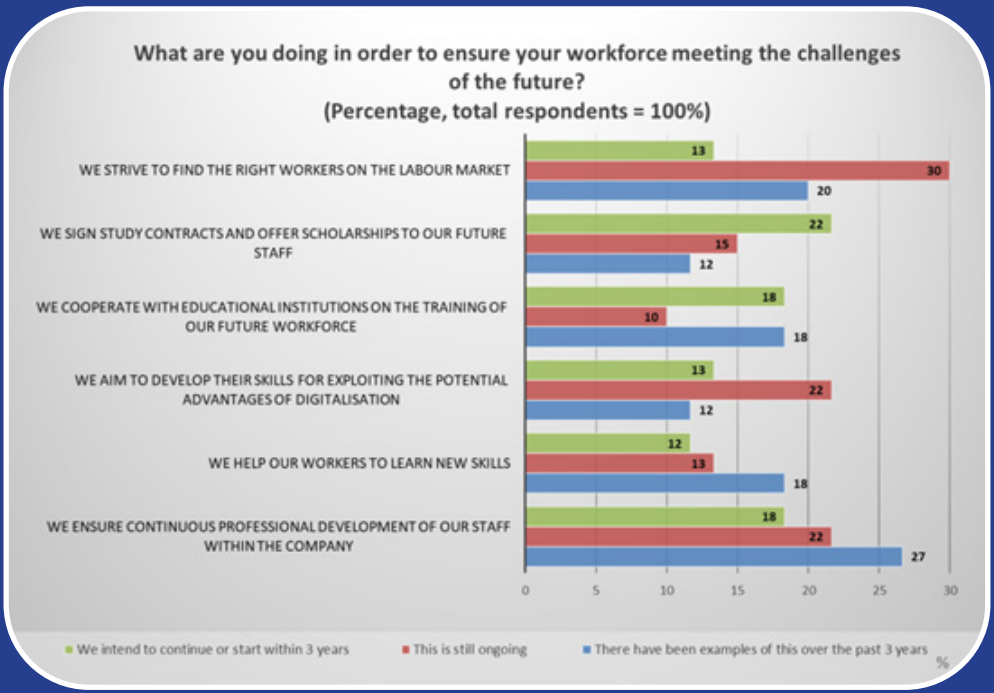

Figure 25: Workforce-related plans in the light of digital challenges

Finally, we asked which of the new digital technologies the representatives of employers consider important for the future development of their company.

Most respondents, one third, see the adoption of cloud solutions important for the future of their business. 28 per cent of the employers believe that the development of robotics and automation and mobile technologies will have a positive impact on their company. Smart sensor systems and 3D printing, with 27 and 25 per cent respectively, are still seen as promising technologies by the representatives of the sectors surveyed.

On the other hand, the analysis of large databases is the most rejected. 20 per cent of the respondents are convinced that Big Data is not important for their company. 18 per cent are against biotechnology, blockchain solutions and artificial intelligence.

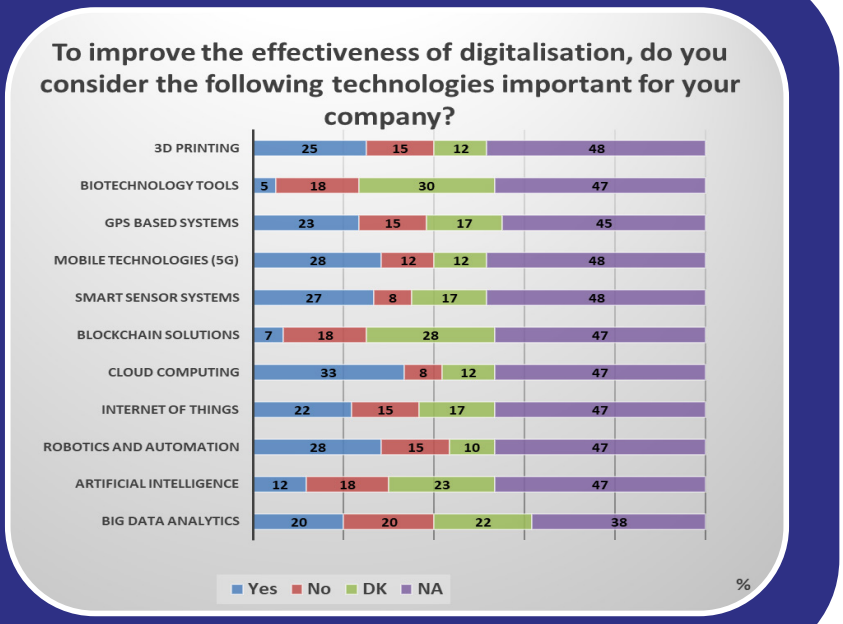

Figure 26: Industry 4.0 technologies in the life of companies

An adverse phenomenon in modern economic history is that the wage gap between skilled and unskilled workers in industrialised economies has increased significantly in recent decades (Piketty & Saez, 2014). This is also true for Hungary, where the gap in the competitive sector is three times wider for the highest paid workers with advanced qualifications compared to the lowest median earnings for workers in unskilled jobs. This has remained unchanged over the last decade and a half, while nominal earnings have doubled. Among the occupational categories, service and sales occupations and skilled industrial occupations have also moved 10 percentage points closer to the highest-earning tertiary educated professionals, while the earnings of elementary occupations have converged by only 3 percentage points. Thus, nominal earnings in this occupational group also doubled, while the relative position of workers did not change significantly.

	2002	2006	2010	2014	2018
Managers	88%	77%	87%	93%	97%
Professionals with higher education	100%	100%	100%	100%	100%
Technicians	59%	56%	52%	61%	63%
Office occupations	43%	40%	43%	45%	52%
Service and sales occupations	30%	27%	31%	40%	40%
Qualified agricultural workers	33%	27%	27%	34%	39%
Qualified industrial occupations	39%	37%	38%	38%	49%
Equipment and machine operators	42%	39%	38%	40%	46%
Elementary occupations	31%	27%	27%	33%	34%

Table 1: Median hourly wage compared to the occupation with the highest median earning in Hungary

Source: Eurostat

Although the wages in service and sales jobs have risen rapidly, it should be noted that until the 2010s, undeclared work was the highest among these jobs and among those in the agricultural sector (Semjén et al., 2009). Later, as a result of targeted government measures, these jobs have also been significantly whitened, but undeclared earnings still account for a significant share of the incomes of workers in the sector (Elekes et al., 2020). Taking all this into account, the nominal changes in the occupations concerned should still be treated with caution.

Of course, the above criticisms also apply to simple, unskilled occupations, as some occupations can be exercised as a self-employed worker (e.g. domestic workers). Nevertheless, the gap in median earnings for low-skilled workers compared to high-skilled workers can be considered persistent. In their case, the rise in earnings is mainly driven by labour market conditions and minimum wage rules, while the positive change in labour productivity is less pronounced (MNB, 2020).

Over the past two decades or more, the share of tertiary educated employees in the Hungarian labour market has increased significantly, partly as a demographic effect and partly as a result of the increased demand for tertiary education. While the number of employees with tertiary education barely exceeded half a million in 1997, by 2020 this figure had risen to 1.2 million, increasing the share of those with at least a college degree in the labour market from 15 per cent to almost 30 per cent. Meanwhile, the share of those with a primary or less education (no vocational training) fell from 20 per cent to 10 per cent, and the share of those with a secondary education remained roughly the same at around 60 per cent. There is therefore a movement between categories, with secondary education acting as a kind of a river between the primary and the tertiary education. More and more people are moving into the secondary education camp from below, and there are also those leaving the category from above for tertiary education.

