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COMPUTER IN COMMAND: CONSEQUENCES OF ALGORITHMIC MANAGEMENT FOR WORKERS

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EXECUTIVE SUMMARY

This study explores the consequences of 'algorithmic management' (AM) for employees. AM involves the use of computers or algorithms to carry out tasks and functions traditionally performed by human managers.

AM has become widespread across the labour market, yet our knowledge about its implications for employees is very limited. Concerns have been raised that AM could lead to a series of negative consequences for job quality and employee well-being. However, empirical research on AM has almost exclusively been case studies, which are not suitable for discovering consequences systematically.

As the first large-scale quantitative analysis of its kind, the objective of this policy study is to explore the consequences of AM. The study is based on a large survey among union members in selected sectors across four Nordic countries: Denmark, Sweden, Norway and Finland. The Nordic countries are known for their strong worker rights and emphasis on healthy work environments. Therefore, they are a good place to test whether AM has negative consequences for the work environment and employee well-being. If AM poses challenges here, it is likely to have similar or even more pronounced negative effects in other countries.

Because the ambition is to discover the consequences of AM, the study focuses primarily on sectors where AM was expected to be relatively widespread: warehouse work and customer service/telemarketing. As expected, the study shows that various forms of AM are prevalent in these sectors. A large proportion of respondents in the survey said that a computer program or another digital system is used to perform different management tasks and functions:

- **Task allocation**: 34% believe or are certain that a computer program or another digital system is used to decide the allocation of tasks at their workplace.
- **Shift scheduling**: 28% believe or are certain that a computer program or another digital system is used to decide shift schedules.
- **Tracking working time**: 40% say they believe or are certain that a computer automatically tracks their working hours and breaks.
- **Location tracking**: 27% say that their location is monitored by a computer at their workplace.
- **Monitoring of computer activity**: 42% say that they think or are sure that their computer activity is monitored.
- **Work speed monitoring**: 42% believe or know that a computer monitors how fast they work.
- **Work performance evaluation**: 40% say that a computer is used to evaluate the quality of their performance.
- **Leaderboard displaying performance**: 15% say there is a leaderboard or screen at their work that compares their work performance with their colleagues.

A large majority of respondents (76%) believe or are sure that at least one of these forms of AM is used in their workplace. Many experience the use of multiple forms of AM.

The study shows that on average, the use of AM has several adverse consequences for employees. The use of AM is strongly associated with a series of negative outcomes:

- **Decreased job autonomy**: the more AM is used in a workplace, the less autonomy employees experience in their work. AM appears to limit employees' freedom to make decisions and use their judgement, skills and abilities in the job.
- **Increased workload**: the more AM employees experience, the greater the workload and work pace. AM seems to lead to an intensification of work.
- **Increased job insecurity**: employees exposed to AM feel a higher degree of uncertainty about losing their job.

- **Lower level of trust**: the use of AM can undermine trust between employees and their leaders. The more employees are exposed to AM, the less they trust their managers and the less they feel managers trust them.

- **Decreased job satisfaction and motivation**: more AM is associated with less job motivation and job satisfaction.

- **Higher level of stress**: the more AM employees are exposed to, the more stressed they feel. AM seems to increase the work pressure on employees and affect their mental well-being.

The study clearly indicates that the way AM is used and implemented today has a range of adverse consequences for workers. Fortunately, the study also shows that the negative consequences are not completely inevitable.

The level of employee influence in the workplace and the level of transparency can significantly alter the effects that AM has for workers exposed to it.

The analysis shows that in workplaces where employees have a significant influence on company decisions and are involved and consulted when new computer systems are implemented, AM does not have negative effects on the degree of autonomy, trust and job satisfaction and motivation.

Similarly, these negative effects of AM can be mitigated if there is a high degree of transparency, where management decisions are explained and communicated clearly to employees.

However, it seems that the negative consequences of AM for workers cannot be avoided completely. AM appears to increase the workload, stress level and job insecurity regardless of the degree of employee influence and transparency, signalling clear occupational health and safety concerns.

The study shows that the introduction of new technology in the labour market comes with a significant risk for employees. Therefore, it is crucial to learn more about how these negative consequences can be prevented. In the areas examined in this study, AM seems to have some severe consequences in the way it is used today. However, the study also suggests several ways in which we can avoid some of these consequences and ensure that AM and the digitalisation of work does not compromise the quality of jobs and workers' well-being. The positive effects of transparency and employee influence point to the role that trade unions and workers' representatives have to play in collective bargaining on the successful introduction and application of AM in the workplace.

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Many aspects of algorithmic management already fall under existing legislation, such as the General Data Protection Regulation (GDPR) and the transparency of automatic decision-making systems. The reality on the shopfloor, as can also be seen from the results of our study, is that these data rights are not always respected and the rules are not enforced.

Many existing workers' rights should be applied to a new and digitalised reality, as is partly done in the different collective agreements in the Nordic countries. The findings of this survey point to the fact that transparency and co-determination of workers can balance out potential detrimental effects of algorithmic management on autonomy, trust and job motivation. However, to ensure these factors are in place in workplaces around Europe, additional and

more explicit rules may be needed. Also, it is becoming clear that transparency and worker influence cannot prevent increases in workload, stress and job insecurity, and the resulting occupational health and safety issues.

The EU's recent Artificial Intelligence Act (AI Act) identifies the employment situation as a high-risk use case that requires several precautionary measures. At the same time, the new Platform Work Directive, which contains a whole chapter on algorithmic management with very specific rules, could serve as a precedent for legislation aimed at traditional sectors. The European Commission has launched an investigation into the merit of such a specific piece of European legislation on AI in the workplace. The new rules will have to align and interact with the national labour laws of the Member States, should not impede the collective bargaining already taking place on these matters, and seek to reinforce workers' existing rights.

In the Nordic countries, this will largely depend on collective agreements which could benefit from a clear European framework for algorithmic management to support the co-determination process. These rules should help ensure that workers' rights across the EU are respected when implementing and applying AM systems. The findings of this study underscore the importance of co-determination and make the case for applying the Nordic model to ensure we do not backtrack on the protection of workers in this digital AI revolution.

1. INTRODUCTION

1. INTRODUCTION

For decades, the evolution of technology has shaped the way we work. The use of new technology in the workplace has consistently been a subject of debate and controversy.

Concerns have always existed about how robots may potentially replace humans in the workplace and make human workers redundant. However, recent advancements in sophisticated algorithmic systems have shifted the focus. Instead of replacing human workers, these technologies are increasingly taking over management tasks that traditionally have been the responsibility of human managers. Rather than being replaced, more and more workers find themselves directed and managed by these new algorithmic systems.

The term 'algorithmic management' describes how various managerial functions that have traditionally been undertaken by humans are now carried out fully or partially by computer systems.

Algorithmic management is increasingly reshaping our work across many sectors of the economy and in novel ways. Initially emerging within the platform economy, it is now used across diverse sectors to decide recruitment, task allocation and work schedules, to monitor and direct the work process, and to evaluate workers' performance, among other things.

Algorithmic management is implemented to increase productivity and ensure more efficient managerial decisions. Yet this shift is not without risks and potential adverse consequences for employees.

This study seeks to shed light on the potential adverse consequences of algorithmic management and to explore ways to prevent them, not the potential positive effects on efficiency and productivity. The focus is on the Nordic countries – Denmark, Sweden, Norway and Finland – known for their strong worker rights, high degree of unionisation and collective bargaining, and emphasis on healthy work environments. This setting serves as a critical case: if algorithmic management poses challenges in these contexts, it is likely to have similar or even more pronounced negative effects in less regulated labour markets.

To date, most knowledge about the impacts of algorithmic management comes from case studies, predominantly in platform-based companies. This study is based on a large survey among workers, and is one of the first extensive quantitative studies that systematically examines the implications of algorithmic management from a worker's perspective. Conducted across selected sectors in the Nordic countries, the study aims to fill a significant gap in our understanding of algorithmic management and its consequences.

