RISKS AND OPPORTUNITIES OF AI-BASED WORKER MANAGEMENT SYSTEMS IN AN AUTOMOTIVE MANUFACTURING PLANT IN BELGIUM

1 Introduction

This report presents a case study on the implementation and use of worker management systems using artificial intelligence/algorithms (AIWM) and the implications for workers' occupational safety and health (OSH) in a company operating in the automotive sector in Belgium. The aim of this report is to produce evidence on the risks, challenges and opportunities of digitalisation of the workplace, and to highlight examples and practices of the design and implementation of digital technologies in a healthy and safe way.

As the case study shows, the introduction of AIWM in the automotive sector is a progressive and logical step considering the evolution of manufacturing. Importantly, AIWM is not just one digital tool but rather a process involving a plethora of digital tools and applications that all together process large amounts of data. In order to get a thorough understanding on the implications of AIWM systems on OSH, the case study focuses on those workers who are most exposed to AIWM in the company under study: operators and team-leaders working in production and logistics on or near the last stages of the assembly line, where all parts are assembled to the freshly painted car bodies. In the company, this is the production stage (or part of the plant) with the highest use of AIWM systems, in comparison to other parts of the plant, and so the impact on OSH is expected to be highest there. Moreover, in this part of the plant, more than half of the total number of workers of the company are employed.

2 Methodology

Methodologically, this research builds on a combination of desk research and field work, which included 10 study visits at the company's premises, 17 semi-structured interviews and numerous informal talks with different actors: operators, team-leaders, (middle) management, people responsible for production, logistics, IT staff, occupational safety and health representatives and trade union representatives. Company visits often included observation, while interviews usually included demonstrations, for instance of the use of (digital) tools.

3 Business model and work organisation

Brief presentation of the company

The company under study is a car manufacturer located in Belgium. The company is part of an international group employing 45,000 workers in multiple plants in different locations in Asia, Europe and the United States. In Belgium, the company employs some 7,000 workers, about 10% of which are temporary agency workers. Each week about twenty workers leave the company due to retirement, voluntary leave, non-renewal of the employment contract or layoffs. The company's Belgian branch in essence comprises of several shops where the bodies of the cars are first welded together, painted, and where finally all remaining parts are added to the car body. At the time of study, the company had a production rate of well over 200,000 cars per year, or on average over 1,000 cars are produced per day or approximately one car every 60 seconds. Both the rate of production, needed to keep the company competitive in a global market, and the focus on quality demand efficient and highly streamlined production processes, which also involve the use of AI-based worker management (AIWM) systems to optimise and coordinate human input into the production processes. As a result, during the two preceding decades, production increased by almost a third.

The adoption of a lean organisation model and advanced technologies

Manufacturing at the company studied is streamlined using an **assembly line** that consists of consecutive workstations performing different tasks and processes. The higher the rate at which products are moved along the line, the more important the throughput of each individual workstation and the timing of the different tasks, considering that the line is set to produce one car approximately every 60 seconds. That is, even minor setbacks or an excessive allocation of time to the performance of tasks can lead to significant drops in productivity and large losses in revenue.

Smooth throughput thus requires the **synchronisation** of **all** tasks performed by both workers and automated production processes on **all** workstations. At the company studied, a digital system is used for both the design of a car and the processes needed for its manufacturing, resulting in a digital description of the different workstations making up the assembly line and of the essential task(s) that must be performed at each workstation. These digital descriptions, called **Process & Inspection Instructions** (**PIIs**), are subsequently transferred to another digital system that is used for the so-called assembly line balancing (**ALB**). In the company studied, ALB is the process of the actual implementation of the digitally designed process(es), which consists of testing, and adapting if needed, **the sequence of all actions** or operations needed **to perform the task(s)** allocated to a particular workstation as described in the PII. For instance, tasks performed by workers (operators) consist of different movements and actions (taking a step, picking up a part, or moving an arm), which must be performed in the sequence determined during ALB. Hereby, every action is automatically assigned a Time Measurement Unit or **TMU** (1 TMU = 36 milliseconds), whereby the total sum of all TMUs in function of the assembly line's throughput will result in a score representing the total workload for one operator working on that workstation or work post. PIIs can also indicate a need for ergonomic aids and what PPE is mandatory (or in some cases forbidden). However, this option is not automated, and reportedly it is not always used. The company's ALB digital system allows for the setting of workstations' workload at exactly (or higher or lower than) 100% of its capacity and will automatically raise a flag when the workload on a post is reaching or exceeding critical levels (measured in terms of TMUs). In the final stages of the ALB of a workstation, the station's team-leader and the prevention advisor are involved, who can decide to ask (external) ergonomists for advice about the ergonomic implications of the workload (e.g., on the need for ergonomic aids).