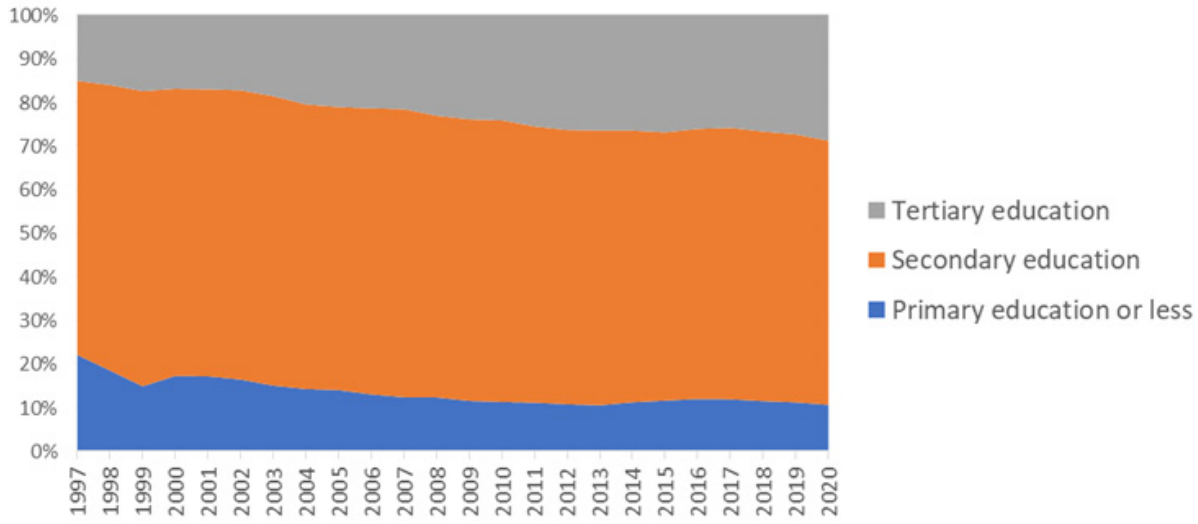

Figure 27: Distribution of employees by education in the Hungarian labour market (LFS methodology)

Sorce: Eurostat

In the period following the change of the political system, the labour productivity of those with tertiary education has risen steadily, but this has not been matched or only partially matched by those with lower education, while significant spatial disparities have emerged, which was reflected in wage differentials as well (Czaller & Major, 2016). This has occurred despite the fact that the labour supply of low-skilled workers was shrinking while the supply of high-skilled employees with high productivity was expanding, but this has not dragged along the wages of the low-skilled. There can be a number of reasons behind this, ranging from unfavourable bargaining power and union under-representation (Dumont et al., 2012) to technological developments that have put skilled labour in the foreground (Card & DiNardo, 2002).

In the last decade, more and more attention has been paid to the labour market effects of automation, digitalisation and robotisation, including their displacement effects. Although initially the view that those doing the simplest jobs could only be replaced by technological progress was popular (Ebel, 1987), many jobs have subsequently become threatened, even among those with qualifications. In their study of 702 jobs, Frey and Osborne (2017) found that around 47 per cent of US jobs are at risk of digitalisation. However, the OECD (2016) study measured a much lower exposure of roughly 9–10 per cent, as they found that not entire jobs, but only certain processes, may be eliminated by automation. Using factual data, Acemoglu and Restrepo (2020) demonstrated the externalities of robotisation in US industrial districts.

The relationship between technological progress and employment is clearly negative, with an increase in the number of robots being associated with a decrease in employment and wages. In their view, this effect is not yet significant, but assuming a significantly larger role for digitalisation and other productivity-enhancing technologies in the fourth industrial revolution (Schwab, 2016), the long-term impact is by no means negligible. **During the previous major technological changes in the world economy, there was a long period of time to adapt. Institutions and the education system, despite their relative inflexibility, were able to respond to changes in the labour market, and even to adapt relatively quickly and easily to certain jobs (Berg & Hudson, 1992).**

In the fourth industrial revolution, however, this happens much more quickly, and the role of adaptability and intercompatibility has become all the more important. Skills and competences are needed that are practice-oriented and that enable the employees to make cross-sectoral job changes without major learning processes. The lack of intercompatible skills is a pressing problem for employers, often referred to as the "skill-gap" (Bessen, 2014)[7]. In 2016, the World Economic Forum compiled a list of skills that global business leaders believed would be of cardinal importance by the 2020s (Table 3). The table shows that 6–7 years ago, experts still considered basic skills to be the most important, as they can be built upon in corporate training and develop the specific knowledge that a company needs for a particular job. The World Economic Forum conducted the survey again in 2020 and found a significant restructuring of large companies in developed countries. Critical thinking, problem solving and technological skills have become more important, while the importance of physical skills, basic skills (literacy) and communication skills has declined somewhat, see Table 2 (WEF, 2020).

1. Analytical thinking and innovation
2. Active learning and learning strategies
3. Complex problem-solving skills
4. Critical thinking and analytical skills
5. Creativity, originality and initiative

6. Leadership skills
7. Technological skills (operations)
8. Technological skills (design)
9. Stress tolerance, tolerance
10. Reasoning, thinking, problem solving, "brainstorming"

11. Emotional intelligence
12. Troubleshooting
13. Service-mindedness
14. Systems analysis, systems approach
15. Persuasiveness and negotiating skills

Table 2: Top 15 skills and competences in 2025 (ranking, forecast)

Source: WEF (2020, p. 36)

Skills	Basic skills	Comprehensive skills	
Cognitive skills	**Job-related skills**	**Social skills**	**Resource management skills**
• Cognitive flexibility	• Active learning	• Cooperation with others	• Finance
• Creativity	• Verbal expression	• Emotional intelligence	• Material management
• Logical reasoning	• Reading ability	• Negotiation skills	• Human resources management
• Sensitivity to problems	• Written expression	• Persuasiveness	• Time management
• Mathematical thinking	• ICT knowledge	• Service-mindedness	
• Visualisation		• Teaching ability	
Physical skills	**Understanding skills**	**Systemic skills**	**Technical skills**
• Physical endurance	• Active listening skills	• Judgment and decision making	• Repair and maintenance
• Manual dexterity and precision	• Critical thinking	• Systems analysis	• Operation
	• Monitoring ability		• Programming
		Complex problem solving	• Quality management
		• Complex problem solving	Planning
			Troubleshooting

Table 3: Skills for the job of the future

Source: Own edition based on WEF (2016, p. 21)

[7]We note that the "skill-gap" phenomenon divides the experts, as there is no clear evidence of the phenomenon. Rather, it is the existence of a "skill mismatch", i.e. inadequate skills is typical, while the average employee remains rather over-qualified for the job they perform (Cappelli, 2014).

The importance of the skills listed in Table 3 varies by sector and job, and there are categories that can be specifically linked to a sector. However, a large number of skills and competences exist that are compatible with multiple jobs, thus creating interoperability between occupations and occupational groups. This opens up the possibility of mapping skills and linking them to potential occupations. Such a study was carried out by Alabdulkareem et al. (2018) on US data, when they investigated the polarisation of occupations in geographically distant communities and demonstrated that regional specialisation is not only present by industry in the US, but also by skill. This is reflected in wage differentials and may also explain the different development dynamics. Their panel database showed well the changes in the supply and demand for skills, allowing them to dynamise processes that had previously been studied only through cross-sectional data.[9]

The assessment of which jobs are the most at risk of being lost due to digitalisation is rather controversial. According to Manyika et al. (2017), manufacturing is becoming "smarter", with manual tasks increasingly being taken over by machines, thus increasing the role of artificial intelligence. According to a report by the European Commission's Joint Research Centre, the definition of smart factories is as follows (JRC, 2019):

- **Information generated during production is digitised and integrated into the production system. This can take place either within the factory area or in external systems.**
- **Application of cyber-physical systems in production management, such as sensors, intelligent robots, 3D printing, etc.**
- **The use of an information network that links the tools used in production and the staff involved in production management and analysis.**
- **Before physical production starts, digital samples are produced, visualised and checked on the basis of simulations and various models.**
- **The data generated during production are analysed in a professional way and information is used to support the processes.**
- **The use of augmented reality software.**

However, digitalisation is bringing about a major transformation not only in manufacturing but also in services, to the extent that the jobs that are the most at risk are mainly those where business has now clearly shifted from face-to-face to digital platforms, such as travel agents, delivery services, etc. (JRC, 2019). However, some authors argue that the significant increase in computing power, robotics and AI will also displace workers in manufacturing, albeit with a slight lag, not least because that was the purpose for which they were developed in the first place (Autor, 2015).

3.1 The relationship between employee skills and jobs

In our research, we left it up to the workers themselves to identify the jobs at risk from digitalisation by leaving it up to them to judge for themselves how they see their own situation at work. As the digital development of companies is highly heterogeneous, even within a single sector, the employee and the employer are the only actors who can judge whether or not a job is at risk from digitalisation developments in the medium term, by looking at the processes taking place in the company. Based on the questionnaire survey, employees were considered to be at risk if their employer has already made them feel that they need further training, especially in digitalisation, or if they themselves consider that they are likely to be made redundant within 5 years due to automation or robotisation. According to the non-representative survey, 34 per cent of the respondents work in a job that is considered at risk according to the above criteria.

The aim of this section of our research is to examine the relationship between skills and competences in the metalworking and automotive parts manufacturing industries, and the mobility between occupations. Our analysis, however, differs from the work of Alabdulkareem et al. (2018) in several respects:

- **Given the small geographical size of Hungary, we did not see any reason to look at the issue in a regional dimension, as we assume that the demand for skills of firms in a sector does not differ across counties.**
- **In the absence of previous data, we were not able to conduct a dynamic study and therefore changes in the supply and demand for skills could not be tracked.**
- **The research focused on the impact of automation, digitalisation and robotisation on different occupations and skills.**

In their current jobs in the metal and automotive industries, there are varying degrees of tasks that require more digital competence.

