



Academia+ Intellectual Output 2

Transnational Report

Future Jobs: Impact, Needs and Challenges



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1. What is the current uptake in UK, Luxembourg, Germany and Portugal of Industry 4.0?

Industry 4.0 or the Fourth Industrial Revolution is driven by technological innovations that have profound effects on both production systems and business models. Although not a brand-new technology, the concept of industry 4.0, or 'Smart' technology, is new to quite a lot of people.

In the UK Manufacturing industry itself, according to the manufacturers 2019 annual report, manufactures understand the benefits of incorporating smart technology into their factories, but over 50% have no plans to implement them or, due to current and past productivity, are unsure of why they should incorporate them. It was found that 77% agreed that it would improve design and production processes and 74% agreed that it would streamline internal company processes from shop floor to admin. This shows that there is a clear and known advantage to incorporating industry 4.0 among many manufacturers. However only 2% of those asked have incorporated smart technologies into their entire factory, 15% have integrated them into all key functions and 23% use them for stand-alone projects. Although this may seem like a lot, this means that 60% of manufacturers surveyed do not use any form of smart technology or industry 4.0 technologies in the UK, which shows that the UK still has a long way to come in incorporating Industry 4.0. However, those who do use smart technologies have reported to use them for a while now which shows that they have been really effective once implemented. For example, across manufacturing, over 50% of those using immersive tools such as AR have been doing so for up to three years.

The difference between industry 3.0 and 4.0 is unclear to some which adds to the confusion. Others have already incorporated industry 4.0 by using smart manufacturing technologies, but they aren't aware that the technologies they are using are smart technologies so don't think that they have moved into industry 4.0. The government has undertaken a series of reports and investigations into incorporating industry 4.0 into the UK. This has focused on looking at skills needed as well as initial adaptations that companies need to make and the many benefits that Industry 4.0 will bring, but so far most of these are theoretical and not that much has been done to help with incorporating Industry 4.0 into the UK. This is a very good starting point but shows that a lot more still needs to be done before industry 4.0 is effectively integrated into UK business.

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In Luxembourg, digitalization is considered a driver of innovation and productivity. At the same time, it is changing the world of work in many ways. Mobile Internet, increasing computing and storage capacity, the availability and analysability of large amounts of data, artificial intelligence - these and other developments in information and communication technology (ICT) mean that production and work processes are not only being digitized, but are also increasingly networked. This has numerous implications for the way people work and the structure of their activities, and thus for the demands on their qualifications. In Luxemburg the study "Arbeiten 4.0 - Chancen und Herausforderungen für Luxemburg" commissioned in 2018 by the Ministry of Labour, Employment and Social and Solidarity Employment, the Chamber of Commerce and the Chamber of Employees, aimed to show the development of digitalization and its possible effects on the world of work and to discuss the associated opportunities and challenges. The study focuses in particular on the effects of digitalization on work content and work organisation as well as the social aspects of "Arbeiten 4.0" and the implications for quality of work and health. Furthermore, current technological developments as drivers of digitalization as well as the implications of the digital world of work with regard to the social security systems and the tax policy framework are taken into account. It is worthwhile noting that above all two denominations have been used to describe the changes that digitalization and automation will or may bring about: "3rd Industrial Revolution" (Rifkin report) and "Working 4.0" ("Arbeiten 4.0 - Chancen und Herausforderungen für Luxemburg").

In Germany, the advancing digitalisation of the world of production and work is a much and controversially discussed topic. The use of new technologies, which allow an interactive Networking between product, machine and labour but also enable horizontal (between the company, suppliers and the customer) and vertical integration (between units within the company) (cf. PWC 2014; Wolter et al. 2015), is seen as an opportunity for Germany's industrial sector to use and expand competitive advantages (e.g. BITKOM 2014; PWC 2014; DBR 2014)“ (IAB 2016a, p.9). In 2016, the IAB asked companies in Germany about their use of new technologies. The result: 46.5% of the production companies surveyed stated that they were not yet involved in the use of such new digitised technologies. In the service industry, the figure was still 29.6% (IAB 2016b p.4). In contrast, only 6.9% of the production companies surveyed (18.9% of the service provider companies) described new technologies as a central component of their business model (IAB 2016b p.4). At that time, 29.7% (among manufacturing companies) and 34.4% (among service providers) were already using modern digital technologies (IAB 2016b, p.4). Since then, German companies have become more digital affine every

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year: Quantitatively, the share of companies open to and using FDigitisation rose to 78% (in 2019). German companies still see their own digital maturity level as having potential for improvement. When asked how they would rate themselves on a scale of 1 to 10 in terms of implementation/daily use and anchoring in the company, they answered rather in the middle range (5.5/10) (Bitkom 2019, p.28). Conspicuous: Especially large companies with 500 or more employees are well above the average (6/10). A trend is already apparent here, which will be mentioned again later: Digitisation and the implementation of new technologies in Germany is closely linked to the willingness/ability of companies to invest.