This study does not set out to map how common algorithmic management is in all sectors of the economy. The focus is on consequences, and for that reason the study concentrates on sectors in which algorithmic management is fairly widespread.

The report consists of three parts:

The first part describes the relevance and design of the study. First, it outlines the political backdrop for algorithmic management in the EU (section 2). The third section provides a review of previous literature on algorithmic management and outlines the basic analytical framework for this study. Section 4 describes the research design.

The second part of the report describes the study's findings. Section 5 presents the descriptive results, showing the prevalence of different forms of algorithmic management. Section 6 describes the consequences of algorithmic management for employees, and the seventh section describes how these consequences may vary under different conditions.

The third part of the report includes a conclusion and discussion of the results (section 8) and a discussion of the policy implications (section 9).

PART I – ABOUT THE STUDY

2. POLICY BACKGROUND

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From a European policy perspective, this research comes at an exciting time. On the one hand, two relevant pieces of legislation were recently adopted: the European AI Act and the Platform Work Directive. The latter piece of legislation contains a whole chapter on algorithmic management, providing very detailed rules we will talk about when discussing the implications of the findings below for policymaking. These rules, which are aimed at protecting platform workers confronted with algorithmic management in its purest form, set a precedent for how European legislators could deal with algorithmic management in traditional sectors.

With the AI Act, the European Union is the first regulatory power to adopt a general legislative framework for applying Artificial Intelligence. On the basis of use cases, AI products are subjected to a risk-based approach. Some use cases have been deemed unacceptable and banned in the EU. Where the work environment application is identified as a high-risk use case, it will come under strict scrutiny under the AI Act.

At the same time, the European Commission has indicated that the workplace will require specific rules to deal with the impacts of AI and algorithmic management. After the AI Act, there is no plan to introduce sector-specific AI legislation. However, the workplace is not a sector but an essential place in the lives of all Europeans. At the same time, workplace and employment relations are highly regulated areas where many aspects fall under the competence of the Member States, and there is considerable divergence in the approach taken within the EU. In addition, it is not only for the legislators but also for the social partners to play their role through collective bargaining when embedding algorithmic management into the work environment while respecting workers' rights. This is something we should not undermine, but rather reinforce with the potential new rules.

It is no accident that the workers' survey of this study took place in four Nordic countries. The Nordic model, with its emphasis on collective bargaining, co-determination and a high level of trust between employers and workers and their representatives, makes it possible to develop a worker-centric application of AI together with the trade unions. Also, because in the Nordic model the high wages and generous social security system need to be financed through high efficiency gains that are shared between workers, employers (and the state), it means that there is a positive outlook towards technological advancements like AI. You can expect the sectors in these Nordic countries to be at the forefront of the digital transformation that is taking place in our workplaces.

As we will show in the findings, even in the well-regulated labour markets of northern Europe, additional policy action is needed to deal with the rapid changes that AI and algorithmic management are ushering in. The employment relationship is one of unequal power between workers and employers, and algorithmic management threatens to exacerbate this imbalance. It's up to the trade unions to organise a countervailing power for their workers and for the regulator to set rules that protect workers' fundamental rights, considering the algorithms that are coming to our workplace. Therefore, we need policy actions to support them in this effort.

3. LITERATURE REVIEW

3. LITERATURE REVIEW

3.1. Defining algorithmic management

The concept 'algorithmic management' ('AM') was first used by Lee et al. (2015) to describe the way algorithms performed management functions in platform companies like Uber and Lyft. Later, the concept was applied to more traditional work contexts, but the concept primarily originates from the literature on platform companies, and is still mostly used in that context.

Several related terms have been used to describe the burgeoning phenomenon of computers being used to perform management tasks. Some talk about a new type of management based on *digital monitoring and surveillance* of employees (Eurofound 2020a), while others have highlighted the use of *artificial intelligence* to perform management functions (TUC 2020, Reinhold et al. 2022). Still others focus on the use of *algorithmic control* in the workplace (Kellogg et al. 2020). Notions such as *digital management methods* (Moore 2018) or *people analytics* (Mallon et al. 2016) have also been used to describe roughly the same as AM. Despite different conceptual frameworks, these branches of literature are closely related to the literature on AM.

The lack of clarity is not only semantic. Definitions also vary to some extent (see for example Duggan et al. 2020; Lee et al. 2015; Mateescu and Nguyen 2019; Möhlmann et al. 2021). Still, all definitions of AM and related concepts focus on the fact that different managerial functions, which typically and traditionally have been undertaken by humans, are now done by algorithms.

An algorithm can be defined broadly as a set of instructions to be followed to solve a problem. As such, the use of algorithms in organisational decision-making is not new. According to Max Weber, decision-making in modern bureaucracies was generally characterised by step-by-step, distributed, rule-bound and nominally objective work procedures (Fourcade and Healy 2016). The split-up, routinisation and automatisation of work processes is also parallel to what Taylorism described almost a century ago.

However, the explosion in computer power and digital data collection has turned the use of algorithms in management into something qualitatively different (Wood 2021: 1; Kellogg et al. 2020: 366). The literature on AM focuses on the adoption of new management technologies and in particular software algorithms, defined as 'computer-programmed procedures for transforming input data into a desired output' (Kellogg et al. 2020: 370).

Different authors highlight various defining aspects of AM. For instance, Duggan and associates only focus on 'self-learning algorithms' in their definition (Duggan et al. 2020: 119), whereas Mateescu and Nguyen adopt a much broader understanding of AM that includes 'a diverse set of technological tools and techniques that structure the conditions of work and remotely manage workforces' (Mateescu and Nguyen 2019: 3). In the context of this study, we will adopt a relatively broad understanding of AM without strict requirements for the type of technology used.

A management task that is performed entirely by a computer without human involvement clearly qualifies as AM. However, in line with most of the literature, we also see a managerial practice as AM if a computer algorithm has been used to assist or inform a management decision, even if the decision itself is not fully computerised. Wood points out that algorithmic systems rarely work completely autonomously without human input, even when this is possible. This is particularly true when we move beyond the platform economy into more conventional sectors (Wood 2021: 3). In line with this argument, Lippert and associates argue that while algorithms are used quite frequently to substitute human managers in platform organisations, algorithms are mostly used to complement and inform managerial decisions made by humans in traditional organisations (Lippert

et al. 2023: 5282). Following the literature, this study adopts a broad concept of AM, because the focus is on AM in traditional sectors.

3.2. Forms of algorithmic management

The interest in AM has exploded in recent years with numerous studies being conducted, especially case studies that focus on specific companies. Looking at these studies, there is a long list of different tasks and functions that algorithms can perform today. Several researchers have attempted to systematise and categorise these tasks and functions in different ways (Holubová 2022; UNI Global Union 2020; Briône 2020; Duggan et al. 2020; Parent-Rocheleau and Parker 2022; Kellogg et al. 2020). Some categorisations are rather complex, others are simpler.

For the purposes of this study, we will adopt a simple categorisation of how algorithms are used in management.

First, algorithms may be used to manage the *work input*, i.e. to allocate tasks to workers. Here, the algorithms are used to decide which employees are needed to complete a task and when.

Second, algorithms can be used to manage the *work process*, i.e. to monitor and evaluate work processes. Here, algorithms are used to track and assess workers' activities and give them instructions for completing the tasks. In other words, they can be used to control how the job is done.

Third, algorithms can be used to manage and supervise the *work output*, i.e. to monitor and evaluate the work product. Here, algorithms are used to assess worker productivity and performance to inform or make decisions on whom to reward or punish. The worker's output can be evaluated against both qualitative standards (is she doing a good enough job?) and quantitative standards (is she producing enough?).

Our categorisation of AM functions resembles Lee and colleagues' original definition of AM. They argued that algorithms could be used to allocate work, provide informational support for optimisation of work and evaluate worker performance (Lee et al. 2015: 1603).

As shown in Table 1, within these categories we can identify a list of management tasks and functions that can be performed by algorithmic systems. The list is not exhaustive, but it sums up some of the most important forms of AM that appear frequently in the literature.

