THE IMPACT OF DISRUPTIVE TECHNOLOGIES ON WORK AND EMPLOYMENT

Irene Mandl, Ricardo Rodriguez Contreras, Eleonora Peruffo and Martina Bisello

Introduction

Europe – like other world regions – is affected by several ‘mega-trends’. Next to globalisation, the transition to a carbon-neutral economy, demographic developments and also digitalisation are changing our economy, labour market and society. Technological innovation is not a new phenomenon but a structural feature of the economy, and a necessary one to remain competitive. However, while some innovations are incremental, there are others that are more disruptive or ‘game-changing’ by changing ways of production and service provision, working and living. Since recently, there seems to be an increasing number of innovations that have the potential to result in deep technological and social transformation. While some of them, such as medical exoskeletons, are already used in practice, for others, such as plant communication, it is expected to take a long time before they will be operationally implemented. Nevertheless, from a policy perspective, it is recommended to start exploring also the potentials of these technologies as well as their possible impacts in order to be better prepared for the future and to consider relevant interventions.

Disruptive technologies can result in a ‘win-win situation’ for employers and employees if companies sense the potential of technological improvements, strategically use them to realise a competitive advantage, while at the same time adjusting work organisation to maintain or improve working conditions and job quality for their staff. However, if awareness about the potential impact of game-changing technologies on work and employment is lacking, or implementation is not realised by considering the potential disadvantages for the workforce, the work and employment standards developed over the last decades in Europe might be at risk.

Against this background, this article aims to highlight first indications of potential positive and negative effects of disruptive technologies on work and employment. Its objective is to increase awareness among scholars, policymakers and practitioners to make them consider the best possible use of modern technologies for the benefit of all.

The next section defines the concepts and technologies used in this article. The sections ‘Employment and labour market impact’ and ‘Impact on working conditions and job equality’ provide an overview of the main identified effects of selected disruptive technologies on the labour market (macro perspective) and working conditions/job quality (micro perspective). Afterwards, the impact of game-changing technologies on industrial relations and social
dialogue will be discussed. Finally, the conclusion indicates some policy pointers derived from the analysis.

**Concepts and definitions**

Digitalisation affects employment, working conditions and social dialogue; but talking about digitalisation as such might not be precise enough to understand the phenomenon. The digital age results from the development and re-combination of technologies and their application to new areas (Pérez 2003). Some of these technologies can be defined as ‘game-changing’ because of the potential disruptive effect they could have on employment, working and living conditions and labour market institutions (Eurofound 2018a).

This article follows Eurofound’s conceptualisation on digitalisation (Fernández-Macías 2018) which distinguishes technologies into three drivers:

- **Automation**: the substitution of human input by machine input
- **Digitisation**: the transformation of physical objects and documents into bits (and vice versa)
- **Coordination by platforms**: the use of digital networks to organise economic transactions in an algorithmic way

These three drivers should be understood as an analytical tool to help better identify work and employment implications; in practice, these drivers are often combined in operational applications (Eurofound 2018a) and examples will be given throughout the chapter.

Under each of these drivers, there fall several specific technologies. In what follows, a selection of technologies is analysed as regards their impact on work and employment. Under the automation driver, technologies such as advanced robotics, automated software (including Artificial Intelligence (AI)\(^1\)) and autonomous vehicles can be listed. The digitisation driver includes additive manufacturing (3D printing at industrial level), Internet of Things (IoT and its industrial applications), virtual reality/augmented reality (VR/AR) and wearables. Coordination by platforms focuses on platform work, understood as the matching of supply and demand for paid labour through an online platform or an app (Eurofound 2015, 2018f) (Table 8.1).

**Employment and labour market impact**

**Automation**

Automation has particularly strong implications for the evolution of the types of human input necessary for the production and service provision processes, and therefore the structure of employment by occupation and sector, as well as the skill levels required. This might explain why in recent years, along with interest in studying the effects of automation, concerns have also grown. According to Eurobarometer 2017, around 70% of respondents think that robots will steal our jobs and that they destroy more jobs than they create.

However, when analysing the impact of automation on the labour market, one can take two different theoretical perspectives: a job/occupation perspective and a so-called *task* perspective, where tasks are the smallest distinct units of labour input (specific actions of transformation or combination carried out by human operators within the production and service provision processes).

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1 Machine learning and deep learning.
Conceptualising jobs as ‘bundles of tasks’ allows for the possibility that only parts of a job – rather than all of it – may be substituted by a specific automation technology (Acemoglu and Autor 2011). Estimates, such as those from the OECD, that do take into account the variety of workers’ tasks within occupations when estimating the impact of automation (Arntz et al. 2016) are substantially lower than those provided by the pioneering work of Frey and Osborne (2013, 2017) for the US where the entire occupation was considered as main unit of analysis.

Next to job loss, the replacement of specific tasks within jobs due to automation technologies may also lead to a transformation (upskilling) of job profiles, enhanced productivity and potentially employment growth induced by demand effects – depending among other things on the distribution of productivity gains (Eurofound 2018a; Bessen 2018). The emergence of new products and services due to the introduction of new technologies is also a possible outcome, although more difficult to assess in terms of potential job creation.