In Portugal companies realized early on the changes related to digital transformation that have occurred at the international level, especially in Europe, as they integrate some chains of value, on which they maintain a strong connection and dependence. This perception, on the part of the companies, has been generating the need to deepen the knowledge about the impact of introducing these new manufacturing principles that enable them to better prepared for the transformation required, both in terms of physical resources and in terms of digital skills. In recent years, investing in the introduction of digital technologies has been one of the highest priorities, the which gives Portugal a position close to the average of the European Union in the ranking of digital competitiveness, as measured by the Digitized Economy Index and Society (IDES).

According to the study by PWC “2016 Global Industry 4.0”¹, in which more than 2 thousand companies installed in 26 countries participated, including Portugal, only 34% of surveyed Portuguese companies considered to be at an advanced level of digitization, demonstrating a great alignment with the global universe of the study (33%). The same study also reveals that 86% of Portuguese companies expected to achieve high levels of digitization in the next five years, exceeding the level of responses obtained by all respondents.

¹ <https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf>



2. How can businesses adapt, to cope with this change on the labour market regarding their activities? And regarding their workforce?

In the UK, transitioning to industry 4.0 will naturally result in labour market and work force changes. It has been found that on average 7.4% of workers are at high risk (>70%) of their jobs being automated, and 64.9% are at medium risk. This however is not spread evenly across the population, as it is mostly low skilled, younger workers on lower incomes who are in these jobs that face automation. In the UK, 32% of those earning the lowest 10% are at risk of their jobs being automated (this is one of the highest figures in OECD countries) and this figure decreases to only 5% among the highest 50-75 of earners and in the top 25% to virtually 0%.

It may be quite alarming for businesses to hear that 7.4% of the population have a high risk of their job becoming automated, but it has been shown that jobs at risk does not equate to employment loss. This is due to the fact that incorporating new technologies takes time due to both financial and legal reasons, so technology is not incorporated overnight and therefore mass job losses will not occur. So, for UK businesses, the transition and adapting the workforce will be about spotting the areas within workers jobs that can be automated, and replacing them with complementary tasks that machines and technology cannot complete on their own. In many ways, incorporating industry 4.0 technologies may result in UK business growth. This is due to the fact that the development of industry 4.0 technologies requires a highly skilled labour force and highly developed infrastructure. As a result, many manufactures may decide to invest in factories closer to their customers instead of the industry 3.0 trend of manufacturing in low cost locations.

In the UK, education, healthcare and wider public sector occupations are predicted to see growth. This is consistent with the population ageing and, with people now leading a variety of careers throughout their life, a greater appetite for lifelong learning. However, some elements of low and middle skilled occupations are expected to become less important in the workforce. These include jobs around administration, sales, manufacturing etc. but agriculture, skilled trades and construction, although can be automatable, may have pockets of opportunity for growth.

To Luxembourgish businesses, as far as the effects of digitalization on the world of work are concerned, two basic lines of development can be distinguished: automation and flexibilization. In the automation of work, robots, computers and software take over

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activities that were previously performed by humans. Digitalization also enables workers to work flexibly, i.e. technically mobile and independent of time and place. While automation currently mainly concerns routine activities in manufacturing, flexibilization seems more relevant for service activities.

Past phases of digitalization have led to the replacement of well codable routine activities by computers, while analytical and cognitive non-routine activities have been complemented by computers. This has led to a polarisation of employment in many countries since the 1990s. The employment shares of low-skilled workers with manual, non-routine activities and the employment shares of high-skilled workers with more analytical, interactive, non-routine activities have become more important compared to medium-skilled workers. In recent years, however, some countries, including Luxembourg, have tended to see skill upgrading, i.e. an increase in the importance of high-skilled employment over low- and medium-skilled employment.

Increased mobile working in the form of teleworking would in some cases eliminate commuting time for cross-border workers which could help to alleviate the traffic problems in Luxembourg. This has actually happened during the COVID-19 related lockdown with the serious traffic jams during the rush hours being more bearable. More flexible forms of work also make it possible to focus more strongly on domestic skilled workers (e.g. persons with reduced performance potentials or persons with a migration background) who have up until now been given little consideration, in the context of securing skilled workers. Nonetheless, it is important to keep the office as a vital place of social interaction through arranged attendance times and this despite the obvious advantages of teleworking. Social dialogue at sectoral and company level can devote more attention to these issues.