Table 1. Overview of algorithmic management forms

Management of the work input	Management of the work process	Management of the work output
Allocation of tasks and distribution of orders	Monitoring of computer activity	Assessment of workers' output and performance
Shift scheduling	Location tracking	Consumer-sourced rating systems to evaluate performance
Assignment of workers to teams	Tracking of worker activity	Recommendations of whom to promote or award bonuses to
CV screening	Screening of worker's communications (email, messages)	Recommendations of disciplinary action terminating or withdrawing work
Interviewing job applicants	Instructions for how to carry out tasks	
Testing job applicants	Social media screening	
Some background checks		

3.3. Potential consequences of algorithmic management

According to the literature, AM can have significant negative consequences for workers. Previous studies indicate that AM can affect both the quality of work and workers' well-being in several ways. Below, we list some of the most important consequences that have been identified in the literature. These potential consequences will also be the focus in the present study.

- *Decreased job autonomy*. AM can limit workers' capacity to make their own decisions and exercise control over how they do their job and which work methods they apply. Several studies have pointed to this (Briône 2020: 9; Parent-Rocheleau and Parker 2022: 4; Eurofound 2020a: 35; Abey et al. 2020: 46; Laursen et al. 2021: 65).

- *Increased workload*. When algorithms are used for extensive monitoring, evaluation and performance assessment, this can create pressure towards higher work intensity and productivity. This effect has been described by numerous researchers (Wood 2021: 13; Gilbert et al. 2021: 15; Abey et al. 2020: 47; UNI Global Union 2020: 13; Mateescu and Nguyen 2019: 13; Parent-Rocheleau and Parker 2022: 7).

- *Increased job insecurity*. The use of AM can increase the use of precarious and insecure employment contracts according to some authors (Parent-Rocheleau and Parker 2022: 7; Kellogg et al. 2020: 376). The technology can pave the way for more flexible jobs, but this can come with significant drawbacks for workers with the loss of the security and social protections associated with traditional employment (Abey et al. 2020: 45). Wood describes this as a 'fissuring' of employment relations (Wood 2021: 9). This is most apparent in the gig economy, where workers are often hired as independent contractors or self-employed rather than as employees, but it may also be relevant in more traditional sectors.

- *Lower level of trust.* Some researchers suggest that the use of excessive monitoring of employees can undermine trust between management and employees (Bråten 2019: 47; Lockwood 2018: 223; McParland and Connolly 2019: 549).

- *Decreased job motivation.* AM can have a negative impact on workers' motivation and engagement in their work (Parent-Rocheleau and Parker 2022: 4; McParland and Connolly 2019: 549). This can also result in lower job satisfaction (Doellgast and O'Brady 2020: 7).

- *Higher level of stress.* AM can lead to feelings of insecurity and stress. Studies have found for instance that the use of intensive monitoring can lead to increased stress (Doellgast and O'Brady 2020). AM can especially increase the level of stress and anxiety among workers because of the increased intensification of work and the drive towards higher efficiency (Eurofound 2020a: 4; UNI Global Union 2020: 13; Kellogg et al. 2020: 382).

Some of the listed outcomes are related to the content and design of the job, such as the degree of job autonomy and workload, while others are more closely related to the employees' well-being, such as stress levels and motivation.

There is a substantial body of literature on how job design can impact employees' well-being. The classic Job-Demand-Resources Model posits that the level of job strain is greatest when job demands are high and the worker's control over their job is low (Karasek 1979). The influential Job Characteristic Model and the Job-Demand-Resources Model both emphasise that high autonomy leads to increased motivation and engagement, whereas low autonomy and excessive demands result in stress and burnout (Hackman and Oldham 1976; Demerouti et al. 2001).

Thus, from the work design literature, one can argue that the listed outcomes of AM occupy different positions in a causal chain. If AM leads to a decrease in autonomy and an increase in workload, it would also be expected to lead to reduced motivation and elevated stress levels. For a good review of work design literature, see Parker et al. (2017) or Oldham and Fried (2016).

Aside from the outcomes listed above, the literature highlights several other potential implications of AM that seem only marginally relevant in this study. Among these are the potential risk of increased discrimination (Mateescu and Nguyen 2019: 14; UNI Global Union 2020: 7), lack of accountability (Briône 2020: 24; Mateescu and Nguyen 2019: 14), lower job complexity (Wood 2021: 14; Gilbert et al. 2021: 41; Parent-Rocheleau and Parker 2022: 5), lower social support and erosion of social interaction (Wood 2021: 14; Gilbert et al. 2021: 41; Parent-Rocheleau and Parker 2022: 5). For a review of the potential implications of AM, see Vignola et al. (2023), Parent-Rocheleau and Parker (2022), or Reinhold et al. (2022).

In summary, previous studies mostly highlight how AM may have negative consequences for workers. However, some researchers argue that AM may also have positive consequences for workers. It may lead to more autonomy for workers (Noponen et al. 2023), increase rather than erode their motivation (Newman 2017), and reduce rather than increase bias and discrimination in decision-making (Briône 2020: 6). In addition, AM can improve productivity and lead to more efficient decision-making, which may be one of the chief reasons why AM is introduced in so many sectors in the first place (Lippert et al. 2023: 5282).

Looking at the literature, it is therefore not entirely clear what influence AM has for workers and whether it is (primarily) positive or negative. As pointed out in a UNI Global Union report, AM tools are just that – tools. Like most tools, they are neither inherently good nor bad (UNI Global Union 2020: 5). The negative implications listed above should therefore be seen as potential risks that may be influenced by the way AM tools are implemented at the company level. In a similar vein, Parent-Rocheleau and Parker (2022: 8) suggest that the effect of AM is moderated by several organisational factors that may intensify, dampen or even annul the negative effects and stimulate positive effects.

Among these moderators is the degree of transparency in the company employing the AM methods. When workers are informed about how AM is used, i.e. what is being monitored and what this information is used for, it prevents or reduces the negative consequences and perceptions, at least if the use of AM serves legitimate purposes (Parent-Rocheleau and Parker 2022: 9).

Additionally, the degree of worker influence and control, for instance through work councils, shop stewards or other forms of co-determination, can moderate the effect of AM (Parent-Rocheleau and Parker 2022: 10). Studies suggest that the potential negative consequences can be avoided if employees are involved in the planning, implementation and operation of AM (Parent-Rocheleau and Parker 2022: 11; Abey et al. 2020: 52).

The propositions regarding the effects of AM on employees are mainly based on case studies. An overview of case studies can be found at Parent-Rocheleau and Parker (2022), Lippert et al. (2023) or Wood (2021). Although highly informative, by nature case studies cannot make inference about the prevalence of systematic effects. So far, only a few large-scale quantitative studies have explored the prevalence of different types of AM in different contexts (TUC 2020, Holubová 2022, Fernández-Macías et al. 2023). A fairly large number of quantitative studies, mainly survey-based, have examined the prevalence of technology or surveillance more broadly (Gilbert et al. 2021; Ilsøe and Madsen 2017; Abey et al. 2020; University of Hertfordshire 2019; Munk et al. 2022; OSF 2020; Bråten 2016; SAK 2019; Nielsen and Nielsen 2018; Hoff-Lund 2022; Prospect 2020). Finally, another set of studies have explored the use of data and technology in management from the employer's perspective (Bévort and Thorsen 2022; Eurofound 2020a: 25-41; Eurofound 2020b; Kropp 2019; Statistics Denmark 2021).

These studies offer crucial insight into the use of different kinds of AM and workers' attitudes towards certain types of new technologies. On a descriptive level this is valuable knowledge. However, none of these studies examine the *consequences* of AM directly, the major exception being Fernández-Macías et al. (2023).