Looking more specifically at the two automation technologies considered in this article, the potential substitution of human input is found in both services and manufacturing, but its extent varies across industries. Advanced industrial robotics (AIR), which encompasses the use of digitally enabled robots working within industrial environments that are equipped with advanced functionality allowing them to deal with less structured applications and in many cases to collaborate with humans, could have both negative and positive effects. On the one hand, AIR could lead to direct labour saving and therefore have a negative impact on the traditional manufacturing job profile – that of the non- or semi-skilled, blue-collar, production line worker – and therefore mostly affect sectors such as vehicle, machinery and

### Table 8.1 Classification of driver and specific technologies discussed in this chapter

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Technologies</th>
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<tbody>
<tr>
<td>Automation</td>
<td>Advanced robotics</td>
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<tr>
<td></td>
<td>Automated software (including Artificial Intelligence (AI))</td>
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<tr>
<td></td>
<td>Autonomous vehicles</td>
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<tr>
<td>Digitisation</td>
<td>Additive manufacturing (3D printing at industrial level)</td>
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<tr>
<td></td>
<td>Internet of Things (IoT and its industrial applications)</td>
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<tr>
<td>Coordination by platforms</td>
<td>Online platforms or apps</td>
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<tr>
<td>Virtual/augmented reality (VR/AR) and wearables</td>
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Beyond the purely technical feasibility of replacing human input for the performance of specific tasks, the way work is organised has a significant influence on which specific tasks can be automated. If work is organised in a way that reduces the importance of key human labour attributes by centralising, standardising and breaking tasks down, the possibilities for its automation may significantly increase (Bisello et al. 2019).

On average across 21 of the OECD countries, only 9% of jobs are found to be automatable, compared with around 47% in the US as found by Frey and Osborne (2013). More recently, Nedelkoska and Quintini (2018) estimate that 14% of jobs in 32 OECD countries are highly automatable (having a likelihood of automation of over 70%) and a further 32% have a 50–70% likelihood of automation. See also Eurofound (2019e) for an analysis of three different automation scenarios; the objective of the study is to determine which tasks are most susceptible to automation and then to determine in which jobs these tasks predominate.

Employment in this type of manufacturing job has been shrinking for many years in developed economies and these production line jobs have been the fastest declining. While trade is also a factor contributing to such developments, namely in terms of offshoring of predictable work processes that are easy to replicate and displace, there is a consensus that technology has been the dominant vector of manufacturing job loss (Eurofound 2018a).
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consumer goods manufacturing (Eurofound 2018a, 2018d). This trend is likely to intensify in the future and to have a higher disruptive potential if more advanced technologies, such as robots enhanced by AI, will be deployed at a significant scale (for a review of the literature and a discussion of employment effects of robots in the manufacturing sector, see Klenert et al. 2020).

On the other hand, the use of AIR can have compensatory positive employment effects related to the emergence of new job profiles in manufacturing which would lead to increased demand for specialised, highly digitally skilled workers. Such workers will likely include data scientists and mechatronics engineers. Apart from specialised technical skills, these employees will need to have highly developed social and communication skills in order to collaborate effectively with departments and teams of other disciplines (Eurofound 2020) (also see the following section about ‘Impact on working conditions and job quality’ under ‘Automation’).

Finally, the impact of automation in the services sector will greatly depend on the extent to which advanced robots are able to safely interact with humans or their ability to navigate in unstructured environments. It is expected that specific areas which involve engaging with robots, supervising or developing automating technologies will be potentially more affected (for example, mobile robots used in factories or warehouses). Robots have also started to replace humans in dangerous occupations and in environments that humans cannot access, enabling new service functions (such as in the areas of emergency and rescue).

As regards autonomous vehicles, considerable job loss in the transport and storage sector could be triggered if the transportation of goods and people were to be fully realised by self-driving cars or drones. While autonomous vehicles may provide some relief in those countries experiencing a labour shortage in terms of professional truck drivers, the overall negative impact in terms of job loss also for other categories, such as bus or taxi drivers, could offset the benefits (Eurofound 2019d). However, the horizon for mass adoption of fully autonomous vehicles is assessed to be longer than ten years and it is unclear exactly how many jobs could be lost and when this transition will occur. At the same time, the deployment of autonomous transport devices could also create new jobs directly related to transport services, such as autonomous transport planners, analysts, fleet managers and supply chain managers. Other services could also be positively impacted, although indirectly, by the changes in the transport sector: for example, the insurance industry could need new types of experts who can understand driving algorithms and interpret the dynamics of accidents.

Overall, the two analysed automation technologies show some potential for both job creation and job destruction. However, assessing the net outcome is a challenging exercise (see Autor 2015 for a discussion on the future of workplace automation). In general, it can be reasonably expected that the demand for higher-skilled occupations such as specialised and technical professions will grow, while low-skilled routine jobs will be mostly negatively affected – especially in manufacturing.

Digitisation

During the past decade the digitisation of processes has intensified in the manufacturing sector with the so-called industry 4.0 where not only advanced robotics but also additive manufacturing, sensors and the use of AI (machine learning and deep learning) are used. The analysis of data produced by these machines contributes to the creation of new production processes and
production environments. Beyond manufacturing, some of these technologies are also applied in services, for example virtual reality for training rescue emergency workers or augmented reality in logistics. In logistics, augmented reality smart-glasses can be used by pickers to guide them to pick up articles instead of using a handheld label reading device (Heust 2017; Eurofound 2019a), thus freeing their movements.

As of today, the aggregate effects of digitisation technologies on employment in terms of job creation and destruction are not clear. Studies on the deployment of these technologies (Eurofound 2018b, 2019a, 2019b, 2019c) indicate rather a shift in tasks and the transformation of existing job profiles as well as the creation of new ones.

