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Making algorithms safe for workers: occupational risks associated with work managed by artificial intelligence

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Summary
It is increasingly common for companies to use artificial intelligence mechanisms to manage work. This study examines the health hazards caused by these new forms of technological management. Occupational risks can be reduced if they are taken into account when programming an algorithm. This study confirms the need for algorithms to be correctly programmed, taking account of these occupational risks. In the same way as supervisors have to be trained in risk prevention to be able to perform their work, the algorithm must be programmed to weigh up the occupational risks – and when such features do not exist, steps must be taken to prevent the algorithm being used to direct workers. The algorithm must assess all (known) factors posing a risk to workers' health and safety. It therefore seems necessary to incorporate a mandatory risk assessment performed by specialists in the programming of algorithms so that all ascertained risks can be taken into account.

Résumé
Il est de plus en plus fréquent de voir des entreprises utiliser des mécanismes d'intelligence artificielle pour assurer la gestion du travail. Cette étude examine les risques pour la santé engendrés par ces nouvelles formes technologiques de gestion. Il est possible de réduire les risques au travail si ceux-ci sont pris en compte lors de la programmation d'un algorithme. Cette étude confirme la nécessité d'une programmation correcte des algorithmes, qui tienne compte de ces risques professionnels. De la même manière que les superviseurs doivent recevoir une formation à la prévention des risques pour pouvoir effectuer leur travail, l'algorithme doit être programmé pour pouvoir évaluer les risques professionnels - et lorsqu'une telle fonctionnalité n'existe pas, des mesures doivent être adoptées pour éviter toute utilisation de l'algorithme pour diriger les travailleurs. L'algorithme doit évaluer tous les facteurs (connus) qui présentent un risque pour la santé et la sécurité des travailleurs. Dès lors, il semble nécessaire d'intégrer dans la programmation des algorithmes une évaluation

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obligatoire des risques, réalisée par des spécialistes, afin de prendre en compte tous les risques constatés.

Zusammenfassung
Immer mehr Unternehmen setzen auf künstliche Intelligenz zur Verbesserung des Arbeitsmanagements. Die vorliegende Studie untersucht, welche Gesundheitsgefahren mit diesen neuen Formen des technologischen Managements verbunden sind. Berufsbedingte Risiken lassen sich verringern, wenn sie bei der Programmierung von Algorithmen bereits berücksichtigt werden. Die Studie bestätigt die Annahme, dass Algorithmen richtig programmiert werden müssen, um diese beruflichen Risiken zu minimieren. Genauso wie Aufsichtspersonen in Risikoprävention geschult werden müssen, damit sie ihre Arbeit ausführen können, muss ein Algorithmus so programmiert werden, dass er berufsbedingte Risiken abwägen kann. Ist der Algorithmus nicht dazu in der Lage, ist dafür zu sorgen, dass er nicht direkt zur Anleitung von Arbeitskräften eingesetzt wird. Der Algorithmus muss alle (bekannten) Faktoren einschätzen können, die für die Arbeitssicherheit und die Gesundheit von Arbeitskräften ein Risiko darstellen können. Es erscheint deshalb erforderlich, bei der Programmierung von Algorithmen eine obligatorische Risikoeinschätzung durch Fachleute vornehmen zu lassen, damit alle bisher festgestellten Risiken berücksichtigt werden können.

Keywords
Occupational risk prevention, artificial intelligence to manage workers, automated decision-making, people analytics, big data, algorithms to manage the work, digitalisation of labour, health and safety at work

> 'A robot may not injure a human being or, through inaction, allow a human being to come to harm'
>
> *Runaround*, 1942 (Isaac Asimov)

Automated work management

The use of digitalised methods of companies is increasing rapidly. For instance, a multitude of sensors (wearables) produce data used to keep track of employees' productivity, mood and emotional state and even to predict their personality (see Ajunwa et al., 2017; De Stefano, 2018; Moore, 2018b, 2020). The information collected allows the creation of worker profiles and the use of *people analytics* (the science of applying Big Data to work) to optimise processes in companies (see Cherry, 2017; Moore, 2017; Charlotte et al., 2017; Dagnino and Armaroli, 2020).

The sheer amount of information accumulated by the new devices and sensors available today makes it unlikely that such data will subsequently be processed by a human resources manager for the purpose of making management decisions for the company. For this reason, companies delegate the processing and subsequent use of the information in decision-making to algorithms or artificial intelligence. For instance, these algorithms are used to distribute tasks among workers, schedule activities, evaluate work or even to hire or dismiss employees (EU-OSHA, 2018: 55; Moore, 2018a; Ponce, 2019).

In this sense, automated work management is at this point in time the last step in optimising efficiency in the management and control of workers and consists precisely of doing away with all human intervention. Artificial intelligence thus becomes a substitute for the person in charge of human resources and for middle managers, even in decision-making.[1]

One of the greatest uses of HR algorithms is the selection and hiring of workers. While it is difficult for any one person to analyse the huge amount of information on a candidate available on the Internet, algorithms are able to track down this information and build a digital profile that can later be compared with other candidates and the company's needs. This can lead to the creation of a shortlist of candidates for final selection by the head of human resources or directly by the algorithm (on the legal issues that this poses, see Todolí-Signes, 2018).

In additional, algorithms are used to coordinate work and establish workers' schedules, assign tasks to workers, monitor and supervise the quality of the work done and indicate the need to carry out improvements in work, among other things (Pega and Marketforce, 2017: 11).