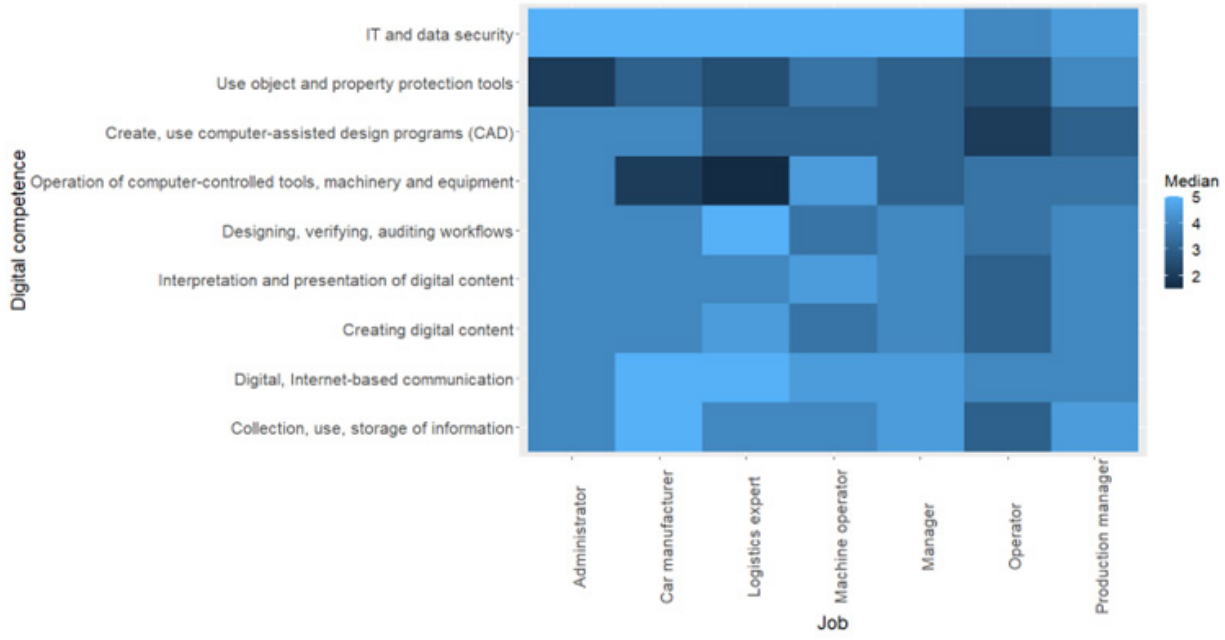

Figure 28: Importance of digital competences in the jobs surveyed (1=not at all important, 5=very important)

[8]For more detail on these, see WEF (2016, p. 25).

[9]See for example the work of Autor and Dorn (2013).

The most IT and digital competences are clearly required by administrative staff, as they are the first people to deal with corporate data. This is where the management of large databases ("Big Data") comes in, and where the most important performance data for senior management comes from. Corporate management requires competences in the areas of digital communication and information management that are more important than in other jobs. In the jobs creating less added value, requiring less skilled employees, there is already a significant distribution of tasks requiring digital skills. The operators typically do not use machines that they have to control and set up. Machine adjusters are also less likely to use tools that require computer skills, for them it is the digital skill needed to operate the tools that matters most. It is clear that logisticians primarily use digital platforms for communication, which typically requires basic IT skills. Similarly, the monitoring and logging of workflows to ensure the smooth running of purchases and deliveries also belong here.

The figure clearly shows that IT and data security (responsible use of tools and applications, adequate protection against leakage of sensitive data, etc.) is the most important digital competence, and is the most important element in almost all jobs. However, this digital knowledge is typically imparted to the employee by the company, as data security standards typically vary from company to company. Even if the employee is not directly working in an area where the security risk is higher than average, he or she is still required to comply with data security regulations. However, production-related information is a strict company secret and therefore all jobs are affected.

The digital literacy needs of jobs also vary by level of education, as the less skilled are unlikely to use tools that require such skills in the first place.

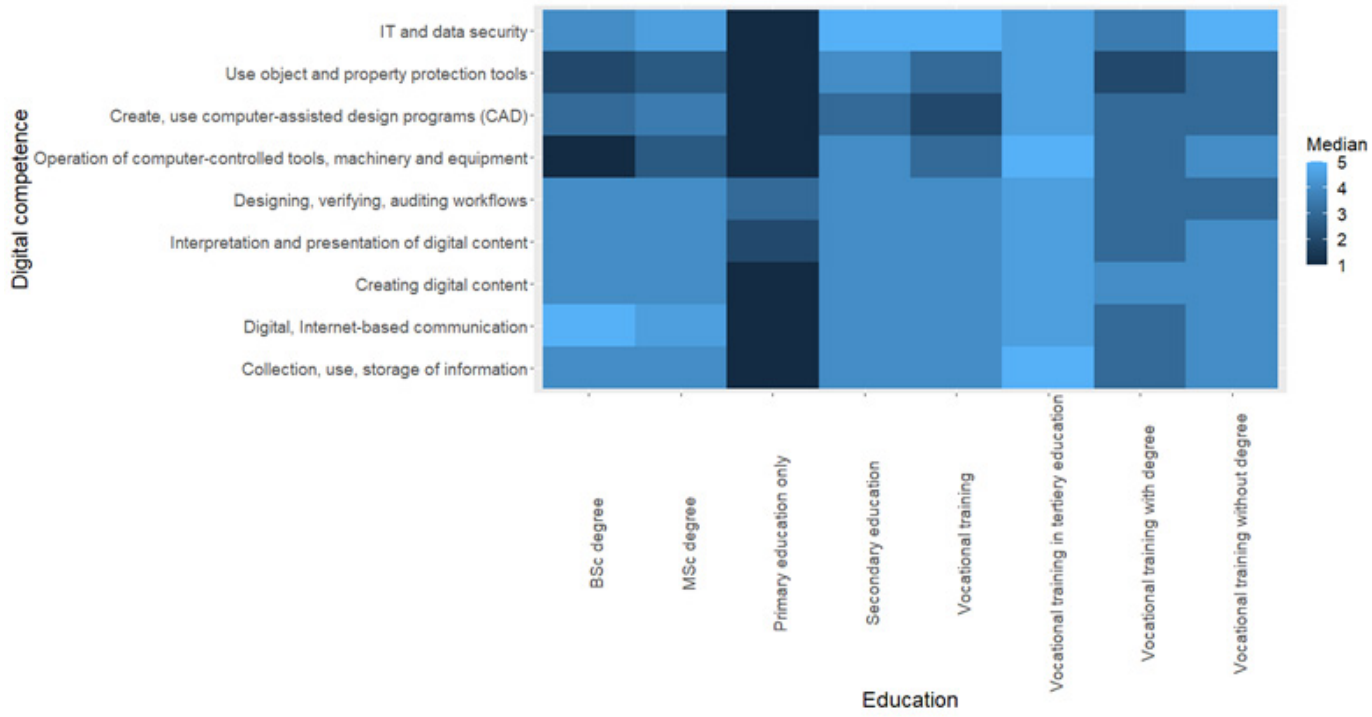

Figure 29: Importance of digital competences by level of education (1=not at all important, 5=very important)

It can be seen that workers without qualifications need almost no digital skills.

As educational attainment rises, the need for information management skills increases, but this almost displaces tasks related to the physical production of products. Thus, an employee with a higher level of education has less need to operate the machinery and equipment used in the production plant (as these are mainly carried out by workers with secondary education), but has to perform many more tasks related to digital communication and information management and processing.

We examined whether being at risk was associated with educational attainment and job, but found no statistically significant association, even though there were more people with qualifications listed in National Register of Vocational Qualifications (Hungarian abbrev.: "OKJ") who felt themselves to be at risk than in other jobs.

Educational attainment	Not at risk	At risk
BSc, bachelor's degree	78%	22%
Qualification obtained in higher-level vocational training	100%	0%
Secondary non-specialised education	71%	29%
Secondary specialised education	65%	35%
MSc, master's degree	50%	50%
Qualification obtained in training listed in the National Register of Vocational Qualifications ("OKJ")	33%	67%
No vocational training	80%	20%
Vocational training certificate	70%	30%
$\chi^2 = 7{,}3062$, significance = 7, p = 0.3977		

Table 4: The relationship between job loss through digitalisation and educational attainment

Despite the fact that the results are not significant, i.e. it does not follow from educational attainment whether the respondent is working in a job at risk or not, it is a telling result that the vast majority of workers with the lowest educational attainment (no qualifications) believe that their job is not at risk, while half of those with a university degree said that they could lose their job due to digitalisation processes. The free-text responses suggest that most workers cannot imagine that their current job could be fully covered by machines or replaced by other automated processes. There were several people who felt that the machines needed to be operated so their job would not be lost.