In manufacturing, so called cyber-physical or industry 4.0 factories (Peruffo et al. 2017) combine sensors (Industrial Internet of Things) and machines, including advanced robotics, into new work processes which can be supervised digitally. When highly digitised processes are grouped together a ‘virtual twin’ of the factory can be built, that is a digital copy of the factory. Virtual twins are also applied in airplanes monitoring and there are applications for digital copies of hospitals and even of cities. The digitisation of processes entails a change in workers’ tasks, that is an emphasis on monitoring and thus the skill to manage digital information and sensors’ data. In terms of job profiles, this translates into demand for data analysis experts as well as software engineers and other profiles which work on interfaces between machinery and data. But the most important implication embedded in the digitisation of processes is the enabling of remote working. If the virtual twin contains all the information about the process, the worker does not have to be in situ: the task can be performed anywhere, provided that there is a fast and reliable internet connection and interoperability across applications as well as cybersecurity is provided.

Another shift in work processes in industry 4.0 is the adoption of additive manufacturing which enables fast prototyping and the production of new shapes and textures not previously achievable with traditional methods and thus requiring fewer assembling tasks. Some new tasks have been observed; tasks such as additive manufacturing equipment loading/unloading (printing material) and cleaning tasks, for instance the residue and dust of the 3D printing. These tasks might be integrated into existing job profiles or be bundled into a new job depending on how companies decide to organise work.

Wearables, which are the application of devices with sensors to people and which could be called the ‘internet of people’, are being used in everyday life (for example to monitor one’s exercise) but can be used in different work settings. For example, monitoring devices have an important application in healthcare allowing patients’ conditions supervision remotely. This type of applications, as for the industrial IoT, are likely to increase demand of ICT professionals and data scientists who can help manage and analyse data flows.

VR, as of 2019, has begun to be integrated into the workplace as a training tool. Initially used by the defence forces, the use of VR has been extended to rescue emergency workers such as firefighters and surgeons. Through VR, the training can take place in a setting where the hazard has been taken away. In certain cases, like in the case of firefighters training, this avoids the need, and the cost, of burning down a building. Moreover, the possibility of repeating the training allows the worker to learn from mistakes and improve performance (Eurofound 2019a). In manufacturing, apart from the afore-mentioned virtual twins, VR can be used in health and safety training as well. In healthcare, VR can support surgical operations preparation by allowing the surgeon to see a virtual model of the patient’s anatomy.

AR has been piloted in surgical operations for training purposes, in logistics, in urban planning and in the tourism sector. In urban planning, AR tools have the potential to increase the understanding of a proposed urban change by superimposing the new features to the real
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Environment, thus increasing citizens’ understanding of the proposed plan (Eurofound 2019a). For what concerns the tourism sector, the use of AR ‘guides’ which can display a ‘what it looked like’ scenario instead of the narrative provided by a human guide could diminish the need of human guides, although in many museums an automation/digitisation of tours has already taken place with the use of audio-guides.

To sum up, while the quantitative employment impact of digitisation is still difficult to assess, there is a high likelihood that job profiles will change, and new ones will be created. This mainly refers to a shift towards higher-skilled specialist occupations, and those taking on a role in supervising the technologies.

Platform work

Platform work is still a marginal phenomenon in Europe, with less than 2% of the population doing it as a main job (Pesole et al. forthcoming). However, there is wide agreement among experts that it has been dynamically growing for the last few years, and will continue to expand.

Platform work can be particularly advantageous for disadvantaged groups on the labour market, as it offers easy and unbureaucratic access to work and income, notably when considering small, low-skilled tasks (Eurofound 2019i). However, an important aspect that needs to be considered is whether platform work offers sustainable career options, acts as a stepping stone into more traditional employment, or results in a situation in which the workers are locked into an employment form perceived as unfavourable by them and/or could result in labour market segmentation. For the time being, no information about such effects, nor about the potential of platform work to crowd out traditional employment, is available.

Those types of platform work that are related to moderately to higher-skilled tasks, strategically conducted by the workers and providing them with high discretion as regards work organisation can contribute to foster entrepreneurial spirit and self-employment (Eurofound 2019i). They provide the workers with an easy and low-risk opportunity to try whether they have the required entrepreneurial skills (like self-organisation or dealing with clients) or to stabilise or expand their activity if they are already working as self-employed or freelancer.

An important labour market risk inherent to platform work is the potential misclassification of workers as self-employed, while in practice they are subject to subordination like employees and have limited discretion to balance the increased higher risk related to self-employment. If this happens, employment rights and working conditions standards are passed by, which might result in a race to the bottom which might also affect other types of employment in the longer run.

Related to the employment status is the potentially disruptive effect of platform work on legalising undeclared work. The fact that collecting data is a key element of the business models and mechanisms in the platform economy provides opportunities to make work more transparent compared to similar tasks conducted in the traditional economy, hence contributing to declaring work that is traditionally done in the shadow economy. At the same time, due to the fragmented and potentially international character of platform work, there are some assumptions that such work is not properly taxed or registered with social insurance authorities, hence potentially increasing the level of undeclared work.