Algorithms are also used to monitor work performance. In Amazon's logistics centres, wearables are used to keep track of the time it takes a warehouse assistant to transport packages from A to B. When it takes longer than stipulated by the company, a warning notice is sent (Miguel, 2018). Hotels and cleaning companies have used these devices to measure the time it takes each worker to clean a lavatory (Moore, 2018a: 142). This is sometimes referred to as 'the digital whip' (Moore, 2018b: 23). These messages serve as a constant reminder that 'Big Brother is watching you', pressuring workers to work faster and faster and comply with the company's wishes.[2]

In short, algorithms currently seem to be replacing middle managers and supervisors through digital work management, meaning that workers get no instructions or feedback about their work/performance from another human being but instead an automated response with predefined parameters.[3] This can cause specific health risks for workers, as an algorithm might not be prepared (programmed) to minimise these risks.[4]

Many studies have described the risks for workers associated with the digitalisation of work (Dembe et al., 2005; Domeinski et al., 2007; Hung et al., 2011; Schumacher, 2011; EU-OSHA, 2013; Van Jaarsveld and Poster, 2013; Derks and Bakker, 2014; Pérez-Zapata, 2015; Lindsay,

1 While recently there has been an increased interest from the literature in these systems, the reality is that enterprise resource planning (ERP) software (such as SAP) has been used since the 1990s to optimise the processes from the business perspective, affecting workers' condition in the same way as described in this article.

2 It should be noted that these systems 'learn' (machine learning), meaning that they can adapt to each of the workers, demanding the maximum that each of them is able to give. Under pre-AI productivity systems, all workers were traditionally treated equally. Yet, without requiring more resources, artificial intelligence is able to 'discover' (through trial and error) the maximum achievable by each worker (Moore, 2018a: 3), depending on their personal characteristics, and to use this technique (digital whip) to demand it.

3 For example, according to the Spanish Labour Inspection Report no. 460016685/17/sms, dated 5 December 2017, if a Deliveroo rider is not in motion (detected by GPS), he or she automatically receives a warning message telling them to get moving again. The ride-hailing company Lyft has a rule whereby drivers with an average rating below 4.6 (out of 5) are automatically deactivated. As another example, if a user rates a driver with less than a 3, the algorithm will prevent that driver from providing the same customer with a service again. In this respect, see: 'We go the extra mile for safety'. Available at: www.lyft.com/safety (accessed 29 April 2020).

4 All this must be combined with workers' rejection (at least for the time being) of the idea of being managed by artificial intelligence. In fact, a survey conducted by Pega and Marketforce (2017: 11) states that while 88 per cent of the workers surveyed were comfortable working with robots, 80 per cent were not comfortable with artificial intelligence as a supervisor or manager.

2015; Akhtar and Moore, 2016; Ajunwa et al., 2017; EU-OSHA, 2017; Fernández Avilés, 2017; Horton et al., 2018; Rodríguez-Rico Roldan, 2018; Moore, 2018a; Moore, 2018b; UTS, 2019, Aloisi and Gramano, 2020; Adams-Prassl, 2020), although most lack systematisation, instead focusing on just one aspect of the risks without adopting an overall perspective or dealing with the specific occupational risks faced by workers when they are managed by an algorithm. In addition, this new reality needs a legislative response to protect workers, an aspect as yet not adequately addressed.

In this vein, the aim of this article is to systematise the specific occupational risks underlying the incremental use of artificial intelligence to manage workers and to identify the legal avenues for addressing these health risks. The remainder of this article proceeds as follows. The next section summarises the occupational risks and their consequences for workers' health. The third section of the article is dedicated to analysing and systematising the challenges that the use of algorithms/AI as a 'digital middle manager' raises for the legal framework to protect workers. The article ends with some conclusions.

Occupational risk factors derived from algorithmic work management

From the studies published in the literature to date, it can be seen that there are multiple occupational risk factors resulting from having an algorithm/AI manage work. To analyse these risks, we need to take two things into account. First, some risk factors could also exist when a human supervisor is in control. Nevertheless, the use of AI could increase the risk factor due to its omnipresent capabilities or its lack of empathy.[5] As Prassal (2020) highlighted, 'machine learning fundamentally differs from traditional management structures'. Additionally, due to the novelty of AI as a 'digital middle manager', it seems a good idea to acknowledge the existence of these risk factors in this particular context. In the same vein, AI-based decision-making could cause a diffusion of worker protection responsibility, possibly leading to more accidents. On the other hand, automatic systems could also serve occupational risk prevention, for instance through monitoring heart rate to avoid life-threatening strain. In fact, AI has both good and bad sides, dependent not on the technology per se but on its use (Berg, 2020). However, as this article aims to propose a regulation for reducing its bad uses, the focus is on the risks posed by AI. I have classified them in six groups, as detailed below, with the main consequences for workers' health discussed for each group.

Constant monitoring

The ability to process data automatically in a very efficient way encourages companies to collect as much data as possible about workers and the work done. In addition to this, new technologies (wearables and the internet of things) are allowing them to use sensors that measure and count 'everything' (EU-OSHA, 2017: 1). There are sensors based on:

- Audio: capable of knowing a worker's mood (cheerful, depressed, anxious, happy, bored, etc.) and even transcribing conversations or simply monitoring the number and frequency of calls made. By the tone of voice, they can also detect each worker's energy level and even

5 As pointed out by Adler-Bell and Miller (2018) 'data-driven software and algorithmic decision-making [. . .] act as a force-multiplier for the power held by firms, with no balancing agent on the side of workers'.

the interpersonal influence in teamwork (leadership, submission, etc.) (on this matter, see Lindsay, 2015)
- Biological signs: steps, heart rate (resting or active), brain function – distinguished by parts (creative, attentive), etc.
- Cameras: including recognition of faces and facial expressions
- GPS: movement, activity, etc.
- Interaction: mouse and keyboard movements, websites visited, even measuring levels of happiness or making predictions about each worker's type of personality (Young et al., 2017)

Not surprisingly, in a survey conducted by Price Waterhouse Cooper, 82 per cent of workers were concerned about the amount of personal data companies collected about them (Spicer and Cederstrom, 2015). Undoubtedly, the feeling of being permanently observed (*Big Brother as stressor*) is a risk factor in itself (OSHA, 2017; Fernández Avilés, 2017: 83). Indeed, invasive technological control and lack of privacy can cause various psychosocial risks (techno-stress, techno-anxiety, techno-fatigue or burnout).