In addition to the numerous advantages and disadvantages, digitisation is above all creating more competition in many areas: for example, 65% of the German companies surveyed stated that any competitors from the Internet or IT sector would enter their market (Berg 2019, p.2). In comparison, the figure in 2017 was still 57%. One consequence of this, with which various companies are meeting these challenges, is, for example, a constant adjustment of their own product ranges. 72% of the surveyed companies already do so, which is 9% more than in 2018 (Berg 2019, p.3). "However, placing digitisation in the hands of IT alone is a one-sided effort. Business 4.0 is more than technology. In addition to technical know-how, it requires entrepreneurial and strategic skills, empathy and the ability to manage initiatives in all business areas" (Bitkom 2019, p. 67). . The number of companies currently investing in digital

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transformations and adaptations systematically increases with the size of the company (64% of companies with 2,000 or more employees are already investing, only 18% of companies with 20-99 employees are doing so) (Berg 2019, p.8).

In Germany, innovation needs a positive attitude towards digitisation - for all employees. The corporate culture changes fundamentally when meetings take place virtually, data replaces gut feeling, products are tailored to individual customers and alien teams dissolve the hierarchy" (Bitkom 2019, p.67). Another major focus point on which companies must focus in order to remain innovative and competitive in digitisation is anchored in human resources. In this context, it is of course first of all important to create/provide the corresponding resources within the company. "Digital solutions can help to attract talent to the company and retain employees in the long term. The cultural change towards more transparency, flexibility and participation also works wonders for motivation and ensures satisfied, loyal employees" (Bitkom 2019, p.67).

Smaller medium-sized companies in particular recognise opportunities here (44%). At the same time, more than half of the companies agree with the statement that digital technologies make everyday work easier and that employees can concentrate more on the core of their work" (Bitkom 2019, p.67). In the German debates on digitisation/ Business 4.0/ Industry 4.0 etc., the latter is very closely linked to a necessary competence profile and an accompanying development of digitisation-specific competences and skills.

In Portugal, as in other countries, the transition to the manufacturing of the future will have to take into account the cycles of reinvestment of installed capacity. The comparison of Portuguese reality with other countries shows that companies have significant challenges to overcome, but it also has enormous opportunities. On the other hand, the lack of digital skills is one of the factors that contribute to the delay in development two other key areas for digital transformation: electronic services and adoption of new technologies. Portuguese companies invest less than they should in an internet presence, in electronic commerce and digital channels.

The ICT sector currently employs around one million people, but the EU estimates that in 2020 there are about 800 000 jobs to be filled. In Portugal, about 15,000 professionals will be needed at the same time. In the future, industrial work at all levels, from operators to engineers and personnel administrative, will consist of the design, maintenance and operation of systems and machinery that perform the tasks. And the required skill level will be fully different. Not only at the digital level, but also skills that

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have to do with entrepreneurship, leadership and engineering. The jobs of the future will require a combination of basic and technical skills, including digital skills and specific businesses, which the current education and training system is unable to respond to. The lack of staff to plan, execute and guarantee the maintenance of systems and industry 4.0 solutions with skills to deal with non-data structured and big data tools will be one of the biggest challenges facing the industry.

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3. What (if any) programs exist to help the companies regarding this?

In the UK, there are a few schemes that are designed to help businesses transition into Industry 4.0, as the UK recognises the importance of incorporating new technologies as well as the desire to remain at the forefront of technology. The Business, Energy and Industrial Strategy committee published a report on “Automation and the Future of Work” in 2019. In this report they collected evidence from businesses, trade unions, universities and other interested parties in automation and found that there needs to be more action in the UK to improve automation, as currently steps being taken are quite small and do not allow automation in the UK to reach its potential. Although the strategy is a step in the right direction, these areas (AI, robotics and future technologies) tend to focus on the need to prepare the workforce for the introduction of robots and automation, rather than how automation and robotics can be managed and benefit the UK. This means that key areas associated with incorporating these technologies now are missing, such as the benefits they will provide to businesses, how to start incorporating these technologies. In addition, the Education Committee launched an inquiry into the fourth industrial revolution which examined how best to prepare young people to take advantage of future opportunities by looking at the suitability of the school curriculum, the role of lifelong learning, and how best to help people take advantage of opportunities in the future. In order to help business, retrain their staff to have the skills required for industry 4.0, “Digital skills Partnerships” were created, formed from the National Retraining Scheme and Local Enterprise Partnerships. Once again, these are positive starting points and will provide some workers and businesses with the training they need, but they are not enough on their own to provide the skills shift that is needed across the whole country so that we can start incorporating Industry 4.0 technologies.