Fernández-Macías et al. examine the correlation between, on the one hand, monitoring and AM and, on the other hand, a variety of working conditions outcomes. Among other things, they find that some forms of monitoring and AM correlate negatively with the degree of autonomy and stress (2023: 27, 34). However, in general their findings are mixed, and the correlations are weak. This may well be because they studied a representative sample of German and Spanish workers, and AM is still not widespread in most sectors of the economy. For instance, only 7% of German respondents had been exposed to more than one form of AM. With little variance in AM and few observations (and therefore lack of statistical power), it is difficult to detect potential systematic effects. That is why the present study focuses on sectors in which AM is expected to be more widespread.

Thus, we have little systematic knowledge about what consequences the use of AM has for workers who are subject to it, and how this relationship can be moderated. We will endeavour to fill that gap with this study.

Source: shutterstock.com/g/dusanfotopetkovic

4. RESEARCH DESIGN

4. RESEARCH DESIGN

This study is based on a survey among union members in selected sectors across four Nordic countries: Denmark, Sweden, Finland and Norway.

The methodological approach diverges from the predominantly qualitative approach in the existing body of literature, as described above. This choice is due to our focus on the outcomes of AM. The quantitative method enables us to find correlational evidence and draw more general conclusions on what consequences the use of AM has for the workers exposed to it.

One proviso seems relevant here. Strictly speaking we cannot draw causal inference from an observational study in which the chief independent variable – algorithmic management – has not been randomly assigned and other techniques for causal identification cannot be utilised. In that sense, the present study is merely correlational. In this context that means that we cannot be sure whether the respondents who are mostly exposed to AM work in companies that have characteristics other than AM that influence the outcome variables. We do however employ standard multivariate regression methods to control for known potential confounders.

The rationale for focusing exclusively on the Nordic countries stems from their distinctive labour markets, renowned for robust workers' rights, high degrees of unionisation and collective bargaining coverage, and a strong emphasis on healthy work environments. Although the results from this context cannot be generalised directly to other contexts, this setting can be considered a critical case: if AM in highly regulated and worker-friendly environments is associated with negative consequences for workers, it is highly likely that similar or even more negative effects will be found in less regulated labour markets.

Our investigation targets specific sectors suspected to be significantly influenced by AM, namely the customer service/telemarketing sector and the warehouse sector. These two sectors have been highlighted as sectors where the use of AM is relatively widespread (Wood 2021; Briône 2020; UNI Global Union 2020). In collaboration with national unions in these sectors, we have distributed surveys to a large number of union members.

This strategy allows us to explore the association between AM exposure and various outcomes, but it requires a large sample with a substantial number of workers who are actually exposed to varying degrees of AM.

One challenge with this strategy could be that certain forms of AM may be more prevalent in parts of the labour market with a low degree of unionisation. This has been pointed out previously in the UK (Abey et al. 2020: 55). However, this does not seem to be an issue in our case, since we find a significant prevalence of AM among the union members in the sample. The Nordic countries generally have a very high degree of unionisation, so union members are undoubtedly more representative for the broader labour market in the Nordic countries than they are in most other countries.[1]

Five unions across the four countries collaborated in collecting the data: HK and 3F in Denmark, HK in Norway, PAM in Finland and Handels in Sweden. These unions, which organise a considerable part of the workforce in the relevant sectors, provided access to potential respondents through their member systems.

The selection of participants and delimitation of the target groups was based on the available information on members' current occupations and collective agreements. Our ambition was to include similar sectors and job functions across countries. To con-

1 Trade union density was significantly higher in Denmark (67%), Sweden (65%), Finland (59%) and Norway (50%) in 2019 compared with the OECD average (16%); see OECD (2024).

firm the sector classification, the respondents were asked in the survey whether our information on their occupation was correct.

Differences in available information and the member pool across the participating unions led to some differences in sample composition in each country:

- In Finland, the target groups were identified by information in PAM's member system on their type of occupation (ISCO codes).
- In Denmark, the target groups in HK were identified by information on their type of occupation (ISCO codes). In 3F, warehouse workers were identified by the collective agreement they were working under. 'Citizen service workers' were included as an additional target group in HK. Although working in the public rather than the private sector, this group has functions that are comparable in many ways to customer service workers in the private sector. Since none of the other participating unions cover workers in the public sector, public-sector employees are only included in Denmark.
- In Norway, the available information in the HK union on members' occupations was scarce or unreliable, so it was decided to distribute the survey to a representative sample of all members in the union. That means the sector classification was only based on the respondents' answers in the survey.
- In Sweden, no customer service/telemarketing workers are included since they are not organised by Handels. The union covering this group in Sweden, Unionen, did not wish to participate in the project. Warehouse workers were identified by the collective agreement they were working under, since there were no ISCO codes or similar.

Table 2 below gives an overview of the sectors included in each country.

Table 2. Sectors included in each country

	Denmark	Finland	Norway	Sweden
Warehouse worker	X	X	X	X
Customer service/ telemarketing	X	X	X	-
Citizen service	X	-	-	-
Retail sales	-	-	X	-
Office	-	-	X	-
Aviation	-	-	X	-
Financial sector	-	-	X	-

Due to the different coverage of sectors, the samples are not directly comparable across countries. Therefore, we should be careful not to draw descriptive conclusions on how widespread AM is across countries. Fortunately, this is not our main purpose.

Rather, we aim to examine associations between AM and different outcomes. For this purpose, the fact that our sample is multifaceted is not a weakness, indeed quite the opposite. If we can find strong correlations that are robust across different sectors and countries, it adds to the credibility of our results. Besides, in the analyses that follow we include controls for sector and countries. In our convenience sample we have sufficient variation in employees' exposure to AM to estimate the effects on the outcomes of interest (see section 3.3 above). This is critical to be able to assess the consequences of AM.

Our final sample contains 6,769 respondents in total, with 5,141 complete and 1,628 partial responses, yielding a response rate of 15.3%. This rate might appear lower than it actually is. We sent out the survey to a fairly broad sample, to make sure we reached as many relevant members as possible. This probably included a substantial number of members not in the target groups. Members working in other sectors who received an invitation for a warehouse

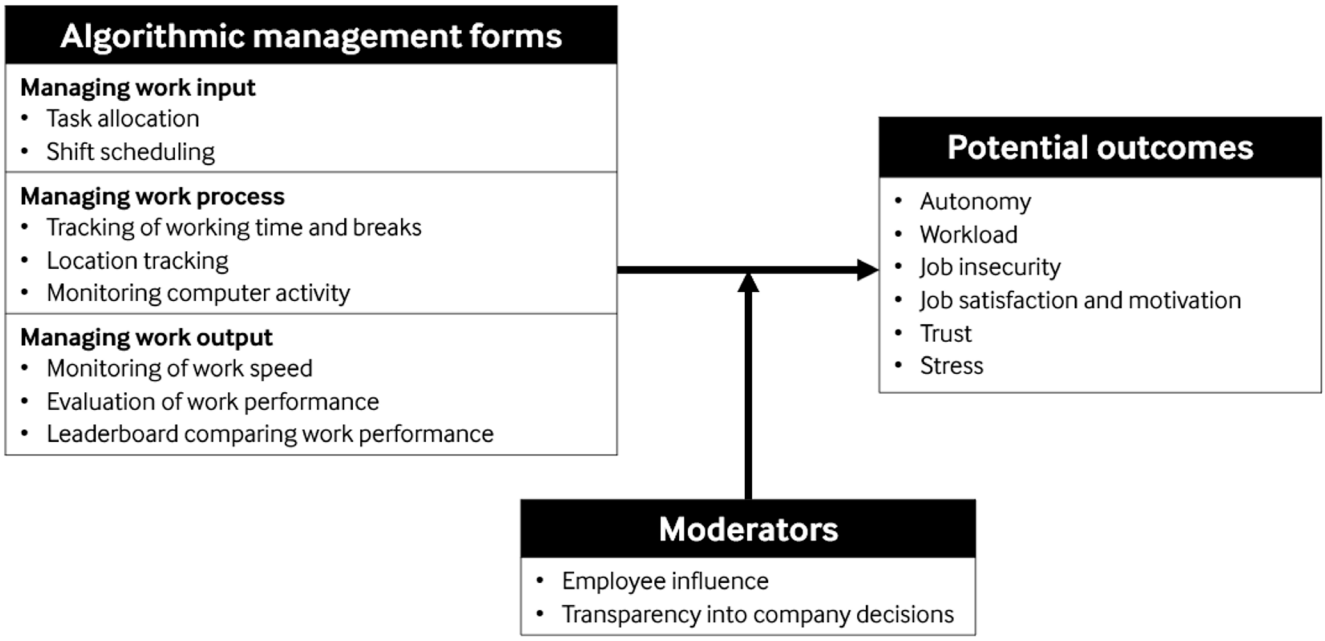
worker survey, for instance, would probably be less likely to participate.