To conclude, numerical labour market effects of platform work cannot yet be assessed. From a qualitative perspective, platform work is deemed to positively contribute to labour market integration and income generation, and to foster self-employment in Europe. On the negative side, it has the potential to disrupt established employment rights and labour standards, and to contribute to undeclared work and labour market segmentation.
Impact on working conditions and job quality

Automation

As indicated in the previous section, automation technologies have the potential to transform the tasks performed within jobs, and therefore the content of the job itself and the competencies needed to perform it. This has in turn strong implications, for instance, in terms of skills use and development. Overall, there is a tendency observed among the analysed automation technologies of a decrease in manual tasks and an increase in the need for intellectual skills. This is clear in the case of the adoption of advanced robots in manufacturing, which may drive employment demand for jobs involving tasks such as engaging with, supervising or developing automating technologies. This shift towards monitoring, programming and machine-control tasks, which is considered to result in better job quality, would also require existing workers to upskill (Eurofound 2018c). With regards to autonomous vehicles instead, these could considerably challenge professional drivers who would need training to develop new skills for tasks that are not fully pre-defined. Indeed, while the main task of driving would be replaced, autonomous vehicles might still require ‘hosts’ or ‘conductors’ to act as neutral parties in the shared, enclosed environment of the vehicle. This could require more creative and social skills, related to controlling passengers’ behaviour and reacting to unforeseen circumstances, for instance. At the same time, it could also mean a shift towards more manual tasks such as loading and unloading, which would not necessarily provide an opportunity to obtain better quality jobs.

The adoption of automation technologies will also necessitate changes to work organisation and work environment. A better understanding of how the robotic system relates to the social and qualitative aspects of the overall work system will be needed. In particular, the management of human–robots interaction will be a key aspect to consider because of the complexities related to it: people management is expected to be significantly affected, especially in terms of supervision of robots (and possibly supervision by robots). Work environment will necessarily be impacted too, due to the technological limitation of current robot technology to work in unstructured environments and respond to unexpected scenarios. In services where the ‘working space’ is generally not as clearly defined as the manufacturing production line, this could either limit the application of robots (confining them to fixed locations or restricted areas of motion) or necessitate a redesign of service delivery areas. For autonomous vehicles, work organisation seems to be oriented in two directions according to the type of transport involved; if transporting goods, the organisation of work might shift to remote supervision and less necessity to move location for workers. If transporting passengers, the scenario is still unclear since it might range from remote supervision to unsupervised and fully autonomous vehicles, and for what concerns workers, they might be needed on board or not (helping passengers with luggage, cleaning, supervising peoples’ behaviour). The use of autonomous vehicles might open up possibilities to use time spent driving and paying attention to the road with time used to complete work tasks, although this could depend on the length of the trip.

In terms of working time, advanced robotics has the potential to shorten working hours due to reduced workload. In order to maximise return on capital investments, production facilities are likely to operate 24/7, hence some specialised staff may be required to be constantly on call and work at unsocial hours in order to deal, for instance, with machine failure. In general, traditional and predictable working time schedules could be eroded. On the contrary, the deployment of autonomous vehicles could lead to more regular working hours and more consistent work schedules, which would have not only a positive effect on the experience of professional drivers at work but also on their quality of life. Autonomous transport devices could also reduce
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the commuting time for workers between their place of employment and their homes; it would also allow for the possibility to use the time not spent driving for work activities (e.g., checking emails, making phone calls, etc.) to be added to the total daily hours worked.

Finally, the impact on occupational health and safety is also very relevant. In general, automation technologies are assumed to result in less physical strain: in the case of advance robotics, physically burdensome tasks can be conducted by machines; in the case of autonomous vehicles, traditional challenges related to posture problems and need for break times in the transport sector could be overcome. This in turn also implies reduced risks of accidents and injuries. However, it is acknowledged by experts that such positive developments are more likely to occur when employers and employees are informed about specificities and potential dangers related to working with such technologies and are instructed on how to react to potential accidents. More generally, there is a need to invest in the safety of processes in situations where robots cooperate with human workers: this is especially crucial in work environments that are not particularly structured, like it is the case for the services sector. Similarly, while autonomous transport devices could improve safety in workplaces where they are used — by reducing injuries or fatalities that occur as a result of collisions caused by human error — they could also result in new risks in the early stage of deployment related to supervision of such vehicles and interactions with them. Interestingly, automation technologies such as advanced robotics are expected to bring about a greater risk of negative psychosocial effects due to machine control of work processes and increasingly secondary role of human intervention.

Digitisation

Among the technologies with a prevalence of digitisation, the skills requirements point towards a shift from manual to intellectual tasks or, in already digitised roles, to an intensification of intellectual tasks. Roles likely to be increased are those where ICT and data skills are required; these skills can help companies, both in the manufacturing and in the services sectors, to collect, store and make sense of data to improve their processes or products. Emphasis is also placed on the ability to communicate among disciplines: for instance the analysis of data flows, be it coming from production processes (IIoT) or from people (wearables), will need to be supported by workers who are familiar with software development, data analysis including AI, cybersecurity and data quality management.

Also, digitisation of work processes offers the possibility of radical changes to work organisation. The way in which each application is used and interacts with other technologies and the workers will shape not only work and production processes but also the other aspects of job quality (working time, work intensity, autonomy, flexibility, control and health and safety). Work organisation choices that a company can make include how much autonomy can be given to workers, for example if the pace of work is dictated by the rhythm of the machine or which type of tasks, very simple or very complex, are carried out by technology and which by humans. Of course, this type of choice is not entirely up to companies but is intertwined with the type of product or service being created. A job with a high social interaction component might not be suitable for digitisation even though it is technically feasible (for example in some healthcare contexts). For two technologies, wearables and VR/AR, an indication of changes seems to be more easily identifiable: in case of wearables workflows will be more data driven while for VR/AR there is a risk of task-driven organisation resulting in workers becoming passive recipients of task assignments.

In terms of working time the digitisation of work could on the one hand allow for remote working and a better work-life balance (although the benefits of teleworking are not clear cut
on the other hand, the supervision of highly automated and digitised processes means that these are potentially running 24/7, implying that a malfunction could occur at unsociable hours and require human intervention.