In Luxembourg, as the COVID-19 provoked lockdown has however shown even more clearly, digitalization enables spatially and temporally flexible forms of work, such as home office or confidential working hours, in which the focus is on the completion of agreed tasks rather than the employee's presence in the workplace. A focus on digital competences appeals to people from different professions, job profiles and qualification backgrounds. Digital competences are essential, alongside specific ICT expertise, for the productive use of digital technologies. As we all know a deficit in digital competences is pointed at as one of the reasons for the declining productivity growth in industrialised economies. However, it is important to regularly review and evaluate the actual use of these services and the success of the measures taken. This allows measures to be adapted dynamically to changing labour market conditions or, if necessary, to introduce completely new measures. At the same time, labour market economic developments

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such as platform-based employment, the development of self-employment and entrepreneurship or training in STEM (Science, technology, engineering, and mathematics) subjects as well as securing skilled labour should be kept in mind. Measures concerning for example, data protection (such as the EU's basic data protection regulation) or the regulation of work placed online, should be considered on a case-by-case basis to see whether concerted action at EU level might be more effective than a national stand-alone approach. In order to take advantage of the opportunities of a digital world of work and to meet the challenges it poses, all actors involved are called upon: employers, employees, politicians and social partners. A frank and open debate has to look for solutions which are on the one hand sufficiently flexible and open up opportunities to try out new concepts e.g. as regards flexible forms of work or further training formats, and on the other hand also offer sufficient protection so that people do not become dependent solely on the labour market.

Large companies in Germany in particular are well on the way to a digital transformation, and small and medium-sized companies in particular still have needs/potential here due to various problems. For this reason, the most varied funding programmes in Germany are aimed primarily at small and medium-sized companies. Financial support is aimed primarily at small and medium-sized enterprises, and financial support is often linked to the commercial sector or the craft trades. "Grant: Depending on the programme, the company receives a subsidy quota of 30-80% of the eligible expenses as a non-repayable grant." (Diehl, 2020). In most programmes there is an own contribution that the company has to make. Loans, on the other hand, are granted at a very low interest rate for up to 10 years, whereby the company is granted various legal and economic benefits in terms of repayment. The federal programme "Digital Jetzt" (digital now) - With this support programme, the Federal Ministry of Economics and Energy (BMWi) promotes smaller companies with a maximum of 499 employees from all German sectors that are planning corresponding digitisation projects, e.g. investments in software/hardware and/or in staff qualification (BMWi 2020). Until 2023, companies can apply for this if they pursue one of the following objectives:

- investment in digital technologies,
- cross-sector digitisation processes
- Improved digital business processes and more opportunities through these
- strengthening of the own competitiveness and innovation capacity
- Improve IT security.
- Strengthen structurally weak regions, secure skilled workers or strengthen their own attractiveness on the labour market (BMWi 2020).

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Like other industrialized countries, the Portuguese government launched a set of policies to stimulate and support the introduction of Industry 4.0 to accelerate digital transformation, following the National Strategy for the Digitization of the Economy - the Indústria 4.0 initiative. The development of the national strategy underlying the Indústria 4.0 started from a collaborative work of identification of industrial fabric needs Portuguese as part of its digital transformation that allowed to define a set of measures (public and awareness), adoption and massification of new technologies in business models of Portuguese companies. Through the Indústria 4.0 initiative, integrated in the National Strategy for the Digitization of the Economy, the Ministry of Economy and Digital Transition intends to generate favourable conditions for the development of national industry and services in the new paradigm of the Digital Economy, through a set of measures based on three axes of action:

- Accelerating the adoption of i4.0 by the Portuguese business manufacturing
- Promote Portuguese technological suppliers as i4.0 players
- Making Portugal an attractive hub for investment in i4.0

To this end, the program consists of 64 measures, public and private initiative, grouped into six axes performance, with which an impact is expected over 50,000 companies operating in Portugal, particularly in the field of qualifications, which are estimated to allow requalification and training 20 thousand workers in digital skills. The program provides a set of Incentive Systems that aim to support the modernization and innovation of its products, services and business models, making them more competitive in the context of Industry 4.0.