Studies on the jobs of the future show that there will be a shift in the demand for employee skills. There will be less and less demand for skills that require physical strength or fully manual work. In our questionnaire, we asked workers about 22 skills in total, which they were asked to rate according to how important they thought they were.

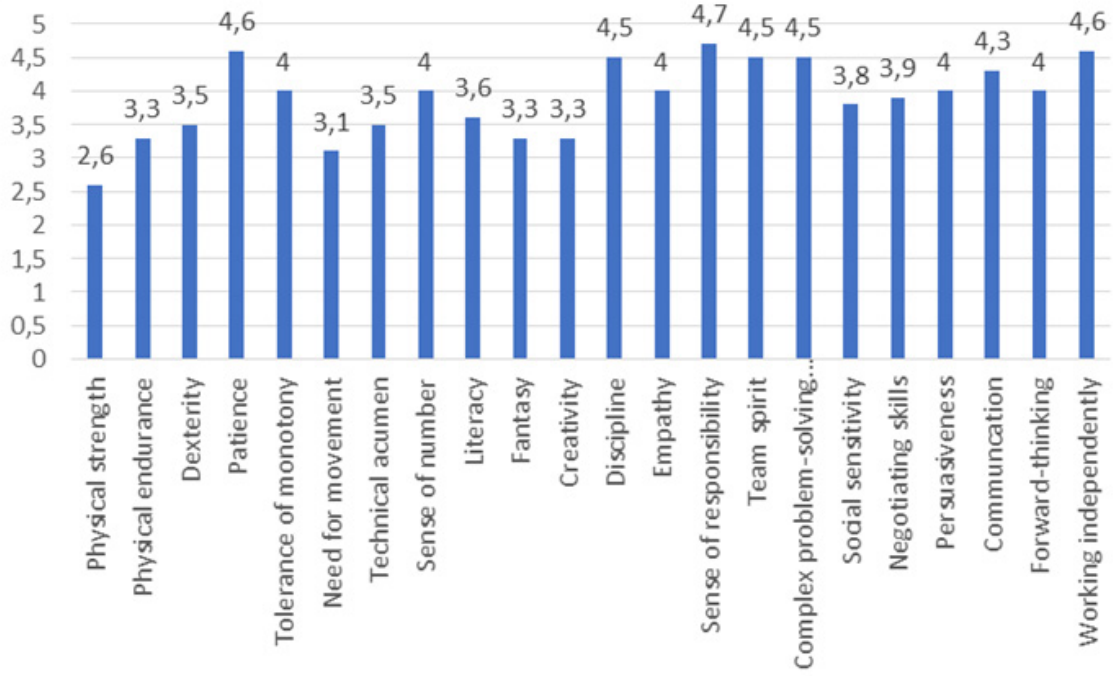

Figure 30: Aggregated rating of factors required to fill the job (1 = not at all important, 5 = very important)

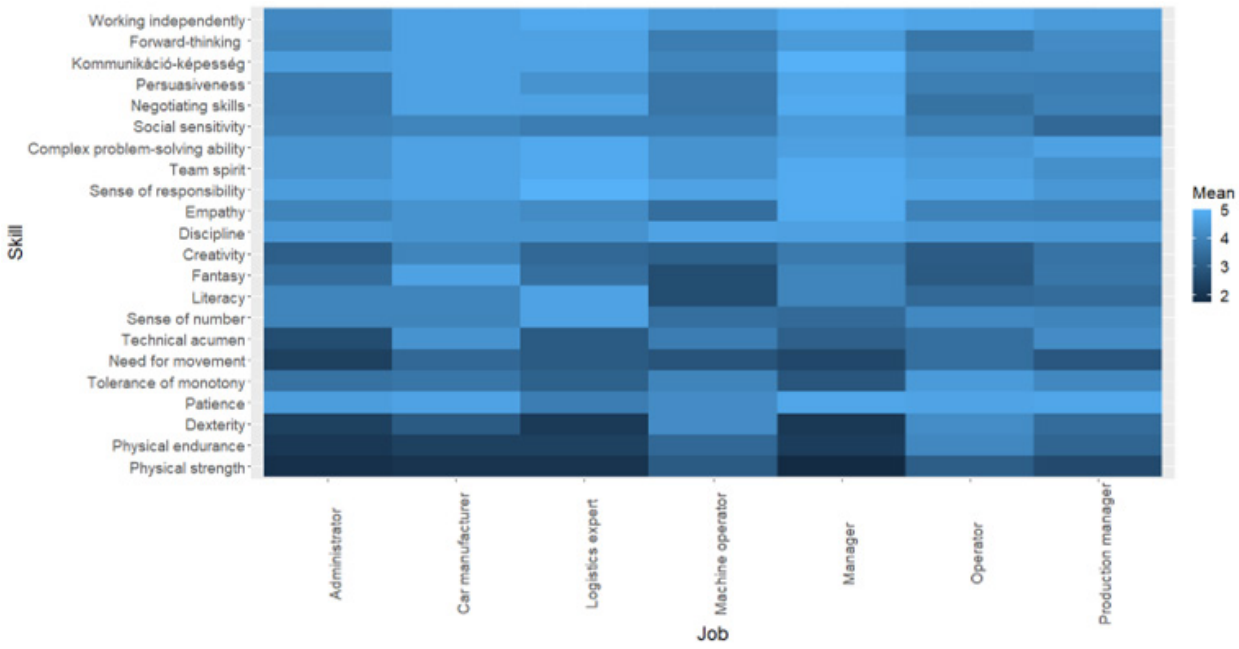

Figure 31: Perceived importance of skills in current job
(1 = not at all important, 5 = very important)

The results confirm that physical strength, physical stamina, mobility and manual dexterity which is the most important skill for performing manual tasks, are the least important skills in the sectors studied. It is worth noting here that creativity and imagination also scored rather low, suggesting that independent problem solving is less prevalent in the jobs of the workers surveyed. Although autonomy as a skill scored one of the highest, this presumably relates more to the ability to carry out tasks without assistance, rather than to the freedom to shape processes in some aspect of their work. It is clear that for management employees, cognitive skills are much more important than for other jobs, while the closer we get to physical workers, these skills become less important. There is, however, no difference in the perception of skills according to whether or not the worker feels their job is at risk, as shown in Table 5.

Skills	Not at risk	At risk	t-test significance value
	Average		
Physical strength	2.6	2.6	0.94
Physical endurance	3.2	3.5	0.49
Manual dexterity	3.4	3.6	0.56
Patience	4.6	4.5	0.60
Tolerance of monotony	4.1	3.9	0.64
Need for mobility	3.2	3.0	0.46
Technical aptitude	3.4	3.6	0.65
Number sense	3.9	4.1	0.49
General education	3.6	3.6	0.95
Imagination	3.3	3.3	0.93
Creativity	3.1	3.5	0.18
Discipline	4.4	4.5	0.53
Empathy	4.1	3.9	0.50
Sense of responsibility	4.6	4.8	0.56
Team spirit	4.5	4.6	0.58
Complex problem solving	4.5	4.5	0.92
Social sensitivity	3.8	3.9	0.61
Negotiation skills	4.0	3.8	0.43
Persuasiveness	4.0	3.9	0.68
Communication skills	4.3	4.2	0.57
Forward-thinking/planning ability	3.9	4.1	0.65
Ability to work independently	4.7	4.6	0.64

Table 5: Rating of the importance of the skills according to the job's vulnerability to digitalisation
(1 = not at all important, 5 = very important)

In the following, we will examine the similarities of the perceptions of abilities using several methods.[10] One way of doing this is to use a specific principal component analysis (PCA) based on the similarity of the perception of abilities.[11]The result of this is shown in the space of the first two (main) dimensions in the following figure:

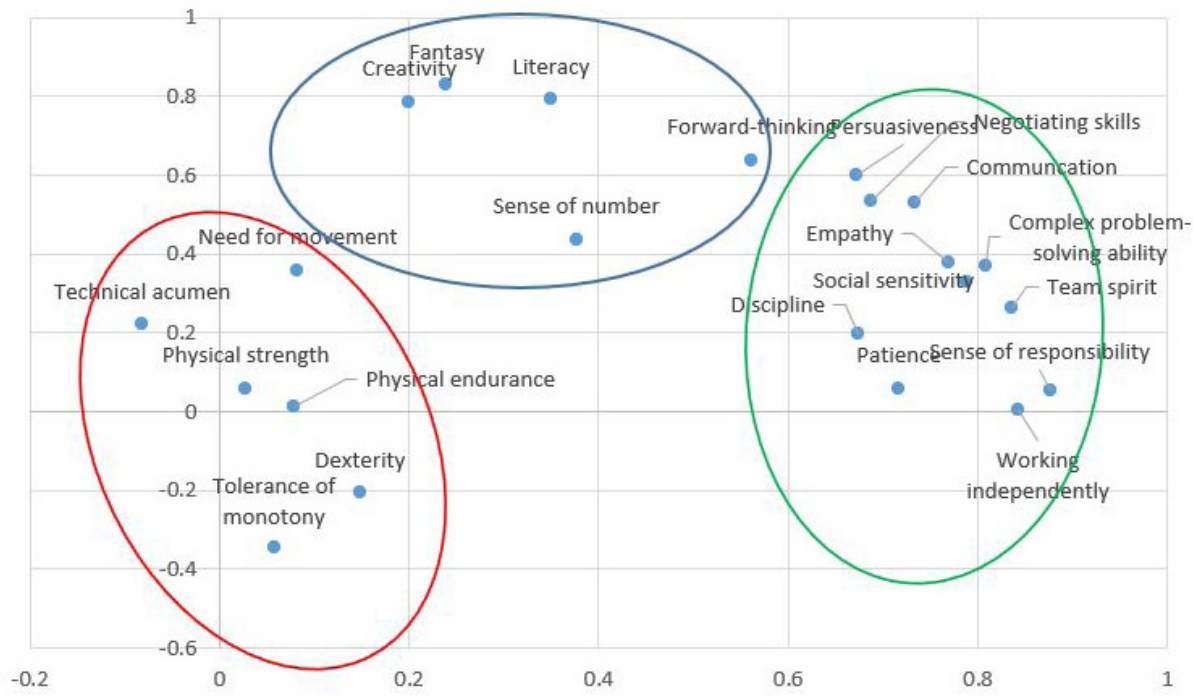

Figure 32: The appearance of skills in the first two dimensions of the principal components[12]

The perception of the skills that lie close to each other in the figure are very similar among respondents. The relative positioning in the coordinate system also captures the direction relative to each other (based on the vector starting from the origin). For example, technical acumen has a completely opposite perception to manual dexterity or tolerance of monotony. It can also be seen that cognitive skills (team spirit, social sensitivity and sense of responsibility) are judged very similarly. In other words, respondents consider that good cognitive ability includes mainly communication skills and social skills, but not, for example, numeracy abilities. Self-actualisation skills (imagination and creativity) are completely separate from cognitive skills. An interesting result is that technical acumen is somewhat close to physical abilities. Accordingly, respondents consider that technical skills are essential for physical work, mainly with machines, regardless of the level of technical knowledge required for the job itself.

We also used another method to examine the relationship between skills. We used a method called hierarchical clustering[13] to study which ability perceptions are most similar and how they relate to each other.

[10]The methodologies are described in Kovács (2014).
[11]Classical principal component analysis can be performed in a continuous variable space, but the assessment of ability is always an ordinal variable, so we have chosen a special case of PCA analysis, polychoric principal component analysis, which computes similarity in a space of ordinal variables.
[12]The axes of the coordinate system represent the correlation with the component.
[13]First, we calculated the polychoric correlation between the abilities, and from this we calculated the distance matrix using Euclidean metrics. The method of aggregation was complete linkage.

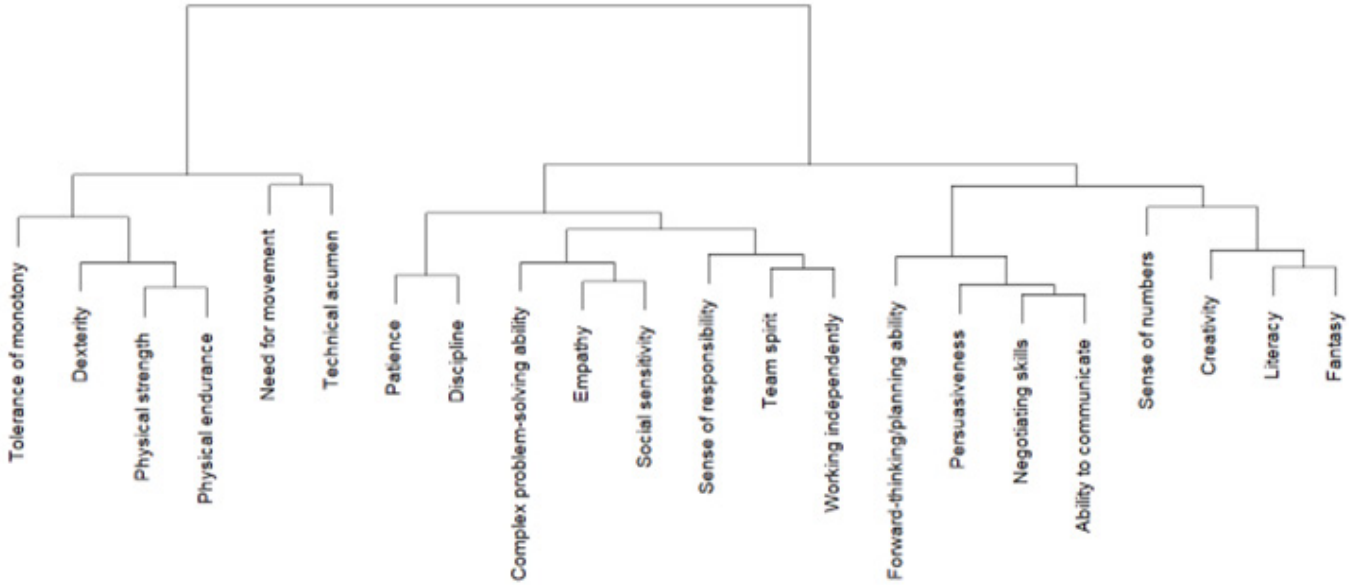

Figure 33: Hierarchical clustering dendrogram to study ability segmentation

The interpretation of the figure is as follows: in each case, the two elements that are most similar to each other are placed on one branch. A third element is added to this circle if the element in question is more similar to an already existing group than to another element. The lower the level of the elements, the more similar they are. For example, physical strength and physical endurance are judged to be very similar. The judgement of manual dexterity is the most similar to the judgement of these two abilities, followed by the tolerance of monotony. The judgements of need for movement and technical acumen are also very similar, but these two elements are closer as a group to the physical strength group than they are separately. The figure above (dendrogram) also confirms the separation of physical and cognitive abilities, but it clearly shows logical combinations such as the relationship between patience and discipline. Similarly, communication skills and social skills are grouped together. Interestingly, the cluster embodying self-expression (imagination and general education cluster) is joined by number sense. That is, respondents also consider number sense as a kind of endowment, an innate skill, which is massively separate from other skills.

Another way of representing the similarity of abilities is multidimensional scaling (MDS), which projects the observed variables into a lower-dimension subspace in an effort to preserve distances (similarities). In the present case, the result is that a set of variables with 22 dimensions (ability scores) can be represented, with some loss of information, in a two-dimensional plot[14].

[14]This method differs from the PCA method presented earlier in that while MDS compresses all dimensions, PCA reduces the number of dimensions and sets a priority order. In other words, the first two dimensions of PCA contain most of the information but not all, whereas MDS contains all the information so that the loss is minimised.

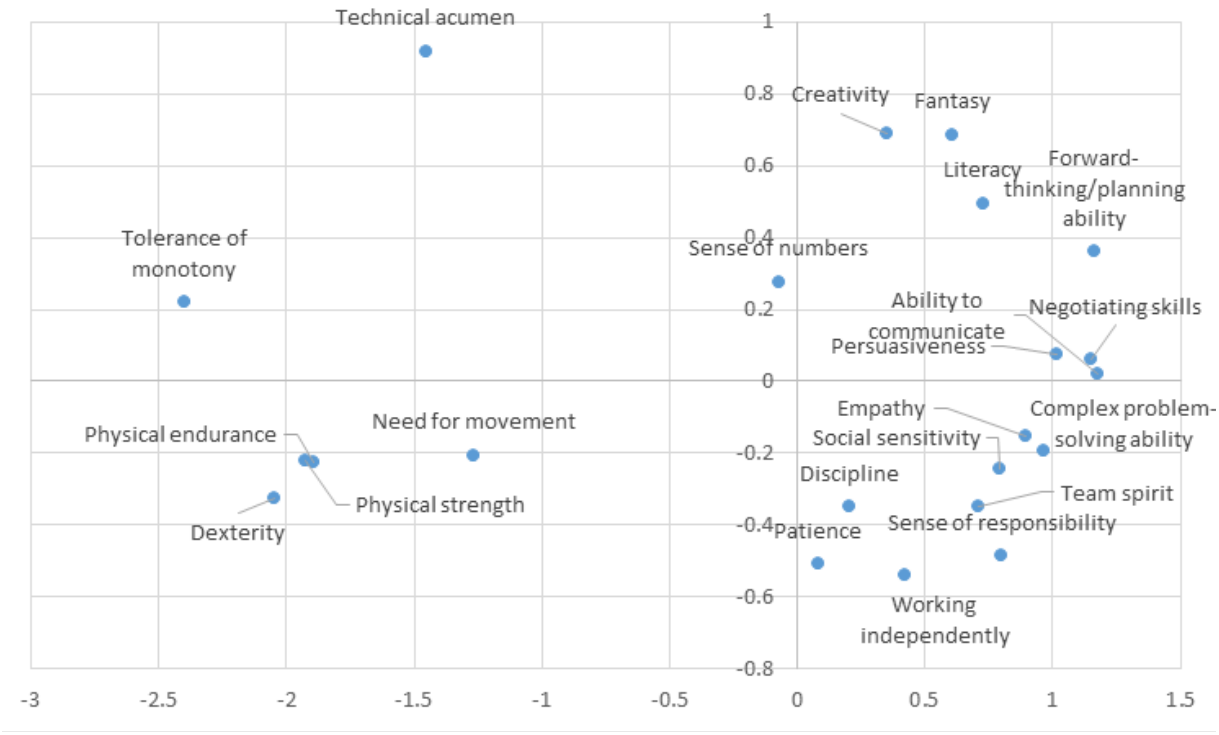

Figure 34: A two-dimensional representation of the perception of ability

In the MDS diagram, it is already clear how the technical acumen is separate from all the other variables. Although it is not significantly different from the physical ability variables along the first dimension, it is more closely related to creativity and imagination along the second dimension. This leads to the conclusion that the technical acumen is a kind of weak intersection of physical ability and creative imagination.