The response rate was lower among the youngest age groups and (to a lesser extent) among men (see Appendix 1). To ensure that this did not influence the report's conclusions, all analyses were conducted both unweighted and weighted based on the gender and age distribution in the population that received the survey invitation (see online Appendix 2). These weights have very little influence on the results, and the study's conclusions are robust with and without weights. All the results presented in the report are unweighted to reduce complexity and to make the results easier to interpret.

The study questionnaire includes questions designed to capture various aspects of AM and an array of questions related to potential consequences that have been highlighted in the literature (see section 3.3 above). The questionnaire is included in the online Appendix 5.

Figure 1 below shows the general analytical framework of the study, summarising the types of AM and potential outcomes that are included in the study.

Figure 1. Analytical framework



In the following section, we explain how the different types of AM are measured in the survey. We will explicate the operationalisation of the outcome variables when we present the analyses in the subsequent sections.

PART II – RESULTS

5. HOW WIDESPREAD IS ALGORITHMIC MANAGEMENT?

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5. HOW WIDESPREAD IS ALGORITHMIC MANAGEMENT?

To investigate whether the respondents are exposed to AM, we included a series of questions in the survey that explore whether a computer program or another digital system is used to perform different tasks traditionally carried out by a human manager.

The somewhat opaque term 'algorithmic management' is not used in the survey. Instead, we asked about the respondents' exposure to eight specific forms of AM individually to obtain a more accurate measure that all respondents understand. Because employees do not always have full insight into how management decisions are made, we allowed respondents to decide whether they were sure or just thought that a 'computer program or another digital system' was used to perform each of the eight management tasks.

> *More than 3 out of 4 respondents in the survey (76%) say that at least one of the forms of AM included in the study is used at their workplace.*

The study shows that AM practices are widespread in the sectors we analysed. More than 3 out of 4 respondents in the survey (76%) say that at least one of the forms of AM included in the study is used at their workplace. However, at the same time, the types and level of exposure to AM vary considerably across respondents and sectors.

Below, we describe the eight forms of AM that we ask about in the survey. The different forms of AM concern (a) work input, (b) work process, or (c) work output, but can also be seen as indicators of a general measure of AM. Since the different forms of AM correlate quite strongly (see below), we have constructed an index that measures the overall extent of AM exposure. This will be our primary explanatory variable in the analysis of potential outcomes of AM.

5.1. Algorithmic management of work input

Work input concerns management decisions on which workers get which tasks. The survey includes two questions related to management of the work input.

Specifically, the respondents were asked the following two questions:

- **Task allocation:** *Is a computer program or another digital system used to decide which tasks you and your colleagues should handle?*
- **Shift scheduling:** *Is a computer program or another digital system used to decide when you and your colleagues should work (your working hours or shift schedules)?*

Just over a third of the respondents (34%) are either certain or believe that a computer system is used for task allocation in their workplace (see Figure 2). By contrast, 59% believe or are certain that this form of AM is not used.

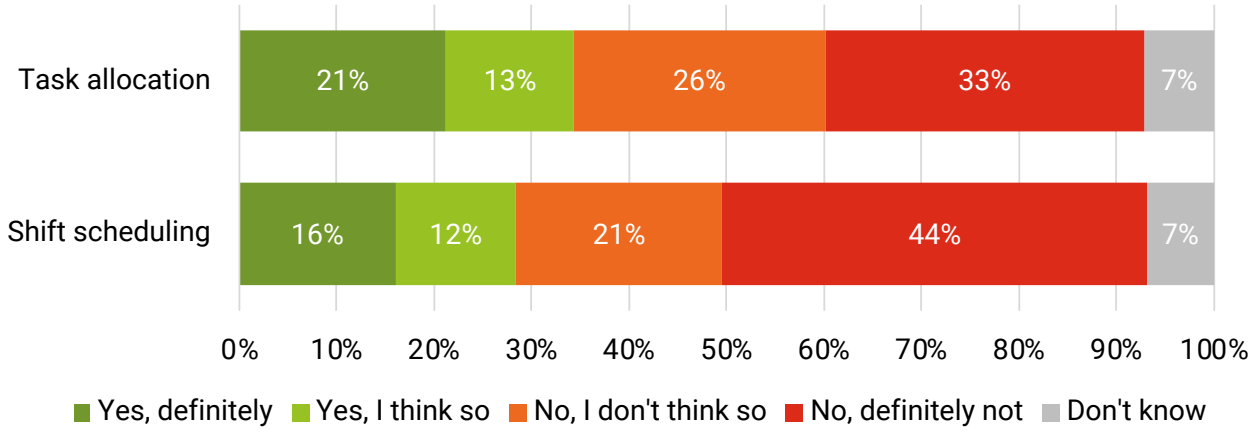
This form of AM appears to be more prevalent in the warehouse sector (44%) than in customer service/telemarketing (33%) (see Table A in Appendix 2). In the sectors only covered in single countries, aviation stands out as the sector in which most respondents feel that computers are involved in task allocation (51%), while it is much less prevalent among citizen service workers (22%) and office workers (16%).

Looking at the other form of AM, just over 1 in 4 (28%) say that a computer program is used to determine schedules and decide when they should work. However, 2 out of 3 (65%) do not believe that computer programs are used to perform this form of management.

This form of AM is equally prevalent in the two main sectors: warehousing (31%) and customer service/ telemarketing (32%). It is more common in both aviation (57%) and retail (52%), and less common in the financial sector (11%), office sector (12%), and citizen service (15%).

As shown in Figure 2, for both task allocation and shift scheduling, a significant proportion of respondents (46% and 40%, respectively) either do not know or are uncertain about whether they are exposed to AM in these forms. This suggests that employees often do not have full insight into how management decisions are made.

Figure 2. Algorithmic management of work input



Note: The number of respondents is 5,296 and 5,278, respectively.

The proportion of respondents who experience these forms of AM is significantly higher in this survey compared to previous studies. The proportion that reported experiencing each of these forms of AM ranged from 7% to 19% in earlier studies in Germany and Spain (Fernández-Macías 2023) and in the UK (TUC 2020). However, both these studies include sectors of the economy where AM practices are expected to be less frequent. The present survey was specifically aimed at industries in which widespread use of AM is expected.

Respondents who said they were exposed to these forms of AM were asked whether they believed that the computer makes these decisions by itself. Only a small proportion of the respondents said that the computer makes these decisions without the need for any human involvement (20% and 10%, respectively). This is in line with the claims in the literature that AM rarely works completely autonomously without human input, particularly outside of the platform economy (Wood 2021: 3; Lippert et al. 2023: 5282).

5.2. Algorithmic management of work process

Other forms of AM are related to management of the work process. Three such forms of AM were covered in the survey:

- **Tracking breaks/working time:** Is a computer program or another digital system used at your workplace to automatically track when you are working and when you are taking breaks?
- **Location tracking:** Is a computer system used to monitor your whereabouts while you are at work? (e.g. your location)
- **Monitoring computer activity:** Is a computer program or another digital system used to monitor your computer activity? (e.g. what websites you visit)

Fully 4 out of 10 (40%) say that a computer automatically tracks when they work and when they take breaks (see Figure 3), whereas 54% say that this does not happen at their workplace. This form of AM is widely used in both the customer service/telemarketing sector (52%) and in the warehouse sector (48%). It is much less common in the office sector (16%) and financial sector (22%) and in citizen service (24%).