In addition to the workstations along the assembly line, and supporting them transversally, the on-site logistics function in the company and the related workforce is dispersed throughout the plant, in line with **just-in-time** principles of lean manufacturing.

Workers' functional flexibility, skills and training

New operators joining the company are mostly hired as temporary agency workers. All new workers first participate in a training programme where they are taught the basics of OSH and OSH risks prevention, company-specific OSH regulations, as well as the basics of assembly line work, lean principles, and the basics of the use of (digital) tools and of AIWM (e.g. Andon), the company's principles and company culture. New operators are trained for two workstations or posts, which allows them to rotate workstations or posts as well as fill in for colleagues who are absent. Subsequently, operators will be trained on the job to allow them to work at more work posts. Operators are trained for up to four posts, as allowing operators to work on too many different workstations or posts is considered counterproductive as they would not be able to perform at peak efficiency at all workstations or posts.

4 AIWM and its implications for the workforce

In the company under study, production is completely data driven and controlled by digital tools continuously collecting, storing and processing a tremendous amount of data related to production and also to worker performance. These data are used to control and steer the assembly line and on-site logistics, quality control, and in many cases, the allocation of tasks to workers. On the assembly line, digital data from different sources are combined and used to assure the timely arrival of parts and overall workstations' timely and required quality throughput. Below, we briefly discuss the main AIWM processes affecting operators and team-leaders and how said processes do so.

Adoption of AIWM

In the company studied, all workers badge in and out when entering and leaving the company premises. Operators, however, also log in and out when entering or leaving a workstation or post via a **Personal Digital Assistant** (**PDA**) dedicated to each workstation. When logging in or out of the workstation, operators scan the code of the car they will start working on or have last worked on. This allows **tracking** which operator worked on which cars and when, as the location of the cars on the assembly line is known and logged using **RFID**-tags and **RFID**-readers. When an operator uses connected tools or generates data by other means (e.g., through scanners) while working, performance of tasks is monitored to the (milli)second.

Operators working in production mainly add parts (upholstery, electric cables, bumpers, wheels, lights and so on, depending on the workstation) to the car bodies in a **predetermined sequence**, as described in the PIIs. Such sequence of selecting the right parts and, where needed, using the right tools at the right moment to assemble them is guided by the AIWM system that allocates tasks to the production operators as described below. In what is called 'a 60 second world', operators typically have **only a few seconds** to perform each task. Operators working in logistics, performing the tasks allocated to them by the AIWM system as explained below in further detail, typically move parts to the line driving small electric tractors pulling carts. In addition to that, under the guidance of the AIWM system, at certain work posts logistics operators merely load the carts or transfer parts from the packaging they arrived in into other boxes or carts, while at other workstations, logistics operators combine preparing carts and driving them to the designated workstation on or near the assembly line.

Team-leaders are responsible for the **timeliness and quality of the production and throughput at their workstation** and thus for the functioning of their team. Team-leaders, both in production and in logistics, are operators that have been promoted to this role. Team-leaders play an important role in the ALB process of their workstation and in the daily assessment of OSH-related matters. Finally, team-leaders are responsible for the swift resolution of all issues affecting production and teamwork as such.

The allocation of tasks to workers by the **AIWM** system **can be considered 'implicit' or 'explicit'**.

'Implicit' allocation of tasks by the **AIWM** system regards mostly production operators and happens, for instance, when a certain car model arrives at the workstation and the worker – having received training as described above – is expected to know which tasks need to be performed on said model. In any case, as already mentioned above, the tasks are described in the **PIIs**, while the timing and sequence of tasks to be executed on the line to build a car is decided **algorithmically** even before production starts.

'Explicit' allocation of tasks by the **AIWM** system consists of tasks allocated directly to the production operator concerned by either **audio** signals (for instance 'pick-to-voice' where the AIWM system issues voice commands via a headset) or **light** signals (for instance 'pick-to-light' which indicates when to pick up, assemble or use which parts or tools), in which case task performance can be acknowledged (and monitored) by the operator using his voice (voice recognition software), barcode scanners or light sensors. Explicit allocation of tasks can also take place through **screens**, for instance on PDAs for some logistics or maintenance operators or for some machine operators assisting or supervising industrial robots or other automated processes. As is discussed below, many operators working in production state such explicit forms of task allocation, e.g. by voice or light, are helpful in the performance of their job and help them to avoid making mistakes by indicating the sequence in which parts or tools need to be picked and used within the limited time tasks need to be performed.