On the other hand, constant observation may cause workers to behave in unnatural ways (always smiling or always being active) to achieve targets requiring great physical or psychological effort, or to be unable to interact socially with colleagues or to take breaks. Constant monitoring can thus lead to stress and anxiety, particularly if combined with a lack of control over one's own time (HSE, 2019) or in conjunction with constant reminders of such observation aimed at achieving modifications in a worker's behaviour. Such monitoring can be especially damaging if combined with the threat of dismissal or, in general, a feeling of job insecurity. As has been noted, monitoring on digital platforms is linked to the use of this information to make decisions on 'deactivating' platform workers.[6]

For instance, a study conducted in Australia on platform couriers found that they felt they were under pressure to continue working even in extreme weather conditions as a result of the surveillance to which they were subjected (UTS, 2019: 3).

In turn, this constant observation may step up demands for the worker to carry out 'emotional work'. There is an abundance of literature (Van Jaarsveld and Poster, 2013) analysing the difficulties encountered by workers forced to always have a smile on their faces, regardless of their true feelings. With increased monitoring, these unhealthy demands will undoubtedly increase. Constant observation may entail the need for workers to continually suppress their own personality, preferences and feelings (Korczynski and Evans, 2013).

The lack of context (and empathy) in data collection and decision-making can lead to the discrimination or unfair treatment of workers who, aware of this possibility, may find their anxiety increasing (EU-OSHA, 2018: 16). In the same way, the fact that it is impossible to contest a decision made by an algorithm can lead to anxiety and frustration (Adams, 2018: 357). In addition, informing workers of their performance in relation to others can lead to increased pressure, stress, anxiety and low self-esteem (EU-OSHA, 2018: 55), especially if such information is presented as objective and neutral even though it is not (Pérez Zapata et al., 2019: 9).

With algorithms there is a real risk of workers being treated as mere fungible assets at the service of machines (or assessed as just another cost) and not as human beings (Bodie et al., 2016: 1037). Relying solely on data and metrics to empower an algorithm to decide over a worker's fate

6 See Footnote 1.

can potentially dehumanise work, with workers behaving like any other production machine (Moore, 2018: 149).

Work intensification

Work intensification refers to the process of raising the expected workload of an employee by increasing the amount of tasks to be undertaken or shortening the time allowed to complete those tasks. Indeed, the European Agency for Safety and Health at Work has indicated that the main source of stress identified by workers are the hours they have to work and the workload (EU-OSHA, 2013). In this sense, some authors suggest that work intensity has become the most relevant risk (together with ergonomic problems) for the health of workers (Pérez-Zapata, 2015).

Workers subject to automated or algorithmic management of their work may see their work (or workload) intensified. Once an algorithm assigns tasks and sets deadlines for fulfilling them, workers may need to increase the speed at which they work to meet the pace set by the algorithm. Note that the algorithm may even make the task 'disappear' from the screen and move on to the next one at the scheduled time, without workers having any chance to go back later to finish the task or to organise their own working time (as in Amazon Mechanical Turk, see Felstiner (2011)). This pressure can lead to stress and anxiety, even discouragement, depression and, in the most extreme case, burnout if the deadlines set by the machine cannot be achieved (EU-OSHA, 2017). It can also lead to other types of risk because the worker may take unnecessary physical risks in order to meet the deadlines set, such as jumping traffic lights, etc.

Additionally, algorithms are able specifically to adapt what is required of each worker, with no overall target set for everyone. Targets can be modified when the worker meets the deadlines – even without the worker noticing the change in the requirements or level of demand. Take for example the time needed to deliver an order from one side of a city to the other by bicycle. The algorithm could set tighter time margins without the workers themselves being aware that it is demanding faster and faster delivery times (as reported by Amazon warehouse workers in Selby, 2017).

Once again, depersonalisation and the lack of empathy inherent in machines/software may lead to greater demands being put on workers, as well as to worker frustration and discouragement when they see no possibility to explain or justify themselves, or any chance of negotiating or reaching an agreement on reasonable targets. In this sense, the use of algorithms as supervisors can cause a mismatch between workers' physical or cognitive abilities and the requirements established by the algorithm (EU-OSHA, 2018: 56), leading to tiredness, chronic fatigue, reduced endurance, mood swings, increased risk of heart disease, neurological effects, depression or burnout (Popma, 2013: 15). In addition to psychological problems, it should be noted that work intensification can also aggravate other common risks, such as road accidents when attempting to arrive on time (Dembe et al., 2005; López Rodríguez, 2019: 8).

Lack of autonomy

Control and supervision by an omnipresent and virtually omnipotent body implies that workers have few possibilities to make autonomous decisions. The algorithm, by the very definition of its functions, decides which, according to its data and configuration, is the best way (i.e., the most productive for the company) to carry out a task and to organise a job. This 'best way' will then be the one demanded of the worker. Indeed, algorithms are expected to be capable of optimising work management, thereby maximising productivity. Thus, once the optimal way to work has been

established, it will be imposed upon the worker. This will entail reducing workers' possibilities to organise their work autonomously and decide how to best perform it. In short, the implementation of algorithmic management will lead to great opportunities for the micro-management of work, with its corresponding reduction in job satisfaction, increased stress, reduction in mutual trust between the parties and a worsening of the working environment (Schumacher, 2011).