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4. What challenges are the companies facing when adapting to Industry 4.0? and what opportunities are appearing?

One of the greatest challenges that UK companies are facing when it comes to industry 4.0 is that they are unsure of how they can implement these changes. Many are aware of the benefits that industry 4.0 technologies will have on their businesses, but being able to incorporate them is a different matter. Once industry 4.0 technologies have been incorporated, businesses will need to hire more skilled workers that can operate smart equipment and maintain factories.

These higher skilled jobs are more likely to come with an increase in labour costs, and this increase in cost, as well as the cost of technology itself, may be an obstacle for many businesses. Infrastructure is also a challenge when adapting to industry 4.0. In particular, the status of cybersecurity is a significant factor, as smart factories that rely heavily on technology will need to ensure that they are secure. In addition, intellectual property protection and the status of 5G development is also a limiting factor when it comes to transitioning to industry 4.0. Although automating has many benefits, right now with the status of technology, in many areas' humans are still likely to have many long-lasting advantages when dealing with complex situations and reacting to new challenges. As a result, the largest difficulty right now may be deciding when to incorporating these technologies. In the UK one of the barriers around automation is its perception, so it is important that real benefits are presented to businesses so that they can make informed decisions about how and when to implement these technologies.

In Luxembourg, in order to take advantage of the economic and social opportunities that digitalization offers, individuals, businesses and governments must be able to use digital technologies efficiently. There is a high and persistent pressure to adapt the skills of economic actors in three areas:

- Firstly, specific ICT skills are becoming increasingly important to support the production and development of digital technologies and enable services. Graduates of the MINT subject groups (mathematics, information technology, natural sciences and technology) are particularly in demand here.
- Secondly, the employees should have basic digital skills such as handling digital terminals, searching for information on the Internet or writing e-mails.
- Thirdly, the increasing use of digital technologies is leading to changes in the work processes and job content of occupations. This increases the need for

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complementary skills in order to cope with the changing requirements such as digitalization in companies generating an increasing amount of data about processes, products, customers or suppliers. Skills for preparing, analysing and interpreting such data are becoming increasingly important. The automation of routine activities implies that many professions will be less physically demanding in the future, but they will become more intellectually demanding, diverse and complex. Accordingly, creative-intelligent and social-interactive activities in particular are gaining in importance for employees. Appropriate skills development of the population is necessary to avoid a possible increase in economic and social inequality, which could result in the preferential employment of workers with good qualification and competence profiles.

In general, of course, the cost factor and the associated business restructuring and possible reorientation is one of the main challenges for German's companies with regard to digitisation. One of the challenges most noticed by companies is an increasingly complex data protection (Bitkom 2019, p.45). 53% of the companies stated that there is a considerable obstacle to the implementation of data protection and its requirements with regard to implementation and constant interaction with digitisation (the proportion of companies who see data protection as a considerable obstacle even rose rapidly from 2017 to 41%) (Bitkom 2019, p.45). Every second company feels that the requirements for IT security are inhibiting, 37% still name lengthy decision-making processes as a challenge, and the lack of skilled workers is still inhibiting 35% according to their own statements (Bitkom 2019, p.45). The rapid increase is exciting here: in 2017, 25% still considered this to be an obstacle, in 2019 already 35%. This reveals one of the central challenges of the 4th industrial revolution. A company survey by KfW also confirms this. In 2019, for example, companies will face more problems and challenges with regard to digitisation than in the last survey in 2017 (KfW 2019, p. 1).

The five most frequently cited obstacles to digitisation are data security requirements or data protection (46%), lack of IT skills in the companies in connection with a lack of availability of IT specialists on the market (38%), difficulties in adapting company and work organisation (36%), difficulties in converting existing IT systems (35%) and a poor quality of Internet connection (30%)" (KfW 2019, p.1). While in 2017 3% of the respondents still stated that digital investments were financially not feasible, this figure dropped to 1% in 2019. In contrast, the number of companies that indicated that they were unwilling to invest despite having the necessary funds rose from 14% (2017) to

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19% (2019) (Bitkom 2019, p.45). 33.2% of the companies with an annual turnover of less than 1 million Euros stated that they had no plans for Digitalisation projects in the next two years. Among the companies with an annual turnover of more than 50 million Euros the number of those who have not planned any FDI digitisation projects is only 4% (KfW 2019, p.2). 16 % of companies in the construction sector do not see any need for digital investment in their business. (KfW 2019 p.9). In the trade sector, the figure is still 8.7%, and 7.9% in the service sector. Also in the craft sector the number of companies that see no need for digitisation of their own business is relatively high at 14% (in comparison 9% of all companies surveyed stated this) (KfW 2019, p.10).