Quality is monitored digitally, via sensor-equipped tools (e.g., nutrunners, i.e. connected wrenches, will report time, torque, number of revolutions and inclination) and via error proofing (e.g., of electric and electronic systems) at designated workstations, or by operators performing quality checks and reporting issues via the digital quality control system. Quality and other production issues (e.g., lack of parts at workstations) are **monitored, logged, controlled and signalled** via both dedicated quality management **digital tools** and an **Andon**-system (a system to alert operators about an issue on a production line), which are part of the wider AIWM system. **Andon alerts** or **calls** can be triggered either manually by an operator (e.g., by pulling the Andon cord, pushing an Andon button, or issuing an Andon call via the workstation's PDA), or automatically by sensor equipped tools (e.g., a nutrunner) or by the AIWM system. An example of the latter case is where the **AIWM** system keeps track of the logistics flow and will issue an Andon call (e.g., if a logistics task was not performed in time). Andon

calls can be signalled via Andon **lights**, a **sound** (typically a fragment of a piece of music, usually a pop song) and **automatically generated messages** that are sent via **SMS** and/or via **email** to the team-leader and the supervisors concerned, the level of escalation being determined algorithmically by the AIWM system.

Team-leaders must address and resolve any issue flagged by an Andon call as soon as possible. If an issue is not resolved within a designated time, or in case a number of Andon calls are generated within a certain period of time, the team-leaders' supervisor is **automatically** notified. Subsequently, if the issues are not resolved, the superiors of the supervisor are notified. The last in line to be notified is the CEO (six to seven **degrees of escalation**, depending on the type and number of issues). These notifications are automatically generated based on a **predetermined set of factors and rules**.

Digital screens are also part of the AIWM system, providing information allowing mainly team-leaders and their superiors both a quick but comprehensive overview of the status of their workstation(s) and the rest of the assembly line (such as **targets** set and reached, **level of supplies**, the **number and type of issues**). Andon calls are thus actually tasks allocated to operators and/or their superiors.

5 Psychosocial and organisational factors at play in the use of AIWM

The pervasive level of digitalisation, and use of data and digital technologies within the company, does not only impact productivity and efficiency, but also affects job quality, including occupational safety and health, on different levels. Below, we briefly discuss the impact of AIWM on worker's autonomy, on work intensification and skill use, and the use of data for monitoring purposes.

Workers' autonomy

Given the high rate of production and the heavily streamlined processes at the company, operators working at the assembly line have **little to no autonomy**. As described above, during ALB, tasks that need to be performed are broken down into each separate movement and action needed and are timed to the (milli)second. Furthermore, the **sequence** in which movements and actions must be performed by the worker is **stringently described** and most often monitored by the AIWM system. There is little to **no room for deviations or improvisation**. As a result, work performed at workstations or posts on the assembly line by production and logistics operators in the company studied is **highly repetitive**. Some operators working in **logistics** do have **a little more autonomy**. For instance, although tasks are allocated to tractor drivers by the AIWM system, these tasks are not part of a predetermined and binding sequence, allowing for some degree of autonomy in deciding which tasks to perform first. Nevertheless, it is understood that all tasks must be completed within the **limited timeframe** set by the system automatically, and that **tasks marked as urgent do not allow for any autonomy**. Team-leaders have a more diverse set of responsibilities, allowing for more autonomy in the performance of their job, although as discussed below, much depends on the specifics of their workstation.

Work intensification and impact on skills

The use of **digital technologies and AIWM** in general lead to **work intensification and higher workloads**, for example the more direct, often **instant and direct allocation of tasks**, to be executed in the assigned timeframe and under guidance of the AIWM system, which determines the sustained pace of work. For operators, the intensification of work and the use of digital technologies and **AIWM seems to be accompanied by an upskilling effect on general skills** such as, among others, being able to work on an assembly line faster and being able to perform continuously under high pressure while maintaining a high level of efficiency and quality. For team-leaders and their superiors, this is different as they are encouraged and expected to use the digital tools and applications available to them. This allows them to **develop skills** that in many cases are transferable to other professional roles, functions and activities, both within and outside the company.

Workers' training, skills and performance are monitored regularly by team-leaders, but are also **monitored by the AIWM system**. For instance, if an operator logs in to a workstation or post after not having worked there for very long, the system will raise a flag. The system also raises flags if operators are reaching the limit of time they were not assigned to a post, allowing team-leaders or supervisors to assign them to that post within a set time so as to maintain their level of training.