This lack of autonomy could specifically cause *techno-necessity*.[7] Especially in the case of algorithms as decision-makers, workers may, over time, be unable to make their own decisions on work management and self-organisation due to a lack of practice – just like youngsters who are increasingly unable to remember (mobile) phone numbers because they are all stored in their phones' memory.

At least two factors increasing the risk of this occurring are considered here. On the one hand, there is convenience. Decision-making is not always a simple task, so it may be convenient to have a machine/software do it. However, this may eventually make us addicted, leading to us losing our own ability over time to do so correctly. On the other hand, if the decisions made by the algorithms are given precedence in social terms because they are deemed to be economically more efficient, this can give rise to algorithms being worshipped as 'gods', to be followed without questioning (Harari, 2016).

This phenomenon has been analysed before. Without replacing supervisors or middle management, many automatic systems already assist in decision-making (e.g. emergency alarms in aircraft flight control systems). In their interaction with these systems it has been proved that humans end up taking for granted the response given by the automated system without carrying out their own analysis of the situation. Three factors lead to this state of affairs.

First, the human tendency to choose the path that requires the least cognitive effort (Wickens and Hollands, 2000). Indeed, it is easier to accept as valid the decision taken by the automated system than to carry out one's own comprehensive analysis with all the available information.

The second factor fostering the consideration of automated decisions as being equivalent to human decisions even when the human being has the last word is the trust placed in these automated systems as powerful agents with superior capabilities (Lee and See, 2004). In an experiment conducted by Dzindolet et al. (2002), the participants, without having extensive knowledge of the automated system, invariably bet that the automated system would offer a greater number of hits than another human, i.e., they trusted the machine more than a human being, despite not possessing sufficient information about the capabilities of either of them.

Moreover, on opting to follow an automated decision, the human's responsibility is diluted. Just as effort is reduced when responsibility is placed on two or more humans (Karau and Williams, 1993), the same is true with automatic systems (Domeinski et al., 2007).

To sum up, there is also a possibility that algorithms will end up reducing the ability of human beings to make their own decisions, even in cases where the automated system is not the final decision-maker but instead a system for warning or assisting humans.

In short, algorithmic labour management can cause greater work alienation. As with the Taylorist measurement of times and movements, workers can become mere parts of a production chain, reproducing the movements determined by the algorithm. However, the greater capacity of the algorithm

7 *Techno-addiction*, was conceptualised by Pompa (2013: 15) as the uncontrollable need to constantly and obsessively use new technologies, reflecting a lack of self-control on the part of the worker. By contrast, *techno-necessity* implies the lack of ability to perform a task without the help of the machine – an ability that the worker may have lost due to a lack of practice.

compared to traditional supervisors may increase the classic risks of alienation and excessive specialisation. This confronts us with the real possibility of the algorithm ending up capturing the body, soul and mind of workers in the quest for increased productivity (Moore, 2018a: 65).

In general, loss of autonomy at work, together with a lack of participation and self-management, can harm workers' health, leading to the absence of motivation, discouragement, low self-esteem and depression (Karasek and Theorell, 1990).

Bias and discrimination caused by the algorithm

The labour management performed by algorithms aims to search for recurring patterns and correlations in order to predict the best way to manage human resources. Indeed, the objective is to build worker profiles, classifying them by parameters introduced in the algorithm itself, and then to decide on hiring, dismissal, shifts, the type of tasks, the professional level, etc. In this sense, one of the main issues is the possibility of these algorithms making discriminatory decisions (Bodie, 2016; Ajunwa, 2017: 106; Todolí-Signes, 2018: 469).

Indeed, automated data processing exponentially increases the possibilities of violating workers' rights and of them suffering discrimination (Pérez Luño, 2006: 93; Garriga Domínguez, 2018: 109). Regardless of whether it is ultimately the HR manager who takes a particular decision or not, the fact that it is based on automated data processing (e.g. the profiling of workers or algorithm-driven appraisals) will increase the likelihood of the decision being discriminatory.

The high probability of unlawful discrimination when an algorithm makes decisions stems from three factors (see Todolí-Signes, 2018): a) even if collecting data on trade union membership, religion, gender, sexual orientation or disability is forbidden by law to avoid decision-making taking such factors into account, algorithms are capable of deriving this information from other data (Crawford and Schultz, 2014: 95); b) the algorithm takes reality as a learning factor when processing data, meaning that the results obtained from this data may perpetuate existing biases in our society (e.g. gender wage gaps); c) the science of statistics itself accords greater value to decisions based on more available information. As there is always less data available on minorities (race, religion, sexual orientation, etc.), this will lead the algorithm to understand that making a decision in favour of a minority group is riskier than making one in favour of a majority group (Hardt, 2014). In other words, to select a candidate from a minority group, a hiring algorithm will demand (by default) more qualities, aptitudes, knowledge, etc. than those required from a member of a majority group, simply due to the fact that it is easier to (statistically) predict the behaviour of a candidate belonging to the latter group.

This unfair treatment can cause anxiety and frustration and even discouragement and depression, all the more so if the algorithm is presented as a neutral element following 'purely meritocratic' patterns. In the survey conducted by Pega and Marketforce (2017: 14) 66 per cent of the HR experts consulted believed that the use of algorithms would lead to greater meritocracy at work. Thus, if this discourse of objectivity and neutrality of the algorithms continues to grow, feelings of injustice and frustration among historically discriminated collectives may increase.