For further categorisation, it is helpful to allow for overlaps and intersections in the grouping of ability judgements[15]. The methodological basis for this is the so-called fuzzy clustering, where the assignment of an item to a group is not unambiguous but stochastic. A similar study was conducted by Horii and Sakurai (2020, p. 6) in a survey of Japanese companies.

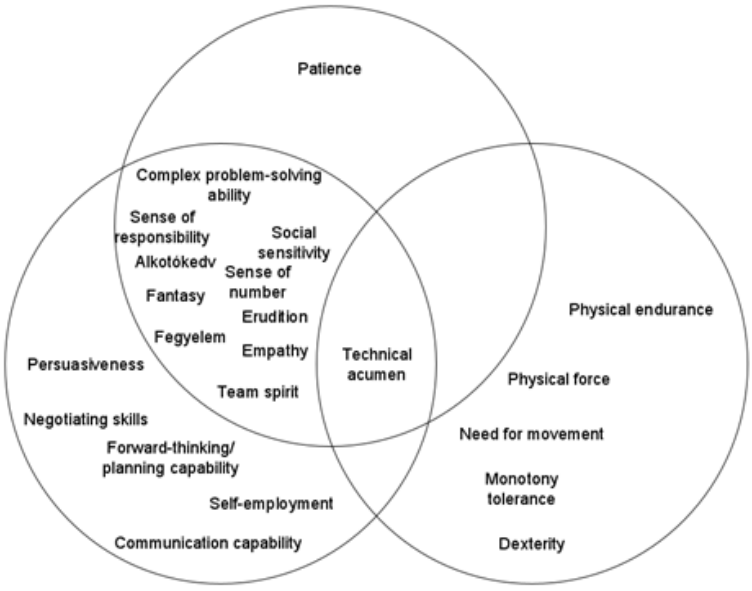

Figure 35: Venn diagram of the perception of skills[16]

[15]In the case of the hierarchical clustering presented earlier, the assignment to a group was unambiguous, i.e. an element could not belong to more than one group.
[16]When constructing the intersections, we set the criterion to reach at least the median probability.

By a similar analogy, fuzzy clustering of jobs can also be done based on the assessment of the skills required for the job.

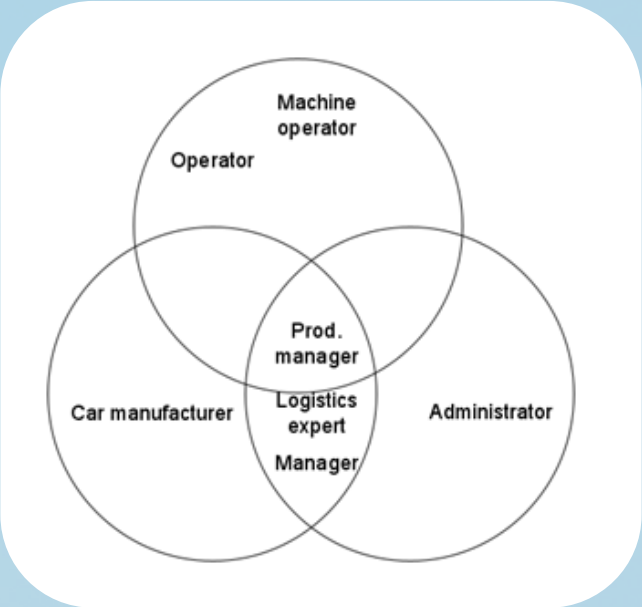

Figure 36: Venn diagram of jobs based on the skills needed to fill the job[10]

From Figure 36 above, it can be seen that production control employees require the most diverse skill set, as they are the ones who provide the link between the line workers, administrative staff and managers. For them, it is essential to have the skills of operators and machine adjusters, who do mainly manual, physical work. The car manufacturer jobs (automotive mechatronics technicians, automotive maintenance technicians and automotive parts manufacturers) are a separate category, as they are typically skilled workers in an industrial field. The fact that logistics and company managers share some of the skills required for car manufacturing jobs suggests that the former two jobs also require qualifications, however they do not require physical skills at all, but rather the skills that are essential for administrative jobs. This also implies that, where manual work processes are the first to be transformed in production, production managers are involved in addition to machine adjusters and operators. However, the latter category is exposed to automation and digitalisation from all directions. On the one hand, the automation of production tools and workflow affects the whole structure of production, and on the other hand, there is an increasing number of data reporting obligations, which need to be transmitted to the administrative staff through the appropriate channels, which are also constantly being digitalised.

3.2. Skillscape visualisation

The relationship between skills and jobs can be visualised using network theory tools.[17] First, we visualise the relationship between skills. The nodes of the network represent a skill, while the edges represent the relationship between skills. A link between two skills is formed when the correlation between them is at least 0.3. Since the correlation is the same pairwise, the network is undirected. The thickness of the edges indicates the strength of the relationship, while the colour of the nodes indicates the importance of the skill.

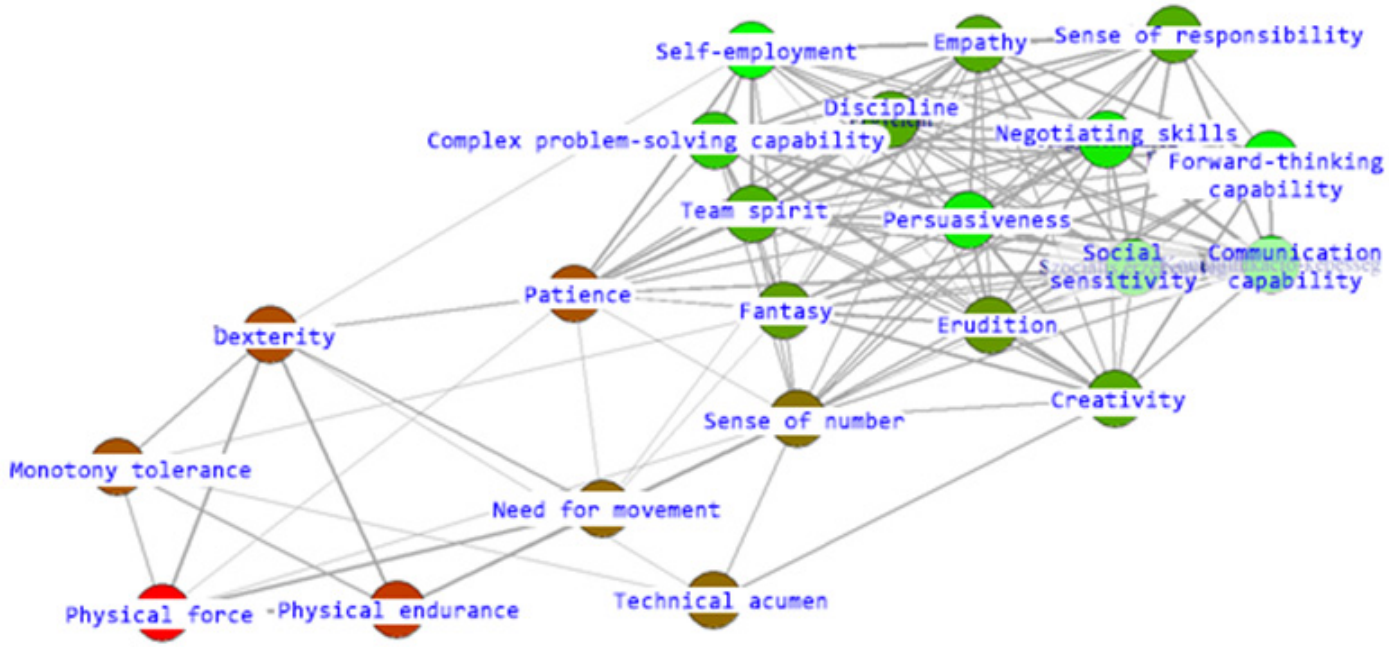

Figure 37: The web of connections of skills

Note: the redder the colour, the less important is the skill

The network of relationships can be further analysed by displaying the closely related skills, summarised in the following table:

[17]Such a study was carried out by MIT on US data. For more on this, see: https://sites.pitt.edu/~mrfrank/skillscape

Skill	Related skills (by closeness)		
	I	II	III
Physical strength	Physical endurance	Manual dexterity	Need for movement
Physical endurance	Physical strength	Need for movement	Manual dexterity
Manual dexterity	Physical strength	Physical endurance	Tolerance of monotony
Patience	Discipline	Ability to work independently	Team spirit
Tolerance of monotony	Manual dexterity	Physical endurance	Physical strength
Need for movement	Physical endurance	Physical strength	Manual dexterity
Technical sense	Number sense	Creativity	Manual dexterity
Number sense	Complex problem solving	Communication skills	General education
General education	Imagination	Persuasiveness	Communication skills
Imagination	Creativity	General education	Forward-thinking/ planning ability
Creativity	Imagination	Forward-thinking/ planning ability	General education
Discipline	Patience	Team spirit	Empathy
Empathy	Social sensitivity	Communication skills	Persuasiveness
Sense of responsibility	Ability to work independently	Team spirit	Complex problem solving
Team spirit	Ability to work independently	Social sensitivity	Complex problem solving
Complex problem solving	Forward-thinking/ planning ability	Team spirit	Communication skills
Social sensitivity	Empathy	Persuasiveness	Team spirit
Negotiation skills	Persuasiveness	Communication skills	Forward-thinking/ planning ability
Persuasiveness	Negotiation skills	Communication skills	Social sensitivity
Communication skills	Persuasiveness	Negotiation skills	Social sensitivity
Forward-thinking/ planning ability	Complex problem solving	Communication skills	Persuasiveness
Ability to work independently	Team spirit	Sense of responsibility	Complex problem solving

Table 6: The relationship system of skills (the order indicates the closeness of the relationship)[18]

[18]The closeness of the relationships was measured by correlation.

The network graph clearly shows that social and cognitive skills are much more important than physical fitness and other physical skills in the sectors studied. The clustering is further reinforced by the fact that the difference is quite sharp, with physical factors being most strongly associated with other physical factors, and the same is true for the set of cognitive skills. The most important elements of the network are persuasiveness and communication skills, both of which have a degree (the number of other nodes they are connected to) of 15 and a maximum centrality (the degree of the nodes they are connected to). This means that the jobs where these two skills are important are the ones where the most other skills are needed.
The skills with the lowest centrality are monotony tolerance and physical endurance, i.e. these skills have the weakest connectivity. If a job requires monotony tolerance and physical endurance first and foremost, it is likely that other skills are less important. The centrality and the number of degrees per skill are summarised in the chart below

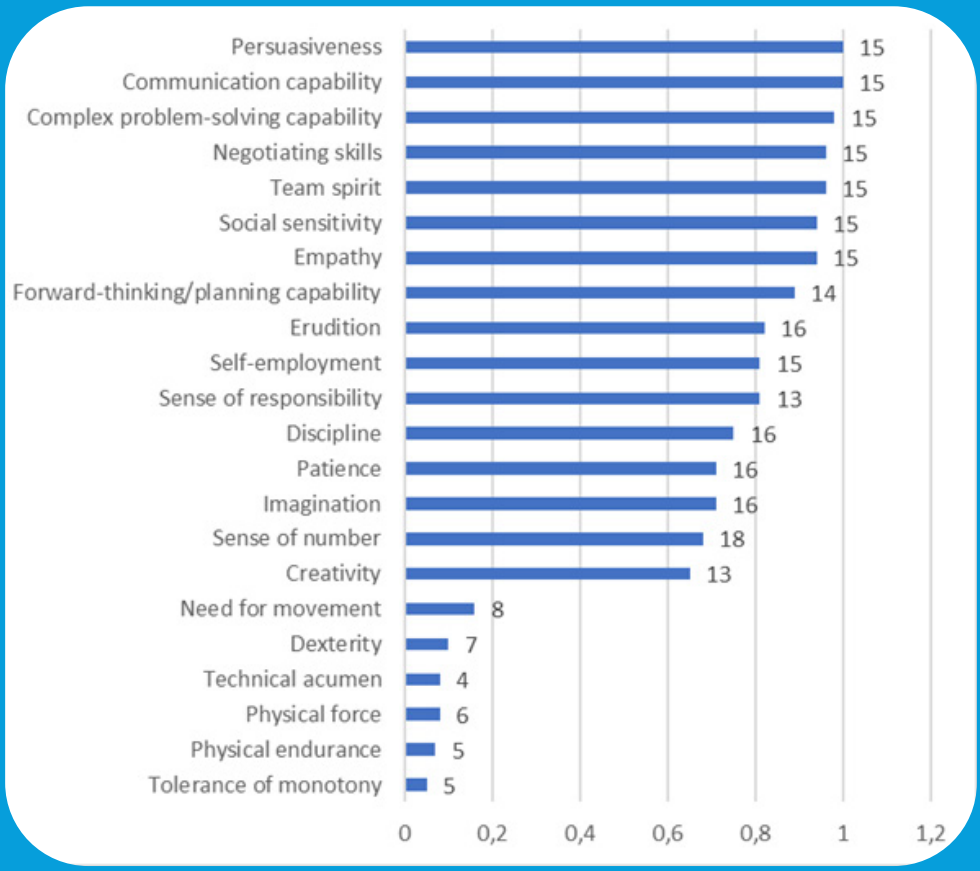

Figure 38: Centrality and degree of the assessed skills based on the network shown in Figure 37

Another analytical aspect of skillscape analyses is the linking of skills and jobs and their representation as a network. In developing this, the following principles were followed:

- **To each job, we have assigned the arithmetic average of the importance of the skills related to them.**
- **A skill was considered important for a job if it had an average score of at least 4 (on a scale of 1 to 5).**

Following these principles, the following network was obtained in the visualisation:

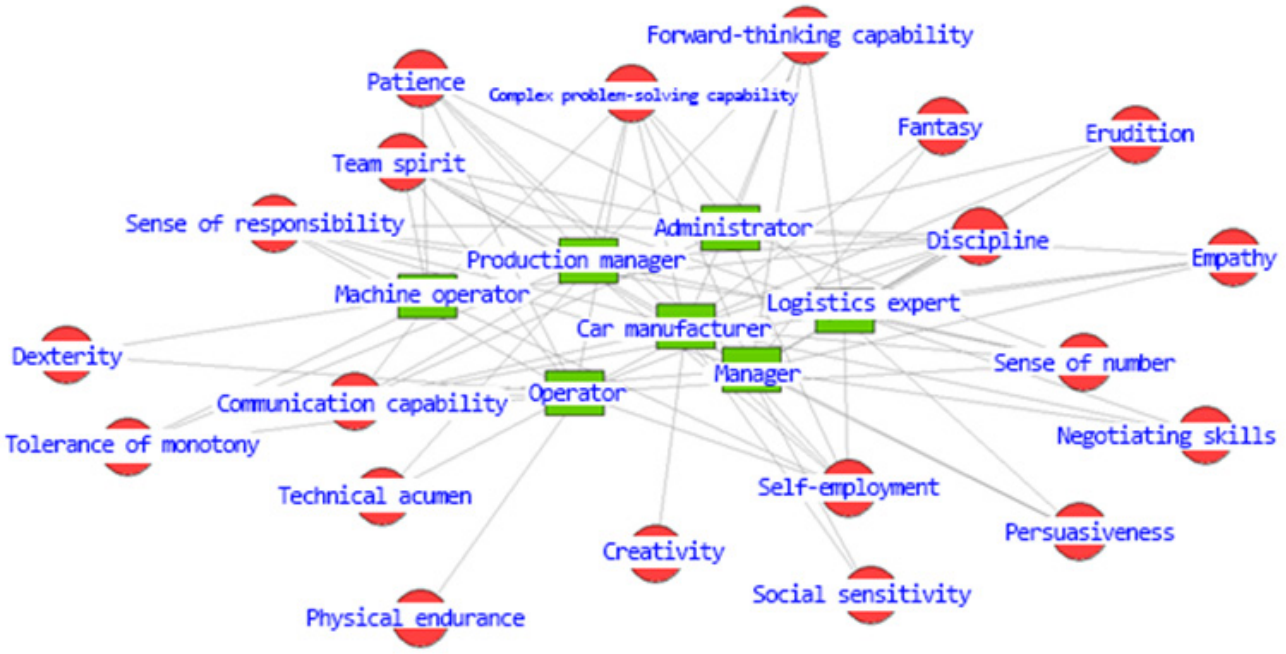

Figure 39: Network map of skills assigned to jobs

In this context, the most important skills are the sense of responsibility, the ability to work independently and team spirit (according to eigenvector centrality). These skills are necessary for most jobs, and the more complex a job, the more likely it is that the above skills are important. The least important skills are physical endurance, creativity and manual dexterity, which are of marginal importance and are only required for certain jobs.