Data availability, control, and surveillance

Data on all workstations' and on workers' performance and throughput are processed continuously, resulting in **vast amounts of historical data** stored in data clouds and data lakes. The data processed are primarily used to control and monitor the company's production and quality related processes. However, the level of data processing allows for the **monitoring of workers at all levels** of the company's organisation up to the millisecond. On the upside, such monitoring – per managerial decision – is at present mostly used to monitor workers' performance in order to identify and resolve quality related issues. Surprisingly, none of the operators interviewed seem to mind the pervasive collecting and processing of data: on the contrary, they apparently welcome the gathering and use of data as an **objective standard of evaluation** of their work, a guide to help them in the performance of their job.

6 The implications of AIWM for OSH

Brief overview of OSH risks

As in all companies manufacturing cars, workers in the company are confronted with various health and safety risks. However, for this case study report, we will only look at the implications of AIWM systems on the health and safety risks that operators and team-leaders are faced with, which we briefly discuss in the next sections.

AIWM and ergonomic risks

Due to the **high workload and speed**, and the **repetitiveness of movements** involved, which are the result of the use of an assembly line and AIWM, most operators working at the company are **rotated** between different workstations and posts **to avoid physical, but also mental strain**. The frequency of rotation depends on the workstation and is decided by the team-leader in concurrence with the team members, the team-leader's superiors and the OSH prevention advisor, as part of the ALB of said workstation.

The use of digital tools for ALB not only allows to set workstations' workload at exactly 100% of their maximum capacity, but also allows their workload to be set above or below the maximum capacity. A workstations' workload setting of more than 100% will obviously have more impact on workers (e.g., increase of ergonomic risks) and will give rise to more frequent rotation.

In addition, as the ALB relies on some of the **principles of scientific management** (i.e. Methods-Time Measurement) and thus on the use of statistics, it makes reference to a (non-existing) '**virtual average operator**' when calculating the workloads. The result is that being a statistical artifact, this 'virtual average operator' thus does not apply correctly to all operators equally, meaning that a certain workload will be harder to handle for a number of operators and easier for others, which is not taken into account by the system. The impact thereof is not monitored, or at least not systematically at the company studied.

Furthermore, the setting of the workload on the assembly line in general and on specific workstations is a **managerial decision** in which variables on production and efficiency are weighed against OSH risks, where safety is more easily measured than long-term health concerns.

Apart from the ergonomic risks described above that almost all operators face, there are those which are specific to specific workstations: 'pick-to-voice' logistics operators, for instance, can experience **physical unease** due to the prolonged wearing of the headset and due to the continuous use of handheld or finger-attached scanners.

Cognitive stress

In many ways, **team-leaders** are company workers who are **most impacted** by the use of AIWM and digital technologies, with their workload and levels of stress depending on the nature of the tasks performed at their workstation and on the performance of their team. On the **upside**, AIWM allows team-leaders to have **more oversight** of their workstation and their team's performance, which **can support stress management**. The Andon system, for instance, provides team-leaders with **(quasi) real-time status updates** resulting in **time efficiencies**, allowing those responsible for 'calmer' workstations to have **more control** and, to some extent, **more autonomy**.

However, some team-leaders face a high number and even an overload of tasks, most of which are critical and extremely time-sensitive and assigned by AIWM, especially in situations resulting in an **escalation of Andon-calls** (e.g., when multiple issues arise simultaneously, or when a faulty sensor or tool continuously generates Andon calls), which can lead to high levels of stress.

'Pick-to-voice' logistics operators can experience **frustration and stress** in cases where the AIWM system does not acknowledge the operator's voice inputs (e.g., due to ambient noise or the need for recalibration of the voice recognition system), resulting in the operator not being able to finish the task and losing precious time. On the positive side, most operators report that the quality monitoring mechanisms **helps** them in the performance of their job and the assessment thereof.

Furthermore, logistics operators using 'pick-to-voice' and 'pick-to-light' systems claim such systems help them to **avoid making mistakes.** Nevertheless, some team-leaders and other superiors indicate that operators relying too much on such systems experience a **lack of attention and alienation**, which may result in mistakes or even accidents. One way the company aims to tackle this issue, is through workstation and post rotation of operators.

Social relations and work-life balance

Outside team meetings or other meetings, the vast majority of operators at the company under study have **little to no time for social interaction** during work hours. One of the only exceptions being logistics operators (e.g., tractor drivers) who move through the plant and thus have some possibilities to (briefly) talk to colleagues. Depending on the workstation, team-leaders have somewhat more opportunities to interact with colleagues, aside from weekly briefings with their colleagues and superiors. Furthermore, where there used to be two 10-minute and one 25-minute breaks in every shift, this was recently changed to three 10-minute breaks, leaving even less room for resting time and interaction among colleagues. Said change was unrelated to the use of AIWM and decided via an online referendum among workers, with some workers contesting the results thereof.