Complexity and lack of transparency

Ignorance of the parameters used to make a decision and the associated lack of transparency can also cause anxiety and frustration. In fact, the amount of data collected and processed by algorithms makes knowing the *ultima ratio* of a decision a very complex matter. And even in those cases where the reasons behind the decision are known, the algorithm will only reveal them if

programmed to do so – something that currently does not seem to be the case.[8] For example, when workers are deactivated from digital platforms, in most cases they are not given a reason but instead simply prevented from accessing the application necessary to perform their tasks (Rosemblat, 2019).

One of the health risks of digital work highlighted by the literature is *techno-overload*. This is related to the excessive burden of information received by workers and their inability to process it properly. With new technologies, workers get flooded with information, making it difficult, if not impossible, for them to differentiate useful information from the rest. Himma (2007) argues that having too much information can result in a kind of permanent state of indecision and insecurity for the worker as to whether the decisions taken are the right ones or not. As can be seen, this does not seem to be a possibility in the case of workers managed by an algorithm. In such a case, it is the algorithm that receives all the information, processes it and makes the decision. Thus, technological overload (in the sense of excess information received by the worker) can be ruled out as a risk in the case of algorithmic labour management.

Indeed, it seems quite likely that the effect will be the opposite: workers will be technologically *under*-informed, i.e., they will be deprived of the information relevant to them. Platform workers whose work sequence and task assignment are handled by an algorithm complain about insufficient information (Rosemblat, 2019). The owner of the data, the algorithm prevents them from assessing or checking whether a decision benefits them, harms them or even whether it is correct or can be improved.

Specifically, when asked about this in a survey, 78 per cent of the workers surveyed considered that they would feel more comfortable about being directed by artificial intelligence if there were complete transparency and the possibility of checking how decisions were reached (Pega and Marketforce, 2017: 11).

Malfunctions and ethical questions

One of the characteristics of algorithms is that they have a learning curve based on trial and error. This means that they need a lot of information and many interactions to improve their own functioning. For this reason, it can be expected that, in the early stages of implementation – where we are now –, there are many algorithms that, despite their promising capabilities, will not achieve the expected results from the outset. The investigation conducted by Rosemblat (2019) documents many complaints from Uber drivers about the malfunctioning of these algorithms. Specifically, Uber uses an automatic response system for incidents reported by its drivers, i.e., when a worker has a problem, an unforeseen situation or a complaint (e.g. they have not been paid what they are due), they are directed to an automatic response system. The work usually done by a middle manager or HR manager is taken over by an algorithm. Uber drivers feel very frustrated about the poor performance of this algorithm: in some cases, the answers are not logical, in others they do not respond at all to what the worker said and, in yet other cases, they give totally incomprehensible answers. Drivers thus not only do not have access to a response from a human, but the response received from the algorithm is clearly deficient and insufficient. However, Uber offers no other form of communication with the company, in many cases leaving workers without a solution and in turn causing frustration and despair.

8 For example, in its State vs. Loomis judgment, the Supreme Court of Wisconsin considered that the claimant had no right to see the methodology used in the algorithm as it is protected by the Trade Secrets Law (see Freeman, 2016).

Moreover, there are ethical issues to be assessed (Moore, 2018a: 29). The EU-OSHA report (2018: 57) raises important ethical questions related to algorithmic decision-making, such as whether an algorithm should put a worker at risk to maintain the safety of an entire workplace. Undoubtedly, the lack of transparency and possible mistrust in an algorithm's ability to make ethical decisions will increase workers' suspicions, thereby affecting their levels of stress and anxiety.

Hence, the algorithm may end up treating workers as just another machine with no feelings or personality of their own, thereby dehumanising them. For this reason, part of the literature understands that the combination of the accumulation of data about the worker and decision-making by an algorithm can lead to increased anxiety and psychological discomfort (EU-OSHA, 2018: 56). Furthermore, treating workers in this way could even be described as violence (Akhtar and Moore, 2016).

Ways of ensuring that algorithmic management does not harm workers

From a legal point of view, Article 5(1) of the European Directive 89/391/EEC[9] states that 'The employer shall have the duty to ensure the safety and health of the workers in every aspect related to the work'. Companies are obliged to perform assessments of occupational risks (Article 6(1) and Article 6(3)), i.e., the risks to workers' safety and health from workplace hazards. Such assessments involve a systematic examination of all aspects of work, looking at what could cause injury or harm, whether the hazards can be eliminated and, if not, what preventive or protective measures are, or should be, in place to control the risks (European Commission, 1996).

Apart from this 'Framework' Directive, there are many individual occupational safety and health (OSH) directives setting out the principles and instruments of the Framework Directive with regard to specific occupational hazards (e.g. exposure to dangerous substances or physical agents), individual tasks (e.g. the manual handling of loads, working with visual display units) and higher-risk workplaces (e.g. temporary work sites, extractive industries, fishing vessels). It is thus quite common to establish specific regulations.

In this context, and still from a legal perspective, there are three possible ways of ensuring that algorithmic management does not harm workers: i) to consider that the Framework Directive offers sufficient regulation to counter the specific risk produced by AI; ii) to have the social partners sign a framework agreement on AI at work; iii) to draw up a specific OSH directive on the algorithmic management of work.