In general, the effects of digitisation technology on autonomy, flexibility and control are strictly related with sector of activity and jobs. In those jobs where wearables are used there is a tendency for less autonomy due to the potential for increased monitoring through the technology. On the other hand, notably where digitisation enhances remote working, workers are expected to experience a higher degree of autonomy and discretion in their decisions on how to structure their work and when to realise individual tasks.

As regards health and safety, in general, similarly to automation technologies, digitisation technologies reduce physical risks either by transferring a number of operations to the online or virtual space (IoT, VR/AR) or by providing new effective ways of risk-free training (VR). VR could also improve employees’ interaction and or empathy and perceptiveness. Wearables also have a risk reducing effect when, for example, workers’ physical or workspace conditions are monitored to get potential danger alerts. Potential health and safety risks have been identified around additive manufacturing, as some of the powders and pastes used in these processes are new materials and their safety in the long term has still to be proven (for example, release of toxic particles). Also, additive manufacturing machines have moving parts and high temperature nozzles from which workers should be sheltered. Some hints of negative psychosocial effects have been noted with the use of wearables since they increase the amount of control over workers.

Platform work

The algorithmic matching of supply and demand is a key characteristic of platform work. Beyond matching, algorithms can also be used to exert control over the worker (Vandaele 2018), thereby limiting their autonomy and flexibility which is generally promoted as one of the biggest advantages for platform workers.

Flexibility over working time is generally given in those types of platform work related to higher skills requirements and less influence of the platform in the work organisation. However, in online tasks – even if higher-skilled – global competition tends to create tight deadlines, which in turn results in high work intensity and stress levels. Additionally, some types of platform work are related to unsocial working hours (that is, beyond core working hours, like on evenings or weekends). Nevertheless, this is to be attributed to the task requirements rather than the specific characteristics of platform work, and hence not different from similar tasks in the traditional economy (e.g. food delivery, taxi services, emergency home maintenance tasks). In some types of platform work the mechanisms of the business model can incentivise workers to realise high work intensity. Examples are pay-by-task models (motivating workers to work at high speed to maximise their income in a given period) or systems with non-transparent task assignment algorithms or client decisions which tend to create insecurity among workers due to the unpredictability of work.

Platform work is often criticised for its low earning opportunities. This is widely based on early surveys flagging the low rates of individual tasks and the low overall income workers achieve in platform work, often limited to online micro-tasks (Ipeirotis 2010; Berg 2016; Leimeister et al. 2016). More nuanced research (Eurofound 2019i) shows that for other types of platform work, notably those delivered on location and where workers have discretion to set payment rates, income corresponds to market rates in the traditional economy. Predictability of
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earnings is rather good in those types where the platform goes beyond matching by determining the work organisation of tasks delivered on location. In contrast, it is rather non-existent in most online tasks, where also a high incidence of unpaid working time is observed (searching and bidding for tasks which might not be assigned to the worker at the end).

The physical environment in platform work does not differ from similar situations in the traditional tasks. Online workers are confronted with aspects related to office/computer work (for example, posture and ergonomics, eye strain) while on-location workers potentially have to face physical hazards (like road accidents in transport-related or handicraft tasks, exposure to chemicals in cleaning tasks). However, health and safety responsibilities (e.g. provision of adequate equipment) are not clear in the platform economy. This can be problematic if the mechanisms of the platform (pay-by-task) and the young age of the worker (lower level of awareness of risks and precaution measures, and interest in investing in such) incentivises workers to prioritise earnings over safety.

Impact on labour market institutions

The impact of disruptive technologies on industrial relations

This impact of disruptive technologies on collective employment relations depends on the nature and degree of deployment of each specific technology as well as the economic activity considered. In general, the impact of the implementation of game-changing technologies, especially automation-related ones, have been even stronger in well-established manufacturing activities. To a lesser extent, the effects can be noticed in the services sector, even though they are also quite remarkable in some sectors such as logistics and transport.

Industrial relations are challenged when disruptive technologies impact employment levels or the job profiles within sectors. The potential job losses or changes in production and work organisation condition considerably the collective employment relations raising the workers’ representatives and unions’ needs to adapt to a changing work environment as well as workforce, and a requirement to come up with responses which might need to deviate from traditional approaches. This is even more challenging when considering that the impact of the implementation of disruptive technologies takes place in a wider context of change and especially higher competition in specific business activities, for example, the automobile, finance and banking, and the telecom sectors. As far as these alterations in production and service provision require significant changes in work organisation and skills needed, workers’ representation and unions should also be requested to have a say.

Throughout the history of industrial revolutions, automation processes were finally integrated in the framework of national industrial relations systems. It took place in various ways and with difficulty over a long period of time. In the end, throughout the last century, organised workers in unions made it possible to embed the subsequent changes in work processes and working conditions mainly through collective bargaining at different levels. Therefore, labour and capital found an institutionalised way to organise their relations and settle their disputes derived from the periods of technological disruption.

Depending on each technology and sector, this time the impact of new technologies may lead to more disruptive potential in social dialogue at the company and sectoral level, particularly when used in combination of various forms of AI. The higher the impact of implementing each technology on the nature of work, workforce and working conditions, the more likely are the implications for collective employment relations. In this regard, the impact of disruptive
technologies on employment relations may be considered indirect as long as the technologies condition core aspects of workers’ representation such as membership and organisational capacity of trade unions as well as influence collective bargaining and power relations with employers. A number of indirect effects of game-changing technologies and overall technological change in collective employment relations can be stressed in Table 8.2.