The two other forms of AM were investigated only among different subsets of respondents because they are only relevant in some types of jobs.

The question about location tracking was only posed to respondents within the warehouse and retail sectors, and to other respondents who said that they do not work at a computer most of the time during a normal working week. Thus, customer service employees and others with office jobs were not asked this question.

This form of AM is less prevalent among the respondents in the study. Just over 1 in 4 (27%) say that they know or think that their location is being monitored. Two thirds (66%) do not believe that such location tracking takes place. This form of AM is more common in the warehouse sector (26%) than in the retail sector (15%).

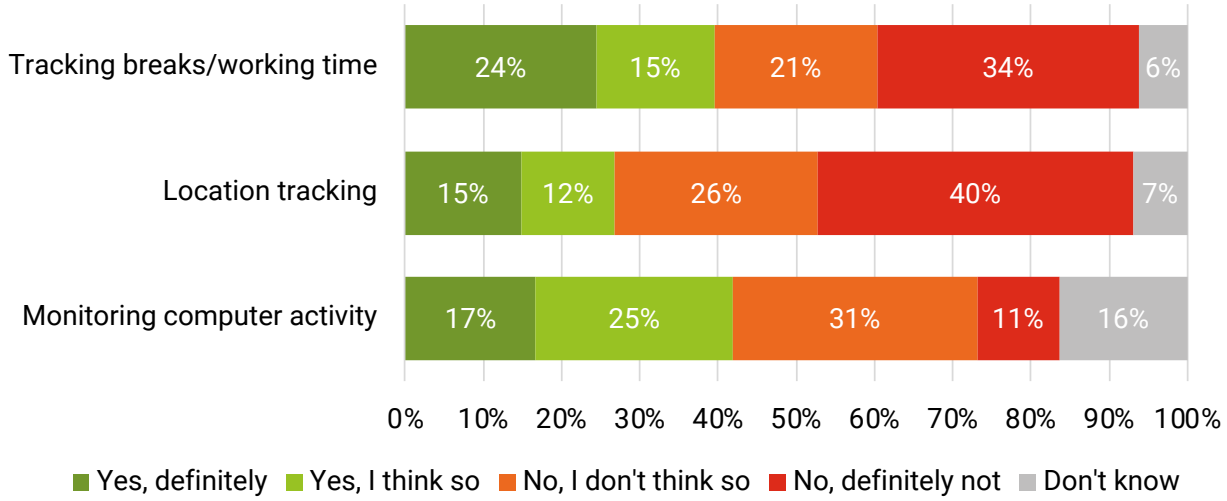
The question about monitoring computer activity was posed to the remainder of the sample – i.e. among others, customer service/telemarketing employees and others who have office jobs and work at a computer most of the time. This form of algorithmic management is relatively widespread. For example, 42% are certain or believe that their computer activity is being monitored, while an equal number (42%) say that this does not happen, as far as they are aware. The results show that this form of AM is quite common across sectors, with citizen service (49%), the financial sector (46%) and customer service (41%) being somewhat higher than the office sector (29%) (see Table A in Appendix 2).

> *A large portion of those surveyed are uncertain whether their computer activity is being monitored. 73% are either uncertain or don't know. This suggests that some forms of AM are more elusive than others.*

It is worth noting that a very large portion of those surveyed are uncertain about whether their computer activity is being monitored. Fully 73% are either uncertain or don't know whether they are exposed to this form of AM. This suggests that some forms of AM are more elusive than others. It is concerning that so many are unaware of the monitoring taking place, especially in light of the fact that employers have an obligation to inform employees about the personal data that are collected about them (see Articles 13 and 14 GDPR).

The widespread use of computer activity monitoring should perhaps be viewed in the context of the Covid crisis. During the pandemic, many people with office jobs worked from home for a while. This led many companies to acquire new software to monitor employees at their home workplaces. We know from prior research that there was a significant increase in global demand for employee monitoring software at the height of the pandemic around March 2020 (Migliano 2023).

Figure 3. Algorithmic management of work process



Note: The number of respondents is 5,253, 2,933 and 2,226, respectively.

The proportion of those who believe or know they are being monitored in these three ways is relatively high compared with previous studies. For instance, the TUC posed similar questions in a survey in the UK, where the figures were lower than those found here (TUC 2020). As described above, this was to be expected given our target population.

New technological tools allow managers to monitor and control employees much more intensively than previously seen. One could argue that this makes AM qualitatively different from management surveillance in the past.

Monitoring of workers' activities and whereabouts are not new phenomena. It has always been a manager's prerogative to monitor employees' activities during work hours. However, new technological tools allow managers to monitor and control employees much more intensively than previously seen. One could argue that this makes AM qualitatively different from management surveillance in the past.

5.3. Algorithmic management of work output

A third dimension of AM is the management and oversight of work output, as previously described. This was also explored in the study with the following three questions:

- **Work speed monitoring:** Is a computer program or another digital system used to monitor how fast you work?
- **Work quality evaluation:** Is a computer program or another digital system used to evaluate the quality of your work performance?
- **Leaderboard:** Is your work performance displayed on a leaderboard or screen so that you can be compared with your colleagues?

Just over 4 out of 10 (42%) say that a computer program or another digital system is used to monitor how fast they work. For warehouse employees, this could be an automatic recording of how many items they pick from the shelves; for telemarketing employees, it could be the number of calls they make. About half (52%) say that they are not subjected to this form of AM.

This form of AM is particularly widespread in our two main sectors, warehousing (61%) and customer service/telemarketing (58%), while the number is much lower in office work (11%), retail (19%) and citizen services (23%).

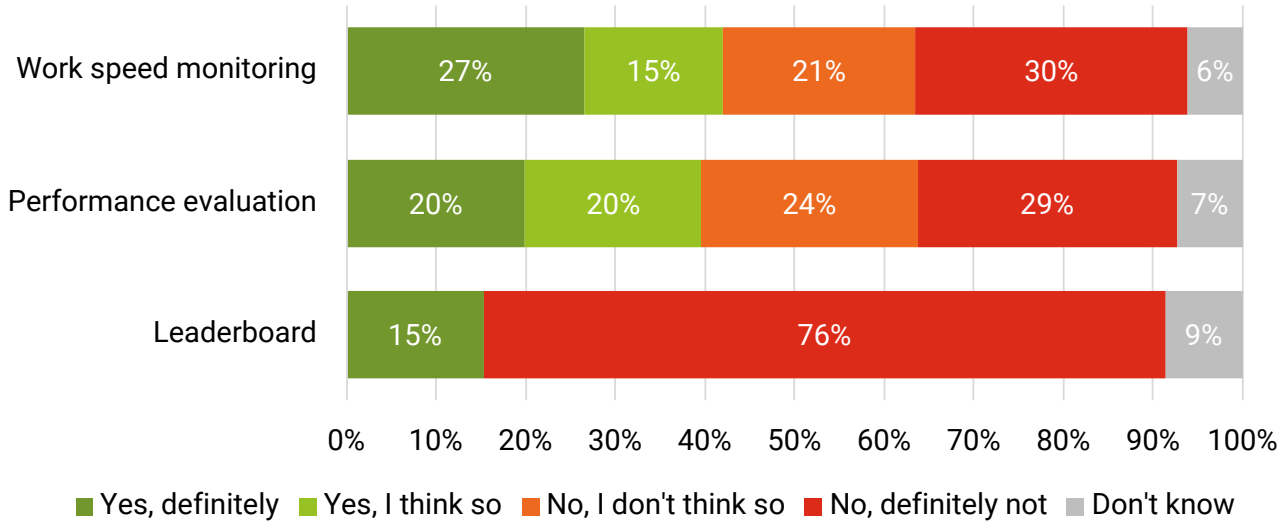
In total, 40% of the respondents say that a computer evaluates the quality of their work performance, such as the number of errors that a warehouse employee makes or the number of sales or cases that a customer service/telemarketing worker closes. Just over half (53%) do not experience this.