In my opinion, the third option is best – for the following reasons:

a. The specific risks analysed above are sufficiently serious to justify a specific regulation. Although companies will remain obliged to ensure the health of their workers – including those directed by an algorithm – under Article 5(1) of Directive 89/391/EEC without a specific directive, the adoption of such would guarantee the uniformity of the measures taken and that they are fit for purpose.
b. The new situations resulting from algorithms (and AI) and the lack of knowledge of their internal functioning can make the health risks go unnoticed, causing insufficient preventive measures to be taken. The adoption of a specific directive would improve the effectiveness

9 Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work

of workers' rights in the prevention of occupational risks. With only the Framework Directive, the specific risks of an algorithm managing work currently go unnoticed and unprotected most of the time (see Moore, 2018b).

c. The adoption of a specific directive would send a message regarding the importance of these specific risks. Conversely, if the European Union does not consider it necessary to adopt a new regulation, this could send the opposite message: algorithmic management does not produce labour risks worthy of specific prevention.
d. A specific directive would make it easier for unions to demand specific measures to prevent harm to workers managed by an algorithm. It would also make it easier for national labour inspectorates to enforce the law.
e. Should there be insufficient consensus between Member States to adopt a new directive, the social partners could instead sign a framework agreement on AI at work with a view to raising awareness and understanding of the work-related health problems of AI.[10] However, such an agreement is not directly enforceable by labour inspectorates or tribunals (soft law), unlike a directive directly transposed into national law (hard law).[11]

A specific directive/regulation is thus proposed, establishing the minimum requirements for protecting workers against the risks resulting from having AI/algorithms managing them. It should contemplate at least the following measures.

External control: assessment of specific risks

As Fernández Avilés (2017: 85) states, the psychosocial risk factors associated with new technologies are often considered 'invisible', but this does not mean that they cannot be assessed like any other occupational risk.

In the case of workers subject to the decisions and organisational power of an algorithm or artificial intelligence, a specific risk assessment should be imposed on the company and carried out by an expert in occupational risks. Given the novelty of this way of working, it seems necessary to create standardised technical procedures with sufficient scientific endorsement, which should be stated in the directive as the methodology to be used.

These procedures should be applied in companies to assess the risks. Dependent on the risks detected, preventive measures should then be established and included in a company's preventive planning (Fernández Avilés, 2017: 91). In doing so, account must be taken of the opinion of workers' representatives (as established by Article 6(3)(c) 89/391/EEC). Undoubtedly, training workers in these specific risks and conducting awareness-raising measures in the company will be the front-line activities in the fight against these risks (European Commission, 2018: 11). In turn, it should be compulsory to establish specific controls to detect the first symptoms (as established by Article 14 89/391/EEC).

In this regard, the directive must establish compulsory checks for workers managed by algorithms to monitor their physical and mental health. It must stipulate that, in the event of detecting

10 Like the framework agreement on work-related stress signed in 2004 by the European Trade Union Confederation, the Union of Industrial and Employers' Confederations of Europe, the European Association of Craft, Small and Medium-sized Enterprises as well as the European Centre of Enterprises with Public Participation and of Enterprises of General Economic Interest.

11 Indeed, the European Social Partners (2008: 28) report highlights some of the implementation problems facing the framework agreement on work-related stress signed in 2004.

any deterioration in their health, the use of the algorithm must be stopped until measures are taken to reduce the risks.

Internal control: 'smart decisions' or how to create non-harming algorithms

Algorithms are programmed to make decisions based on the data provided. This programming must take risk factors into account when making decisions that affect workers. The proposed directive should therefore include the provision that any algorithm that interacts with workers must be submitted to prior assessment (internal control), ensuring that the decisions made take workers' health and safety into account. This prior assessment would be the equivalent of checking whether supervisors or middle managers have sufficient knowledge of occupational risk prevention to perform their duties in the workplace and as part of their jobs.

Basically, the proposal is to adapt existing requirements to the world of AI. For example, Article 6 of Directive 89/391/EEC already establishes that 'Within the context of his responsibilities, the employer shall take the measures necessary for the safety and health protection of workers, including [...] provision of information and training, as well as provision of the necessary organisation and means'. This means that a supervisor has to have the proper information and training to reduce occupational risk. It thus seems necessary to establish the same for the algorithm. The algorithm that replaces that manager has to be programmed to take account of all possible occupational risks. The directive should include a provision in this sense.

The algorithm should be programmed to take account of the following factors:

a) Respect for privacy and the application of the precautionary principle

The new technologies allow an almost absolute invasion of workers' privacy. For instance, current technology makes it possible to 'read workers' minds', discerning whether they are happy, sad, active, relaxed, creative, and even determining their personality. The fact that technology allows this type of analysis does not however mean that it is consistent with workers' right to privacy. Hence, to protect the mental health of workers (and their rights to data protection and privacy), all automatically collected data about the worker must pass through the filter of proportionality established by the GDPR and the ECtHR.

In this sense it is noteworthy that the ECtHR, in its ruling of 5 September 2017 *Barbulescu vs. Romania*[12], states that a company cannot unlawfully interfere in the private life of its employees in the workplace. Indeed, the lawfulness of any measure restricting fundamental rights (even when there is a legitimate reason, as with the control and surveillance of work) is determined by strict observance of the principle of proportionality ('proportionality test') (Hendrickx, 2020). To pass the proportionality test, a measure restricting fundamental rights – e.g. the use of a wearable – must comply with the following three requirements: whether it is capable of achieving the intended objective (suitability test); whether it is necessary in the sense that there is no other less intense measure for achieving that purpose with equal effectiveness (necessity test); and, finally, whether the measure is balanced, i.e., whether it generates more benefits or advantages for the general interest than harm to other conflicting goods or values (proportionality test in the strict sense).[13]

12 Application no. 61496/2008.

13 In a similar vein but with a different result, the ECtHR ruling of 10 October 2019, Case López Ribalda II Application nos. 1874/13 and 8567/13 is interesting.

However, these provisions are established for data protection, not for health protection. Even though they can be of use in protecting workers' health, any new directive should set its own rules to combat the health hazards resulting from the invasion of privacy and discrimination. Therefore, while the proportionality test can be useful when only data protection is at risk, when health is at risk, the law has to be more restrictive. In this sense, instead of the 'proportionality test', a more conservative approach must be applied, in this case the 'precautionary principle'.