Table 8.2 Implications of changes caused by disruptive technologies for collective employment relations

<table>
<thead>
<tr>
<th>Changes stemming from the implementation of disruptive technologies</th>
<th>Implications for collective employment relations</th>
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<tbody>
<tr>
<td><strong>Transformations in production processes and work organisation</strong></td>
<td></td>
</tr>
<tr>
<td>Outsourcing and subcontracting of digital processes or tasks: blurring company boundaries</td>
<td>Potential disruption in collective workers’ representation as the reduction in the number of employees may make it harder to reach thresholds to set up representation bodies – work councils</td>
</tr>
<tr>
<td>Digitised (mainly IoT-supported devices and VR) processes and tasks enabling remote control of the machinery and equipment</td>
<td>Increasing difficulties for unions to represent and organise geographically dispersed workers</td>
</tr>
<tr>
<td>Use of platform services and platform workers</td>
<td>Disruption of union solidarity</td>
</tr>
<tr>
<td><strong>Transformations in working conditions</strong></td>
<td></td>
</tr>
<tr>
<td>New digital skills needed in production processes and tasks</td>
<td>Labour demand tends to favour higher-skilled profiles where the level of unionisation is lower</td>
</tr>
<tr>
<td>Emerging occupational health risks, rather psychosocial than physical ones</td>
<td>New field to be researched, monitored and negotiated by workers’ representatives and unions in specific or general bodies</td>
</tr>
<tr>
<td>Constant data management process and monitoring production tools</td>
<td>Risk to fully or partially individualised wage setting and/or supplementary remuneration, undermining collective bargaining</td>
</tr>
<tr>
<td>Applying centralised management algorithms</td>
<td>Concern for the autonomy and privacy of employees</td>
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</table>

Automation blurs company boundaries and creates more complex organisational forms of production, both of which impact collective employment relations. In combination with developments related to work organisation – for example, increased remote working (Johnston and Land-Kazlauskas 2018) – these shifts resulting from automation could compromise the minimum threshold for consultation rights and thus the ability of employee representatives to engage in negotiations (IBA GEI 2017). Overall, these tendencies will diminish opportunities for workers to organise into trade unions and, consequently, reduce collective bargaining rights and workers’ participation in the decision-making processes that affect working conditions.

The earlier discussed effects of disruptive technologies of setting more complex organisational forms of production may impact workers’ representation and unions’ representativeness at the workplace level. Even though there would be different approaches to the implementation of technology at the company level, it is quite likely that growing physical distance as a result of remote working can render unionisation less easy to organise.

Nevertheless, some of the technologies discussed can contribute to improve the organisation of workers. For example, it has been pointed out that IoT-supported social media and other digital platforms can also be used for labour organisation, with platforms enabling crowdfunding efforts to fund union initiatives or opening up alternative methods of collaboration between workers’ representatives and new forms in worker representation (BDA 2015).
Available literature and studies have described how tripartite social dialogue has dealt with technological change (Eurofound 2016, 2017; EESC 2018). It becomes evident that this issue has become part of the employers’ and unions’ agendas, likely driven by the German industry 4.0-like strategies resulting in first national tripartite statements, joint declarations and different types of ‘digitalisation’ agreements showing the governments’ willingness to involve the social partners.

This joint approach has also been adopted at the sectoral level between the social partners themselves. Beyond the cross/industry statement on digitalisation produced by the EU social partners (BusinessEurope, ETUC, CEEP and SMEunited) in 2016, over the past years the EU sectoral social partners have reached various declarations, joint statements and other instruments stressing the pathway to adapt businesses and workforce to technological developments. Particularly the need to adapt skills policies as well as labour market regulations and institutions has been highlighted.

In most EU countries, collective agreements at both sectoral and company levels are just mentioning the importance of technological change and digital transformation committing the signatory parties to continue discussing this challenge and above all, promoting training to facilitate technological adaptation of employees. Just isolated examples of collective agreements can be found regulating the right to disconnect in relation to working time as well as fragmented measures related to technical adaptation or privacy at the workplace.

This lack of specific measures may be due to the following reasons:

- Technologies, and game-changing technologies in particular, or the combination thereof, evolve fast, while collective bargaining is a ‘heavy’ institution reacting slower to digital developments. For example, most collective agreements last more than two years before being renegotiated or renewed.
- Employers and unions have wage setting and working time ‘over-the-top’ in their negotiation agendas when facing collective bargaining. Impact of technological change in production is considered a discretionary power of the employer, and it is assumed that these issues should not be subject to negotiation as such, unless they have substantial implications for work organisation (work shifts, for example).

However, the effects of technological transformation at company and workplace levels are taking place step by step in collective bargaining mainly through a combination of working time measures and skills policies. In this regard, some experiences are leading the way to manage the effects of automation: carmakers in Germany such as Daimler, Volkswagen, BMW, Audi and Bosch, as well as automotive parts manufacturers like Continental, have introduced ambitious remote working programmes for hundreds of thousands of employees (where, for instance, robots can be managed remotely). Following the same track, SAP’s 22,000 employees in Germany also have the same right to work wherever they want in the country.