In Portugal, although 4.0 skills are often talked about as a need for the future, the truth is that jobs now exist based solely on this new type of skills, especially digital skills.

Social network managers, digital marketing professionals, programmers, system architects, online store managers or data analysts already rely only on a computer and their digital knowledge to develop their work from anywhere on the globe. It is therefore important that today's professionals prepare for the future and start learning to learn today, trying to be curious about their surroundings and looking for training to acquire new skills. But it's not all about digital skills. Soft Skills such as the ability to undertake and innovate, creativity, emotional intelligence, communication, collaboration, problem solving, tolerance or responsibility will be increasingly valued, humanizing workplaces dominated by technology.

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5. Which trends are being followed/implemented by the companies?

It is difficult to track trends in the UK as many businesses have still not incorporated Industry 4.0 technologies, and those who have, have done so quite recently. This may be due to the fact that governmental research and advice mainly focuses on preparing the workforce for Industry 4.0 instead of helping businesses implement Industry 4.0. As a result, although not many businesses have incorporated Industry 4.0, quite a lot are preparing their workers for the transition to a more automated workplace. To do this, some businesses are starting to upskill and increase the salaries of their staff as this offers a path to a future where jobs can be adapted to fit around Industry 4.0.

Robot operators, through this upskilling process will become robot programmers etc., therefore meeting some of the skills and occupation demands of Industry 4.0. This trend of upskilling is supported by initiatives such as The Made Smarter Review and North West pilot, which include commitments to develop skills to work with automation in manufacturing. However, there are still difficulties when it comes to upskilling and training staff as there is little incentive for businesses to provide training beyond the minimum, as they risk their investment being lost when workers leave the business.

In Luxembourg, internet platforms make it possible to outsource individual tasks to non-dependent employees. "Mobile labour markets" are platforms on which local, location-based services are provided, such as passenger transport, logistics and household services. On so-called "online labour markets" on the other hand, services such as design and creative tasks, programming activities or micro-tasks, e.g. in the area of data research or text production, are exchanged directly via the platforms and are thus provided independent of location. In addition, the activities provided can be differentiated according to the degree of complexity and range from simple micro-tasks to complex projects that require highly qualified specialist knowledge.

In Germany "further education and funding are in demand. Four out of five companies are already doing so and are strengthening the digital competence of their employees. Two thirds of the companies offer corresponding training. It is especially important for medium-sized companies to invest in the further training of their employees. Because in the "war for talents" they have clear disadvantages against the large companies with a strong reputation" (Bitkom 2019, p. 65). "Digital competences are (new) skills that enable employees to use digital technologies, to use them within the scope of their job profile and, in addition, to drive the digital transformation of business processes. Three Dimensions can be distinguished: In addition to professional, technical and business

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skills, digital fitness plays a major role. The latter is based on openness, interest and a drive for change in the face of digital possibilities" (DDFP 2016, p. 10).

Digital professional and technical competences and skills are always closely linked to their respective usage context, e.g. the correct usage of a tablet, a specific software or even complex big-data analyses. The degree of recognition of this competence category is always linked to the employee's particular tasks (DGFP 2016, p. 10).

Digital fitness mainly covers specific competences and skills which, in an entrepreneurial context, are aimed at all employees who participate differently in their various entrepreneurial tasks and roles. The central point here is to generate and maintain a value creation of digital processes and structures that works for the entire company. "The basis for adapting the business model to the new requirements in the medium term is provided by the development of the so-called digital workforce Fitness" (DGFP 2016, p. 14). This is therefore a portfolio with which the employees of a company can tackle, master and implement the new challenges of digital transformation in a value-added manner. An example of this is given here:

- Interest and openness towards digitisation
- Basic knowledge of the technological possibilities
- Application to your own field of activity
- Sensitivity with regard to the legal framework (DGFP 2016, p. 15).

According to a study by PwC - 2016 Global Industry 4.0 - in Portugal, 86% of companies expect to achieve high levels of digitalization by 2020, including horizontal and vertical value chains. In the rest of the world, 72% of companies have these expectations.

More than half of the pioneering companies, which already have significant levels of investment and advanced levels of digitalization, achieve more significant gains in performance, with revenue increases and cost reductions of more than 20%, by 2020.