In terms of jobs, the most skill-intensive are car manufacturers, company managers and logisticians, while the least skill-intensive are machine adjusters and operators. In the latter case, relatively few, typically marginal skills are required that are not required elsewhere, while the managers, logisticians and car manufacturers draw on a wide range of skills.

4. COMPANY INTERVIEWS

The picture revealed by the desk research was refined through company interviews, and problem areas were highlighted. In total, 8 company interviews were conducted. The sample consisted of medium and large companies in the metal and automotive industries, and the respondents were in all cases managers with an insight into a broad spectrum of employees, ranging from unskilled workers working directly in production to company managers. Companies were selected to cover as many job roles as possible. Contacts were obtained from trade unions and sectoral federations, and discussions were conducted by telephone and online. The following companies were interviewed:

Automotive industry:

- Videoton Holding Zrt.; headcount: 9,000 employees
- Cascade Engineering Kft.; headcount: 330 employees
- Continental Automotive Hungary Kft.; headcount: 4,000 employees
- Technocar-MC-2003 Kft.; headcount: 154 employees
- Logistics centre of a German-owned automotive company; headcount: 200 employees
- Adient Hungary Kft.; headcount: 3,000 employees

Metal industry:

- Technoplast Group Kft.; headcount: 50 employees
- Szimikron Kft.; headcount: 50 employees
- VASAS Hungarian Metalworkers' Federation; represented employees: approximately 20,000

The majority of the interviews confirmed the experience of the survey. Without exception, the digitalisation and automation situation in Hungary was described as weak, with smaller companies saying that this is the privilege of large companies. Small companies typically cannot afford to implement the degree of digitalisation reform that large multinationals can. However, if the customer demands it, SMEs are forced to invest. Several executives noted that state-of-the-art technologies are not necessarily needed to carry out most domestic manufacturing processes, as the technology used does not yet require the opportunities offered by Industry 4.0. The need for modernisation is more driven by labour shortages, when productivity gains can fill some vacancies. However, mass replacement is far from being the case, as production can be maintained by attracting foreign labour.

The majority of respondents pointed out that the equipment in SMEs is outdated and often not even suitable for the full implementation of the processes required by large companies. In the automotive industry, large multinational companies also have a lack of state-of-the-art machinery, which is seen as a result of a lack of skills in the workforce. This is also, according to several respondents, a management decision to achieve the required profit by not modernising the fleet. The purchase of new machinery often involves not only investment in machinery but also infrastructure improvements (energy supply, size constraints, etc.), so it is often cheaper to maintain old machines that are already in operation, even if this often means temporary stoppages in production due to breakdowns. The situation is different for large multinational companies, where the parent company provides the machinery needed for production, but often far from the most modern versions.

Without exception, the skills of employees are broken down into two groups by the respondents. Employees with vocational or tertiary education tend to have good skills, but there is a significant break in age. Young employees are more open to new processes and new tools, while older workers are more reluctant to take part in modernisation. However, unskilled workers are often not suited to being trained or to perform more complex tasks because they have basic literacy and numeracy problems. This may also be the case for skilled workers with secondary qualification, as better-skilled workers are more likely to go to work for a larger company for a higher wage, and less-skilled workers face similar problems to unskilled workers. The problem with workers is mostly seen as a lack of theoretical vocational training. In most companies, workers have to be sent for training immediately after recruitment (this is natural). There they are trained to do the job on the basis of the theoretical knowledge they have learned in school. The people sent for training are typically a very heterogeneous group. Some can absorb the training easily and some take longer (or it does not work at all). It is very important that the employee is encouraged to develop and learn even in their own time, so that they can take on more serious tasks at work. The company cannot be expected to take everyone on. This intrinsic motivation is sorely lacking among domestic workers.

There is a consensus among respondents that it is mainly the jobs of low-skilled workers that are at risk of being lost. However, it should be noted that only the job or certain tasks are at risk, the employment is not, because there is a huge labour shortage, so even if a job disappears, the workers concerned can move to another position. The more skilled a worker is, the less risk there is that their job will be lost. For those with tertiary education, respondents consider it unlikely, while for those with secondary education, the likely scenario may be the loss of certain tasks, but the job and the employment are not at risk.
The respondents clearly highlighted the failures of the domestic education system when it came to possible solutions. The government-subsidised training programmes are often not up-to-date, but rather quick fixes, while fewer and fewer fresh graduates enter the labour market with less and less marketable skills. Trade unions, associations and chambers provide a good assessment of the situation, but they are not always able to offer effective solutions, while the government mostly ignores the needs.
There are pioneering companies in Hungary, paradoxically rather small ones, all of them first-tier suppliers of some kind, but almost exclusively make export sales. For them, the customer may require, for example, full traceability or remote control. But this is far from mass production; it is more about one-off sales in small series. Their operations require specialised knowledge, and as small companies, they have access to it and can maintain it. But is it doubtful whether these pioneering companies could produce on a large scale? Probably not, they are not set up to do so, nor do they aim to mass produce.

Overall, the interviews confirm the previous experience and there is agreement that there are no jobs at risk at the moment due to labour shortages. If this changes, it is possible that low-skilled workers will drop out of the system, but for the other employees, digitalisation does not currently pose a serious threat.

5. CONCLUSIONS AND RECOMMENDATIONS

The clear picture that emerges from the research is that neither the employees nor the employers currently fear that automation and digitalisation will lead to job losses in the near future. This contrasts with claims in the international literature, where predictions began to emerge a few years ago of a significant increase in digitalisation by 2025, with not only jobs but also certain professions under threat. It is true that these studies were mainly based on developed countries, and in particular on consumer services (e.g. travel agency, delivery, etc.). However, the literature also notes that, in the case of manufacturing companies, it is more a question of developments that tend to lead to losses of functions, but with fewer jobs at risk.

Our research in the metal and automotive sectors confirmed this view. At present, the labour market and, as a result, company processes in Hungary are dominated by labour shortages. In other words, the main driver of development and innovation is the replacement of vacancies by automation and digitalisation. Currently, there is no strong digitalisation pressure in these sectors, but this is partly due to the fact that the most advanced technology has typically not yet arrived in the country, and is not being pushed by foreign parent companies.

While there are some specific cases where the client requires the use of certain advanced technologies not previously used, this is by no means common, as the vast majority of tasks can be performed using existing assets. However, technological progress will sooner or later reach our country, so preparation is indispensable. There is openness on the part of the government to support development, but these are not intervening at the right level, as they are targeted and focus more on the purchase of equipment and training, which can be funded mainly by EU grants. However, it is clear from our survey and interviews that the problems mostly occur after the workers have started working, but the root of the problem lies much earlier, in primary and secondary education.

Our analysis of skills reveals that the so-called cognitive skills are much more necessary for filling jobs in the sectors studied than physical strength, endurance and tolerance of monotony. Moreover, the skills and abilities in the former group form a whole network, while the latter skills are barely, if at all, connected to others. This means that if a job requires a high level of physical fitness, other skills are hardly relevant. While complex problem-solving skills include important skills such as teamwork, forward-thinking, empathy, persuasiveness, etc. All these can raise professional knowledge to a high level and integrate the employee into the workforce of any sector, in any size of company.

Good professional knowledge is essential, but in most cases, specific training is required on entry, and this is where learning skills, abilities, perseverance and commitment come in. Without these, even an employee with a good professional foundation cannot integrate well into his or her working environment.

Recent graduates with medium or high skills are currently in a good position, but there may be problems with low-skilled or non-skilled workers. It is essential that the government pays attention to this group, promote their catching-up and prevent them from being left behind at school. At present, about 20 per cent of the Hungarian workforce is low-skilled, but there are also functional comprehension problems among the skilled (reading, writing, arithmetic, reasoning, etc.). It is their position that is most exposed to the “dangers” of digitalisation. At present, the labour shortage certainly ensures their job, but its alleviation may lead companies to reassess their employment.

The government’s task is therefore twofold: on the one hand, it is necessary to make changes in the primary and secondary education that will increasingly steer children of school age and the next generation towards digitalisation, based on international experience. On the other hand a safety net has to be provided for the workers potentially without professional qualifications (and probably having few marketable skills) when labour shortages begin to ease. In the meantime, state-supported education programmes need to be increasingly geared towards modern technology, and the conditions for this in terms of equipment and human resources for teaching need to be created as soon as possible.

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