Again, this form of AM is especially common in customer service/telemarketing (52%), warehousing (50%) and aviation (54%) (see Table A in Appendix 2). It is used much less in the retail sector (26%) and office sector (20%).

Finally, respondents were asked whether their work performance is displayed on a leaderboard or screen, so that they can be compared with their colleagues. We also consider this to be a form of AM, as we assume that this type of leaderboard implies that a computer is measuring and assessing performance. The figures show that 15% have this type of leaderboard at their workplace, while 76% do not. Unlike the other forms of AM, the presence of a leaderboard is very visible to employees. Therefore, they were only given the option to answer 'Yes', 'No' or 'Don't know' to the question.

The customer service/telemarketing sector stands out as the sector in which leaderboards are most widespread (30%). They are less common in the warehouse sector (14%). Leaderboards are also quite common in the retail sector (18%), but less so in the aviation sector (5%) and office sector (9%).

Figure 4. Algorithmic management of work output



Note: The number of respondents is 5,215, 5,214 and 5,197, respectively.

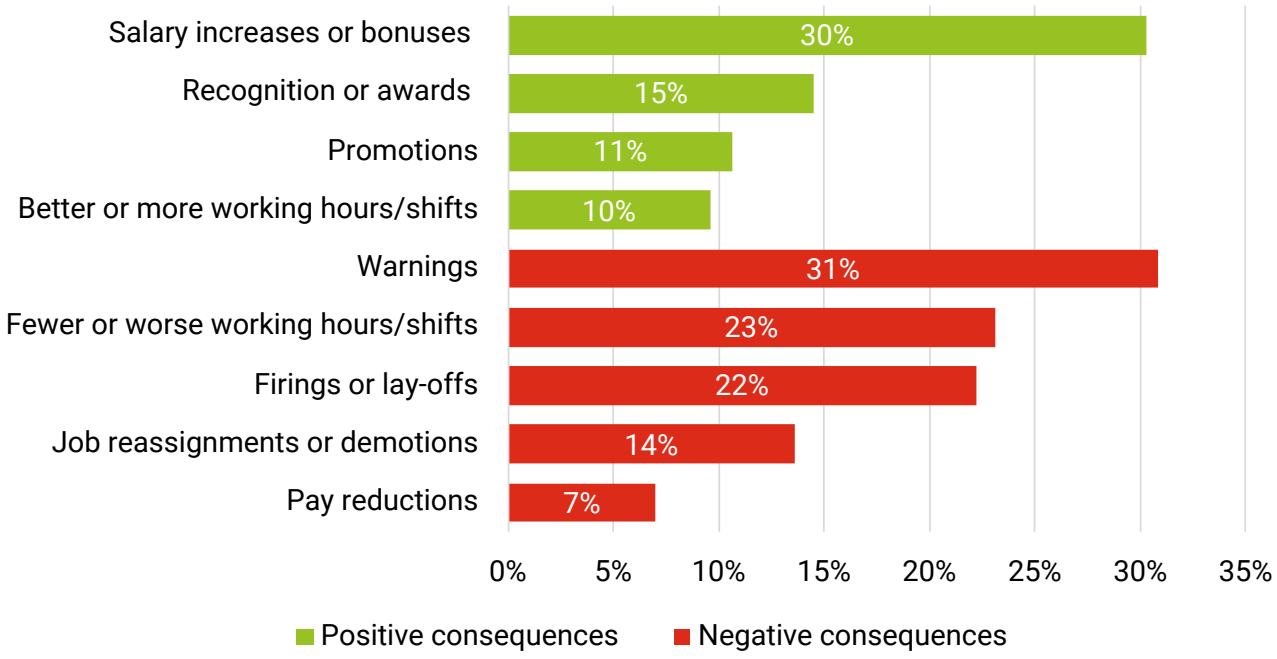
The question on the prevalence of leaderboards is very similar to a question posed by Fernández-Macias et al. among a representative sample of the Spanish and German working population (2023: 30). Here, 11% of Spaniards and 2% of Germans mentioned the presence of a leaderboard in their workplace. Once again, the proportion is higher in the present study than in previous ones, because we have deliberately chosen to focus on employees in sectors where various AM practices are expected to be quite common.

Those who said that a computer is used to monitor their work speed or evaluate the quality of their work performance received a follow-up question asking what they believe this monitoring is used for (see Figure 5). The results show that employees believe that the computer's monitoring of their work can have quite significant consequences for them, both positive and negative.

More than half of the respondents (54%) say that they think it is used to take decisions about one or more positive consequences. A smaller proportion (30%) say that they believe the monitoring is used to decide who will receive salary increases or bonuses, while 15% believe it is used to decide who will receive recognition or awards (such as employee of the month). Lastly, 27% don't know whether it is used for any of these purposes.

A considerable share of respondents (48%) also believe that these tools are used to make some decisions that have negative consequences for employees. For example, 31% say that computer-based performance monitoring can lead to warnings, 23% state that it can result in fewer or worse working hours, and 22% say that it is used in decisions about firings/lay-offs. Conversely, 30% say that they don't know if the monitoring is used to take decisions about any of these negative consequences.

Figure 5. Usage of work speed and performance monitoring



Note: The number of respondents is 2,484 and 2,480, respectively. 'Don't know' responses are included in the calculation base. The question formulations are provided in the online Appendix 5 (questions 20 and 21).

5.4. Construction of a general algorithmic management index

The primary purpose of this study is to discover the consequences of being exposed to AM. There is reason to believe that the consequences of AM depend on the *extent* to which employees are exposed to more or less AM. The intuition behind this argument is simple: if AM is only used, for example, to plan working hours or the whereabouts of warehouse workers, it probably has fewer consequences than if AM is used to make all kinds of management decisions in a company. Thus, it is not simply a matter of whether employees are exposed to some form of AM or not, but rather a phenomenon with varying degrees of intensity.

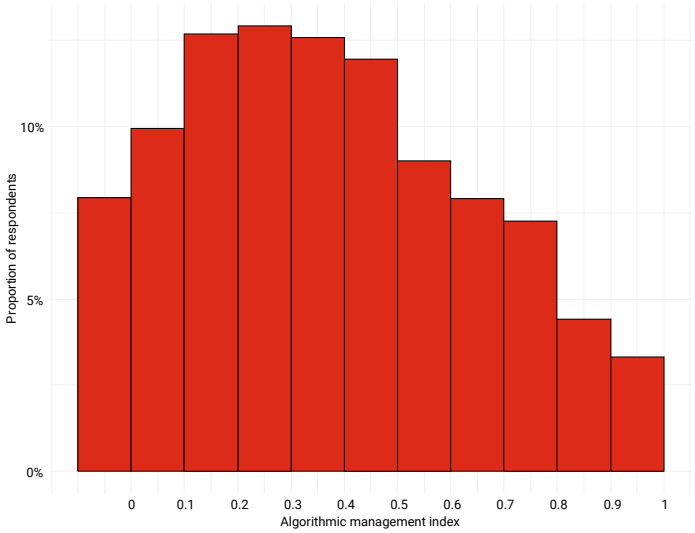
Therefore, we have constructed a general AM index, measuring the extent to which a respondent is exposed to AM. Each respondent receives one overall score in the index based on how many different forms of AM they are exposed to, and how certain they are on this usage.

Thus, the AM index is based on the respondent's answers to the questions about the eight forms of AM. The index ranges from 0 to 1. A score of 0 means that the respondent is confident that *none* of the mentioned forms of AM are used in their workplace. A score of 1 means that the respondent is confident that all forms of AM are used in their workplace. Box 1 contains a detailed description of how the index is constructed, as well as the considerations underlying this approach.

Figure 6 below shows how respondents are distributed within the AM index. The respondents are evenly distributed within the index, and exposure to AM varies considerably across respondents. For example, 8% have a score of 0, meaning they are certain that none of the different forms of AM are used at their workplace, while 3% have a score of 1, meaning they are certain that all forms are used. Both the average and the median are at 0.38.