Digital represents an opportunity for Portuguese companies. 8 out of 10 companies plan to introduce at least one of the digital products or services. In addition, 57% of Portuguese industrial companies expect an average increase in their revenue through digital up to 10%, 55% expect a cost reduction above 10% and about 70% expect efficiency gains above 10%. Although there is still no certainty about the professions that will prevail in the future, they are expected to focus on 6 major areas:

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- Automation and programming - Automation, robotics, programming, cybersecurity, artificial intelligence, additive manufacturing, 3d printing, big data, drone control and or mobile robots.
- Network, people and risk management - People and team management, project management, social media management, digital marketing, customer-oriented business management (CRM, strategy, internationalization), operations management or risk management.
- Optimization and efficiency - Collection, analysis and treatment of data (data integrity and smart data), monitoring and availability, quality control or efficiency management (lean, 6sigma).
- Green and sustainability skills - Environmental management (3R, circular economy) and "green" management of technology and resources (e-waste).
- Product design - Product and service development and design thinking.

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6. Which skills/competences are most requested to the workforce by the companies?

Skills shortages are already prevalent in the UK labour market. According to a skills survey carried out by the Department of Education, the number of vacancies caused by skills shortages has doubled since 2011. In addition, the Engineering UK 2018 report found that 46% of manufacturing businesses reported difficulties in recruiting skilled machinists or technicians and 39% had difficulty recruiting experienced engineers with specific skills. It also found that there has been an increased demand for engineers with experience using artificial intelligence and automation technologies. Automation will have the largest impact in the UK on low skilled and low earning workers as they hold jobs where tasks can easily be automated. 32% of those earning the lowest 10% are at risk of their jobs being automated, which is one of the highest figures among OECD countries. Therefore, the best strategy will be for businesses to train, or retrain, low skilled workers to have the desired skillset for Industry 4.0.

Thankfully, many UK workers already have social intelligence skills as the UK has a more communicative workforce and more face-to-face tasks than other OECD countries. Further support for promoting social intelligence skills in the workforce comes from the fact that in many cases, human interaction is a societal preference. Certain jobs, such as nursing or caring for the elderly etc. are likely to remain human centred roles, even if technology and artificial intelligence has the capability to carry out a lot of this work. It is most likely that technology would complement this work but not replace it as people value personal interaction in these roles. For smart factories to develop, a lot of cross functional jobs will be needed. A recent report from the Manufacturers' Organisation found that almost 50% of UK manufacturing companies will need additional IT staff. Skills in demand across the workforce are predominantly soft skills – interpersonal skills, creativity and flexibility – but those in the manufacturing industries relate to more technical knowledge.

In Luxembourg, there are several challenges to trying to bridge the skills gap of workers in a digitalized labour market:

- The workforce will have to understand the underlying processes and develop the knowhow needed for collecting and using data and leveraging digitalization in the intelligent production of smart products or services. So, in an ideal world employee will be both experienced and knowledgeable as well as able to flexibly and continuously (self-)assess their competences,

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learn and adapt themselves to new developments and requirements at their workplace. With these high demands comes the risk that some workers will be excluded from being employed in Industry 4.0 environments.

- There will also be a need to standardize, develop, and deploy intelligent assistance systems for live guidance, training by experience, and performance assessment from observation. "If some (parts of) jobs might disappear due to Industry 4.0 changes, emerging needs related to Industry 4.0 'collateral' effects would still require non-routine work requiring human expertise (hard or soft), embedded through technological artefacts or not: "the more we depend on technology and push it to its limits, the more we need highly-skilled, well-trained, well-practised people to make systems resilient, acting as the last line of defence against the failures that will inevitably occur" (Kagermann, Wahlster, and Helbig; 2013).

Tasks in the Industry 4.0 context will be more interdisciplinary and combine e.g. elements of mechatronics with design, data analytics, and business administration. On one hand, intelligent assistance systems carry substantial potential to relieve professionals from routine work, on the other hand, these systems will require them to focus more on creative, value-adding tasks. This might or should result in a more flexible work organization, allowing industry professionals to better align private life, work, and education and training. In an ideal world employability of workers will be increased by providing access to better paid jobs and allow them to keep their jobs through upskilling, while job performance requirements increase.

In Germany, a central problem at this point is the fundamental speed of the digital transformation, which can only be considered retrospectively in consulting concepts. Whereby, in turn, any necessary content could be outdated. Especially with regard to digital competences, counselling concepts are currently in the process of adaptation and redesign. Consulting is subject to the digitisation process in two respects: On the one hand, consulting and an entrepreneurial consulting offer is always strongly dependent on the current development in the respective companies. A constantly differentiating entrepreneurial requirements practice requires a holistic approach and focus, both for companies and for consulting. On the other hand, consulting itself as an entrepreneurial offer on the market is subject to digitisation processes, especially with regard to the current corona situation, digital consulting is increasingly coming into focus. In this respect, consulting is of course always confronted with the challenge of designing one's own meaningful concepts that incorporate and think along with digital processes.