Unfortunately, technological risks are constantly underestimated. New technologies can cause harm without us knowing it. The historical approach has been to allow new technologies to interact with humans/workers unless there is sufficient information about the harm they cause. This could lead to years and years of harm before the causation is proven. First, the harm can appear at a much later date. Second, even when it becomes evident, it may be difficult to link the harm to that technology without the backing of scientific evidence.

This is why the precautionary principle has been developed in recent decades. The principle states that 'when an activity represents a threat to human health [. . .] precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically' (Pless, 2003: 1–2).[14]

Indeed, it can be said that managing people/workers by means of an algorithm/artificial intelligence is such a novel innovation that it is impossible to predict all the possible consequences for the health and safety of workers (in the same sense, see Whittaker, 2018: 81). The present study and the state-of-the-art literature probably only foresee some of them. Such innovations must therefore be introduced with caution and always with safeguards. That would help prevent privacy and discrimination risks but also possible malfunctions and other occupational risks (including future ones). That is why it is so important for the directive to expressly include the precaution principle, thereby allowing OSH agencies and labour inspectorates to ban the use of an algorithm/AI if harm is suspected, even though there is still insufficient proof linking it to the damage.

b) Adapting to workers' skills and reducing intensity

In the same way that an algorithm is able to explore and discover workers' maximum potential regardless of their health in the medium and long term, an algorithm (or ERP (enterprise resource planning) software) can be programmed to establish an optimal workload respecting OSH rights. 'Adaptive automation' is defined as the ability of a computer programme to adapt to the processing speed of each human being and which is capable of preventing work intensity and overload (Steijn et al., 2016). This means that computer experts have developed a methodology to make algorithms adaptive to the worker and not the other way around. For example, with this methodology, if the algorithm detects that a worker's heart rate is above a safe threshold, the workload will automatically diminish. The directive should impose the use of this 'adaptive automation' every time AI is used to manage workers.

14 The precautionary principle was first formulated at the UN Conference on Human Environment held in Stockholm in 1972. It was incorporated into the West German Environmental Policy (as the *Vorsorgeprinzip*) in the 1970s, applied internationally for the first time at the First International Conference on the Protection of the North Sea in 1984 and at the Vienna Convention on the Protection of the Ozone Layer in 1985, and has been included as one of the key guiding principles of the environmental policy of the European Union and its Member States in numerous legal texts of the highest rank, including the Maastricht Treaty (which was modified by the Treaty of Nice in 2001).

It should be borne in mind that, according to the European survey on health and safety at work (EU-OSHA, 2013: 52), reorganising work and reducing work pressure are considered the best ways of preventing psychosocial risks.

c) Margin for worker autonomy

Despite the economic benefits resulting from having an algorithm take all work-related decisions, for the sake of workers' mental health a minimum margin of worker discretion and autonomy needs to be maintained. The programming of the algorithm must include some degree of choice for the worker. In some cases, the algorithm could give the worker different organisational 'packages' to choose from, instead of issuing strict orders. For example, when an algorithm chooses the route to be followed by delivery workers, it must give them more than one option and sufficient information to make a final decision (km, gradient, kind of road, traffic and so on).

Giving workers at least some feeling of freedom and autonomy will benefit their health, while at the same time preventing them from losing decision-making and self-organisation skills and capabilities and allowing them to take account of their own tastes and preferences.

d) Transparency

One of the factors contributing greatly to workers' anxiety and frustration is not knowing which data are being collected, how they are processed and what criteria are used by the algorithm to reach the specific decision. Increased transparency will reduce workers' anxiety, while at the same time providing them with more information with which to assess whether the algorithm is working correctly. Indeed, the EU General Data Protection Regulation (GDPR) already establishes the obligation to inform the person concerned of the reasons that led to that decision being made when it has been automated (Ajunwa et al., 2017; Todolí-Signes, 2018). In other words, when making automated decisions, the company must indicate this fact and provide information about what parameters are used to reach this decision (and what weighting is assigned to each of them). This interpretation is in line with the requirement of Article 5 GDPR, which stipulates that all data processing must be legal, fair and transparent, and also with Article 13(2)f and 14(2)g GDPR which require that when the data subject is the object of automated decisions, including profiling, the data controller must give the data subject *meaningful information about the logic involved, as well as the significance and the envisaged consequences of such processing for the data subject*.

However, as the GDPR is not OSH legislation, to be effective, the specific directive should establish an obligation of transparency to prevent health risks. It should be remembered that national labour inspectorates have no competence to directly enforce the GDPR.

e) The algorithm must assess all factors posing a risk to workers' health and safety

In general, with a view to protecting workers and avoiding all kinds of health risks, the algorithm that handles the management of the workforce should be programmed in such a way that it collects and processes all available information on possible risks to workers. Again, just as supervisors must be aware of the risks involved in the work assigned to the workers under their charge, an algorithm must be programmed to take these risks into account. These specific risks should be those established by the mandatory assessment of occupational risks for each specific occupation or job.

By way of example, a study of the heat endured by bicycle couriers concludes that an algorithm should always take into consideration roads with more shade (UTS, 2019: 4). However, when an

algorithm sets the route to be followed by a courier it will probably not take shade into account, instead only selecting the fastest route. Thus, in addition to the aforementioned leeway for workers to choose the route with the least risk to their health (dehydration, heat stroke, etc.), the algorithm itself should take this into account, especially in cities prone to high temperatures and in jobs that require physical effort. Like this example there will be many more considerations needing to be taken into account in the configuration of the algorithm before it can be considered respectful of workers' health and safety.