In other sectors, collective agreements in large companies as TIM (formerly Telecom Italia) or Unilever (industry 4.0 agreement) intend to deploy massive training opportunities and re-qualifications programmes for the entire staff. Interestingly, in line with the recommendations regarding the redistribution of the ‘value of data ownership’ of the High-Level Expert group on the Impact of the Digital Transformation on EU Labour Markets (European Commission 2019), the collective agreement in Lamborghini has agreed to establish a bilateral commission
to analyse to whom the data produced by the company’s IT systems will be available, either the workers or the company only.5

It is in the financial sector where the examples of managing the impact of digitalisation using collective bargaining are more frequent and explicit. In the Italian banking sector, the collective agreement (280,000 workers) includes the creation of a joint national committee to analyse the impact of new forms of technology and digitalisation aimed at identifying the skills required in the future.6 In the same sector in Germany (near 200,000), the collective agreement set up specific programmes to assess the readiness of workers for the digital transition.7 Similarly, the collective agreement in the banking sector in Belgium has established pathways for workers whose jobs may be under threat due to digital transformation, providing them with training and coaching in a digital platform.8

These examples do not hide that in the first decade of the century there were relevant cases of economic activities and sectors such as banking, media and post mail services dramatically restructured due to digital transformation. In these cases, the whole industrial relations system (strong social partner representativeness and well-established social dialogue) played a crucial role to smoothly manage technological redundancies with a combination of early retirement schemes and training, amongst other social and labour measures.

More recently, the increasing emergence of platform work, with its blurring impact on employment statuses and less favourable conditions of employment for workers in terms of job stability, income security and predictability as well as working hours, has many potential implications for industrial relations and social dialogue. Platform work has been extensively analysed over the past years (Eurofound 2017, 2018e, 2018f, 2019f, 2019g, 2019h, 2019i). The specific characteristics of platform work and the unclear employment status of workers challenge the ability of platform workers to have their interests represented. As they are widely considered self-employed, at least in some member states traditional trade unions do not have a mandate to represent them, and competition regulation may not permit them to organise through other means. In this regard, the ILO Global Commission on the Future of Work (ILO 2019) recommends ‘the development of an international governance system for digital labour platforms that sets and requires platforms (and their clients) to respect certain minimum rights and protections’.

Platform economy actors are at an early stage of engaging in forms of social dialogue or collective bargaining. Some initiatives to organise and mobilise platform workers are emerging in several EU Member States, driven by trade unions or by grassroots organisations (Vandaele 2018; Eurofound 2019i) as the Belgian Collectif des Courier-e-s, a self-organised collective of food-delivery riders.

As an example of institutionalised collective voice, recent legislation in France provided platform workers with the right to set up or join a trade union and to organise or participate in a strike without negative consequences for their contractual relationship. There are also some examples of collective agreements signed by institutional trade unions workers’ autonomous collectives and the management of a platform firm, such as the food-delivery company

Sgnam-MyMenu in Italy. The agreement set a fixed hourly rate in line with the sector’s minimum wage, compensation for overtime, holidays, bad weather and bicycle maintenance compensation (Aloisi 2019). Similarly, and widely promoted as the first collective agreement on platform work, the agreement between Hilfr (a platform company providing cleaning services) and the largest Danish trade union, 3F, established a minimum wage and workers’ entitlement to contributions to pensions, holiday pay and sickness benefits (Eurofound 2019i).

Interestingly, flexibility in collective bargaining may offer capacity to frame platform work through extension mechanisms. Thus, the agreement signed by Bzzt (a platform of personal transport by tuck tuck) covers its drivers under the taxi agreement (Swedish Transport Workers’ Union). Another example is the coverage provided by the collective agreement for temporary agency work for Instajobs workers (a platform for student work) signed between the platform and the largest Swedish trade union Unionen. The same ‘temporary agency work window’ has been followed by Gigstr (low-skilled tasks) in Sweden (Jesnes et al. 2019).

An interesting example – likely the first one at the sectoral level – of collective agreement covering food delivery riders was signed in the Italian logistics sector in 2017. The agreement covers working time, the requirement for notice and compensation for changes in working schedules and compensation in case of illness.

It is quite likely that more examples of collective bargaining or other forms of social dialogue will follow. The European Commission announced the discussion on challenges related to platform work and possible solutions as an essential commitment in the Road Map presented in January 2020. Priority issues like employment status, working conditions and access to social protection of platform workers, access to collective representation and bargaining have been discussed during 2021 through different policy documents and public consultations such the one on ‘Collective bargaining agreements for self-employed – scope of application EU competition rules’. It is expected that the European Commission publishes a proposal addressed to improving the working conditions of platform workers by the end of 2021, including a legislative initiative, an impact assessment and further consultation of the social partners under Article 153 TFEU.

Conclusions and policy pointers

Role for EU investment and policies

Despite accounting for only about 7% of the world’s population, Europe accounts for 20% of global R&D investment. However, statistics relating to the number of patents and other indicators suggest that the EU is lagging behind other regions – notably the US and China – in technological development, including those technologies that are considered potentially more disruptive.

EU policy has started to address this gap, for example by financially supporting the development of disruptive technologies such as AI, although further efforts and more holistic approaches might be needed. Efforts are also required to close the financing gap between R&D grants and private investment.

EU regulations supporting disruptive technologies

While many policies support the development and adoption of technologies, legislative action should also be taken to integrate automated processes in the workplace. Regulatory frameworks, especially in the area of standardisation and interoperability, need to be established and fine-tuned both for companies (e.g. related to IoT) and workers (e.g. to prevent potential hazards related to additive manufacturing or advanced robotics).
Even though GDPR protects personal data, the types of data produced during working time need to be defined more specifically. The ownership of workers’ data, in particular related to performance and behaviour, and in blurred employment relationships like platform work, should be specifically regulated. It should also be recognised that workers’ and consumers’ data are used to increase a firm’s value, and they should be compensated accordingly.