The majority of operators interviewed did not report experiencing work-related stress symptoms outside the workplace, although a pick-to-voice logistics operator did report **hearing the AIWM's voice after working hours** and having **trouble sleeping when first starting the job**, while a team-leader reported **taking home work-related stress and frustrations** caused by, among others, the AIWM system to the point of having trouble sleeping when being at their previous workstation. The operator subsequently stated the situation at their previous workstation had not changed and felt sorry for the person who had replaced them, knowing all too well what said person was experiencing every day.

7 Social dialogue

Industrial relations

Relationships between workers, trade unions and management seem to be good at the company studied, and trade union representatives reported being fully allowed to play their role. As mentioned before, interviewed workers both in production and logistics do not seem to mind the level of digitalisation and monitoring in the workplace. However, it is worth mentioning that this could be the result of a 'selection bias', with workers who do feel affected by the extensive use of digital technologies not being available for an interview (for instance because they are on sick leave or left the company). Trade unions at the company – which are informed and systematically consulted by the management before the introduction of digital technologies and tools – seem to have accepted the extensive and pervasive digitalisation of the workplace as a necessity in a highly competitive global market, and in some cases, even as a more objective means of evaluation of workers' performance. However, it is worth noticing that the use of data is not equally accepted at all plants of the group that the company is part of, as reported in the interviews.

Participatory practices

Investment in on-the-job-training, shortages in the Belgian labour market and the company's culture and traditions are some of the main reasons that the company's human resources (HR) policy is to retain workers as much as possible and not to use gathered data as a 'stick' but rather as an occasion to address and resolve issues. Furthermore, HR launched a campaign to improve workers' involvement and commitment at work. One part of this ongoing campaign is to have operators from time to time take over team-leaders' responsibilities (for instance quality control).

Relations with institutional stakeholders

Of relevance to OSH is the use of an 'external service for prevention and protection at work'. As established by Article 40 of Act of 4 on August 1996 on the wellbeing of workers in the performance of their work in Belgium, an external service for prevention and protection at work always consists of a risk management and a health supervision section. The first dealing with occupational safety, occupational medicine, ergonomics, industrial hygiene and psychosocial aspects of work. The health supervision section, on the other hand, is managed by an occupational physician and includes the nursing and administrative staff necessary to carry out health supervision. This service is an independent third party who, in the company under study, is consulted and provides advice on OSH-related issues and, among other tasks, deals with workers who are on long time sick leave. However, due to the legislation on data-protection and professional secrecy of health-care providers, data on the reasons for reportedly high number of long-term absenteeism cannot be shared with the company.

8 Key takeaways

The introduction of **AI-based worker management** (AIWM) systems in the studied company represents a significant advancement in manufacturing, building upon concepts like assembly lines, scientific management, lean manufacturing and automation. AIWM promises increased productivity, but also brings forth challenges and risks particularly concerning OSH. At the studied company, the **pervasive adoption of digitalisation and AIWM** has been largely accepted with minimal resistance, possibly due to a superficial understanding of the extent of the data collected and the ways in which it could be (mis)used among workers and their representatives, and in spite of the information and consultation strategies put in place by the management. Another factor at play could be the extensive use of **temporary agency workers** and the fact that procedures for such workers (including mechanism of representation, consultation and participation) differ from those that apply to workers directly employed by the company.

While AIWM is primarily used to achieve better monitoring and optimisation of production and quality processes, its **extensive data processing capabilities** also enable detailed monitoring of workers. This monitoring is crucial for performance evaluation but raises concerns about worker privacy and the potential for **increased workload and stress**. Despite the company's emphasis on OSH, the negative impacts of AIWM on workers' wellbeing and its potential for preventing or mitigating OSH risks (e.g., reducing stress and enhancing control) seems not to have been sufficiently addressed by the company. The company's management **prioritises productivity but acknowledges that the demands of the job are not suitable for everyone**, physically or mentally. This selective acceptance may create a bias where dissenting voices either leave voluntarily or are unable to join in the first place, potentially skewing perceptions of AIWM's impact.

Moving forward, there is a **need for further research into the implications of AIWM on OSH** and worker wellbeing, as well as **consideration of more integrated data processing systems that balance productivity gains with ethical and OSH concerns**. Additionally, initiatives aimed at **improving worker involvement and commitment** such as the HR campaign described above highlight attempts to mitigate risks stemming from extensive digitalisation and AIWM, although these efforts require further refining, adapting and extending such initiatives to address issues effectively.

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