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In view of this new labour reality, a set of skills emerges to which it is necessary to direct education and professional training, so that young people are able to adapt to the various news and developments that are ahead.

One of the most important skills for the employers will be the ability to learn daily and to be curious to seek solutions for problems. For Portuguese companies it is important that the professionals of the future are able to adapt easily to changes and learn new ways to evolve and perform their tasks with agility, using the technological tools available.

Technical and strategic vision already represents important skills for professionals and in the future, this will be a point that will gain even more relevance. It is important that new managers look at the business and, with data support, are able to outline a path and adapt quickly to new contexts and realities, ensuring that their organizations will be able to keep up with the constant metamorphosis of the market, maintaining competitiveness.

Decision making and people management are also essential skills for companies. With an increasing amount of information and a tendency to reduce intermediate staff, professionals will increasingly need to make decisions in order to respond to the different requests that will be placed in their daily lives. Therefore, social skills will become increasingly relevant, and it is important that professionals maintain a good relationship with the team and with the people who incorporate the operation, in contrast to the increasing automation that will emerge in company operations.

In an increasingly global world, it is important that professionals are able to communicate with each other and find common languages that allow sharing information. In the future, it is important to master English, a language considered global, with other languages being a good addition to the skills map sought by companies, corresponding to the requirement of increasing globalization.

In a world in constant change, it is important that professionals strive to be always up to date and within the news of their areas of activity or others of interest, guaranteeing the organization to follow trends. Continuous training is increasingly essential.

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7. What are the challenges and knowledge gaps that careers practitioners face when dealing with this industrial revolution?

One of the largest challenges that career practitioners face is that they don't know the landscape of the future labour market. As a result, it can be difficult to offer careers advice when the labour market is changing in such a fundamental way to include jobs, we aren't yet aware of, reduce the needs for jobs we currently have and to change current jobs in unforeseeable ways. This may mean that careers practitioners will need to focus more of their time on learning about current labour market trends, for example, which areas are growing and why, which areas are shrinking a why etc. In addition, as the future labour market is unpredictable, there may need to be increased focus on informing clients that their careers may not be linear, as many careers have historically been.

Increased mechanisation is accompanied by a changed range of tasks for employees and the development of new fields of activity and occupation. The execution of these new fields of activity and occupation requires a corresponding range of qualification and further training measures for companies, entrepreneurs and employees. Reskilling, upskilling and lifelong learning also play a role in counteracting the risk of employees becoming "incapacitated" as a result of new forms of social interaction between man and machine. In addition to requirements for new competence and qualification profiles of employees, a further (inter alia social) requirement is evident in employee data protection and data security. Data protection and data security, a balance must be found between the opportunities and possibilities offered by "Big Data". New technologies as well as the organisational changes they entail, can lead to altered exposure profiles which can also have an impact on health. expected to lead to opposing developments in the stress and strain caused by work. While flexible forms of work undoubtedly do create greater scope for a better work-life balance which should or at least could have a positive effect on the work-life balance of cross-border and commuter workers in Luxembourg in particular, at the same time however, important recovery phases may sometimes be interrupted or shortened by a possible dissolution of the separation between work and private life. The changes in the labour market due to digitalisation can have an impact on social security systems.

Particularly with regard to the shortage of skilled workers, digitisation is emerging more and more strongly and is becoming a central topic. A central problem at this point is the fundamental speed of the digital transformation, which can only be considered retrospectively in consulting concepts. Whereby, in turn, any necessary content could

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The biggest challenges to the development of digital operations identified by Portuguese companies were the lack of digital culture and training (58%), the indefinite economic benefits in digital investments (38%), the lack of collaboration capacity of business partners (33%) and unresolved issues related to data security and privacy (29%). Additionally, the lack of staff to plan, execute and guarantee the maintenance of systems and industry 4.0 solutions, namely with skills to deal with non-data structured and big data tools will be one of the biggest challenges facing the industry. A situation that can be overcome if the management of companies takes a position proactive workforce development, namely through partnerships with external organizations, secondary or technical schools, and universities. This will ensure existence of a flow of labour that is attracted by digital technologies and that are able to handle more advanced production systems.

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