**Strategic use of technologies for labour market purposes**

The new capabilities of disruptive technologies should be exploited to improve labour markets. Technologies falling under the digitisation cluster (i.e. IoT, additive manufacturing and VR/AR) can foster flexibility through remote working. VR/AR can also provide alternative training methods for hazardous occupations.

Advanced robotics, or the use of exoskeletons, can reduce physical strain and hazardous tasks, which could enable the integration of disabled or older workers into the workplace. Furthermore, there should be a focus on research into hazardous tasks that can be carried out by machines in order to make workplaces safer.

Platform work could be used as a strategic tool to foster labour market integration of disadvantaged groups, to extend working life or to legalise undeclared work. However, before deciding on such a pathway, more needs to be learned about potential unintended side effects, such as crowding out of traditional employment with more favourable working conditions or its contribution to labour market segmentation.

**A European vision for technology and digitalisation**

Digitalisation entails more than solely implementing new technologies in work processes, as it is interrelated with other mega-trends like internationalisation and the transition to a low carbon economy. Accordingly, it requires a long-term and holistic strategic vision, and that the implications of digitalisation for both human capital and the value chain be taken into consideration. Usually, digitalisation will involve reorganisation at the company level, driven by competition in an increasingly technological and globalised environment.

The way in which technology is adopted and implemented is highly significant and therefore prompts the need for effective human resources management approaches, which should involve worker representatives or trade unions. Human resources management policies are increasingly expected to be able to ease technological change through people management.

Technological transformation does not take place overnight, and the pace of change should be tailored to help manage the transition period. Organisations need to identify early on the strategic vision driving the adoption of technology and, consequently, the overall effects for the organisation and for the staff. This is particularly important for those organisations adopting robotisation in combination with other general-purpose technologies such as IoT and AI, which are usually run from the cloud. Such combinations of technologies enable the implementation of smart factories or digitised networked workplaces, with profound impacts on production and work organisation.

EU companies have significant experience in dealing with transformative automation, and lessons learned should be applied to the current technological transition. A narrow approach to technological change, which mostly takes advantage of automation to reduce the workforce and labour costs, should be avoided. Instead, labour-friendly strategies, which seek to reskill the workforce in line with efficiency and productivity gains, should be applied.
Employment and skills

After the first wave of near-dystopian predictions about the impact of automation on job losses, more recent estimates confirm the limited quantitative effects of automation on employment. It is widely accepted that a job is composed of a bundle of tasks to which workers apply their skills in exchange for wage; some of these tasks can be automated, but others cannot. Presently, estimates suggest that automation will thus replace only very few jobs completely (automating all task content in a given job), while impacting the job profile of others. The latter is of importance as it alters skills requirements to which employers, workers and the education systems need to adapt.

The increase of remote working enabled by some of the analysed disruptive technologies could pose serious challenges to policymakers and workers alike. If jobs can be done remotely, they may not be performed – and therefore paid – at the local level. Technological change should be viewed as an opportunity to adjust work processes and reorganise the production process and the provision of services to improve, rather than replace, workforce capacity. As more tasks become automated over time, tasks that are not replaced by machines are likely to change and could increase in value, while other new creative tasks requiring human talent may be created. In this transition period, further public and private research and monitoring is needed to ensure that workers and machines work together effectively.

Significant investment in skills at all levels is essential in this technological transition. As future jobs in the technological sphere will be constantly evolving, continuous and lifelong training should be at the core of the EU strategy to address technological change. To stay ahead of global competition, the EU needs to solve two issues in particular: how to equip the new generation of workers with the right skills, both transferable and specific, and how to help workers whose jobs might be lost or substantially changed through the adoption of disruptive technologies.

Training policies should be based on effective tools anticipating future skills needs and close collaboration and synergies between business, education providers, social partners and governments. Apprenticeship systems and vocational education and training need to be reoriented in line with these changes, and collective bargaining at all levels can play an important role in anticipating and managing change by establishing agreed training and skills policies.

Social dialogue and employment relations

The more disruptive the technology, the greater the impact it has on the labour force and on working conditions, and thus on social dialogue. Companies focusing exclusively on technical change, rather than on the people working with the technologies, are pursuing a short-term strategy that is unlikely to foster workforce cohesion. Social dialogue involving workers affected by disruptive technologies – ideally going beyond standard employees but also focusing on non-standard work including self-employment – therefore becomes a crucial way to create new, more appropriate agendas for negotiation and identify new areas for employer–worker cooperation.

Contributing to manage the impact of technological change and the effects of game-changing technologies is already on the cross-industry and sectoral policy agenda of employer organisations and trade unions, both at the EU and national level. The social partners have addressed these challenges at the macroeconomic level (the potential employment effects and the need to refocus the skills gaps) and at the sectoral and company level.
Collective bargaining contributes to effectively manage transition periods supporting companies and sectors to restructure and adapt accordingly, dealing with the risks of increasing wage inequality and polarisation in working conditions. A new wave of collective agreements managing digital transformation and digital organisation of work through working time flexibility, reskilling and upskilling, work-life balance and working conditions such as workers’ health and safety, including psychosocial risks, are already leading the way for updating collective bargaining.

In this regard, despite the existing innovative experiences, collective bargaining coverage of platform workers is still at a very early stage. However, social partners and particularly trade unions are making efforts to reach agreements addressing social protection and other working conditions standards stemming from the new form of work in digital platforms. Furthermore, the use of digital means and platforms could contribute to better organise the activities and influence of the social partners themselves as well as to monitor and extend their capacities and increase their membership.

References


The impact of disruptive technologies