It therefore seems necessary both to perform these risk assessments and to revise algorithms accordingly.

f) Worker representation

Due to the novelty and the high level of risks faced by workers under algorithmic management, any new directive should ensure a high level of worker representation and possibilities for intervention. Article 11 of the Framework Directive details two forms of workers' participation: i) Consultation of workers or their representatives; ii) Consultation of workers or their representatives with specific responsibility for the safety and health of workers.

In this sense, the proposed directive should specifically include the right to participate in the assessment of an algorithm. Workers can provide important clues about where the risks lie and how to prevent them. They might also have specific knowledge about what features of the algorithm cause harm – anxiety, frustration, stress, low morale, even dehumanisation. The workers' representative therefore has to be informed about how the algorithm functions and must be consulted about how to improve it with a view to reducing its inherent risks. Apart from that, the specific directive should establish the right of workers' representatives to propose OSH-related improvements to the algorithm.[15] In the same vein, workers' representatives should always have the right to ask for an OSH-related modification of/improvement to the algorithm which the company should then be obliged to implement or give a reasonable explanation as to why the proposed modification is rejected.

The human in command *principle*

The European Economic and Social Committee's expert report on artificial intelligence directed by Muller (2017) established the principle of 'human in command' (De Stefano, 2018), i.e., there should always be a human being making the final decisions. In the same vein, the ILO's expert report (ILO, 2019) on the future of work recommends 'adopting a "human-in-command" approach to artificial intelligence that ensures that the final decisions affecting work are taken by human beings'.

Indeed, the fact that the algorithms make it possible to optimise data processing should not lead to the abandonment of functions that typically correspond to humans. The majority of workers reject the idea of being managed by a machine, although they would probably be more likely to accept it if they knew that there was a human being in charge.

For example, in the case of Uber drivers whose incident and monitoring system is automated, they should have the right to contact a human supervisor when the software does not provide a satisfactory solution to their requests.

15 This right would be an adaptation of the generic 'right of proposal' from Article 11 Directive 1989/391/EEC.

Similarly, when workers are 'deactivated' or penalised, they should have the right to know the reason behind the disciplinary action and have the opportunity to justify the actions leading to the sanctions and explain them to a human supervisor. Denying workers the chance to have human contact or to receive feedback from a human superior seems to be behind most of the anxiety and frustration issues occurring in this type of algorithmic workforce management. At the same time, the existence of a responsible human being can also reduce the ethical problems involved in this way of working.

Finally, work dehumanisation must be avoided, starting with the right to human contact. Algorithmic management, if not handled carefully, can lead to workers being treated like commodities, devoid of the empathy and respect that every human being deserves.

In this regard, the proposed directive must include the right to human intervention in some predetermined scenarios. That would mean that the company could not legally delegate all responsibility and all communication with workers to an algorithm. The company could use an algorithm to optimise the productive process as a general rule but, in the event of a conflict with the workers or a problem, it should allow human intervention.

Conclusion

Companies are increasingly using more or less advanced mechanisms of artificial intelligence to manage work: to establish work shifts and production times, in the design and allocation of tasks for workers, and in hiring, appraising performance and dismissing. Companies rely on technology to gather all the information available, process it and make the management decisions (productivity optimisation) benefiting them most. Human supervisors, middle managers and HR experts are being supplanted by automated processes run by algorithms – or in its most advanced stage by artificial intelligence.

This work examines the possible health hazards caused by such new forms of technological management. Constant monitoring by sensors, work intensification resulting from decisions taken by software without empathy or knowledge of the limits of human beings, reduced worker autonomy due to decisions being made by artificial intelligence, discrimination despite the mantle of algorithmic neutrality of those decisions, as well as possible operating errors can all end up causing severe physical and psychological health problems for workers.

This study upholds the need for a specific regulation to protect the health and safety of workers managed by an algorithm or AI. Many of the risks mentioned above can be reduced or prevented if they are taken into account when programming an algorithm. Previously targeting human interactions, legislation is now needed to control these automated features. Any such new regulation should stipulate that an algorithm's programming takes these occupational and health risks into consideration – *inter alia* privacy rights. In the same way as supervisors have to be trained in risk prevention to be able to perform their work, the algorithm must also be programmed to weigh up the occupational risks – and when such features do not exist, steps must be taken to prevent the algorithm being used to direct workers.

In specific terms, the algorithm must be transparent, adapted to the real capabilities of workers, leaving them a certain margin of autonomy and respecting their privacy. It is also recommended that the precautionary principle should be adopted in the use of AI to manage workers. As we cannot foresee all possible risks involved, it is better to be safe than sorry when introducing such innovative technology. In short, the algorithm must assess all (known) factors posing a risk to workers' health and safety. It therefore seems necessary to incorporate a mandatory risk

assessment – through a specific directive – performed by specialists in the programming of algorithms so that all ascertained risks can be taken into account.

At the same time, it also seems necessary – as established by the European Economic and Social Committee and the ILO – for artificial intelligence to always be under human control, allowing workers at the very least to justify their actions or express their concerns to a human supervisor.

Although there may be other ways of guaranteeing the safety of workers (self-regulation, the OSH Framework Directive, the Machinery Directive), this article argues for the adoption of a specific directive on the safety of algorithms. Its adoption would send a message on the importance of their specific risks. Conversely, if the European Union does not consider it necessary to adopt a new regulation, this could send the opposite message: algorithmic management does not produce labour risks worthy of specific caution. Furthermore, its adoption would guarantee uniformity among the measures taken by companies, as well as ensuring that they are fit for purpose.

In general, the objective of the proposed directive is to reduce the occupational risks suffered by workers subject to AI. At the end of the day, the need for this norm is justified by the fact that, as a society, we should not allow people to become mere commodities (human 'resources') handled in a dehumanising way by an omnipresent and omnipotent machine/software, and even less so without the necessary controls to prevent harm.

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