Thus, the results indicate that many respondents experience one or more forms of AM. The vast majority (76%) believe or are sure that at least one form of AM is used in their workplace.

Figure 6. Distribution of respondents within the algorithmic management index



Note: Respondents who answered at least 5 out of the 7 questions have been assigned a value on the index. The upper limit is included in all intervals.

As evident from the overview above, there are significant differences between sectors regarding the prevalence of various forms of AM used in workplaces. Overall, customer service/telemarketing employees and warehouse workers are subjected to the most AM, while employees in the office, citizen service and financial sectors experience the least (see Figure A in Appendix 2). This aligns with our expectation that AM would be particularly widespread in the warehouse and customer service sectors, which was the reason for initially focusing on these two sectors. However, the results also show that the prevalence of AM is substantial across sectors. Even among office workers, who experience the least AM, approximately half (51%) report experiencing at least one of the mentioned forms of AM in their workplace.

Box 1. How is the algorithmic management index constructed?

The index is constructed from the eight questions measuring the various forms of AM. Two of the eight questions about AM are substitutes and only given to subsets of the sample, so each respondent is asked about seven forms of AM.

The AM index is calculated as an average of the seven indicators, all of which are equally weighted. For each form of AM, respondents can have a value ranging from 0 ('No, definitely not') to 3 ('Yes, definitely'). If the respondent is not sure whether a specific form of AM is used, they are assigned a score of 1 ('No, I don't think so') or 2 ('Yes, I think so'). To ease interpretation of the results we have standardised the index to range from 0 to 1.

The decision to differentiate between 'think' responses and 'definitely' responses was intended to minimise measurement error. It is assumed that a respondent who is certain that AM is used is more likely to be correct than a respondent who thinks it is used. If that is true, the average measurement error is reduced by assigning a lower value for 'think' responses than for 'definitely' responses. Additionally, the aim is to measure the intensity of AM. It is assumed that intensive use of AM will be more visible to the employee. Thus, respondents who say that AM is 'definitely' used are probably exposed to more intensive AM on average than respondents who are not sure. Including this variation in the index therefore provides a more nuanced measure of AM. To test the robustness of our measure, all analyses were also conducted with an alternative AM index where 'think' responses and 'definitely' responses are coded similarly. This does not change our results substantially, as can be seen in our online Appendix 3.

Furthermore, we conducted a series of analyses to examine whether it is appropriate to combine the eight indicators into one measure:

- First, we examined how the different forms of AM correlate to determine whether it is meaningful to group them under a single phenomenon. All forms of AM correlate positively and most of them quite significantly so (see Figure A in Appendix 3). That means that respondents who experience one form of AM also tend to experience other forms. Besides, adding them together reduces measurement error (Cronbach's alpha is 0.80-0.82, depending on whether location or computer activity tracking is included).
- Second, we investigated how each of the eight indicators correlate individually with our outcomes of interest. All indicators correlate as expected with the outcomes (see Figure B in Appendix 3). The size of the correlations varies, but they all have the same sign and discriminate in similar and expected ways. This also suggests that the overall AM index is valid and an appropriate construct for the purpose of our analyses.
- Third, we examined whether we should measure each of the three dimensions of AM (input, process, output) separately instead of creating one general index. However, this does not offer any additional explanatory power, since the general AM index is a stronger predictor for all outcome variables of interest than any of the separate indices measuring each dimension (see Figure C in Appendix 3).

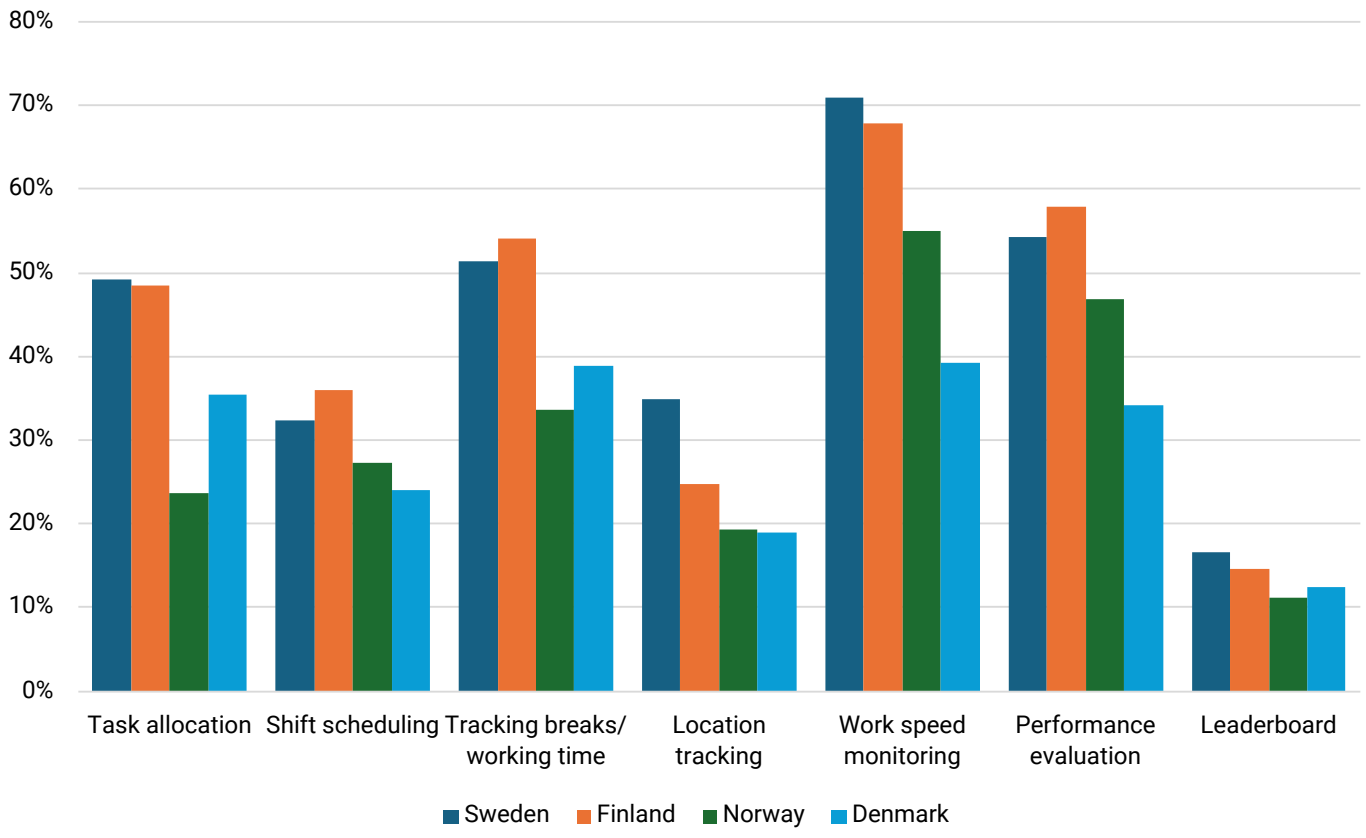
5.5. Comparison between countries

As described earlier, there are differences in the samples in each country regarding which sectors are included. This makes it difficult to compare results across countries, as any differences may reflect differences in the sample composition.

To make the numbers comparable, we can focus on our two primary sectors, warehouse and customer service/telemarketing, which are represented in four and three countries, respectively.

Looking first at warehouse workers, we can observe substantial differences between countries, as shown in Figure 7. Warehouse workers in Sweden and Finland generally experience more AM than those in Norway and Denmark. Across all seven forms of AM, the proportion of respondents indicating its use in their workplace is highest in these two countries. Consequently, the overall score on the AM index is also significantly higher for warehouse workers in Sweden and Finland (0.50 and 0.48) compared with Norway and Denmark (0.36 and 0.33) (see Figure B in Appendix 2).

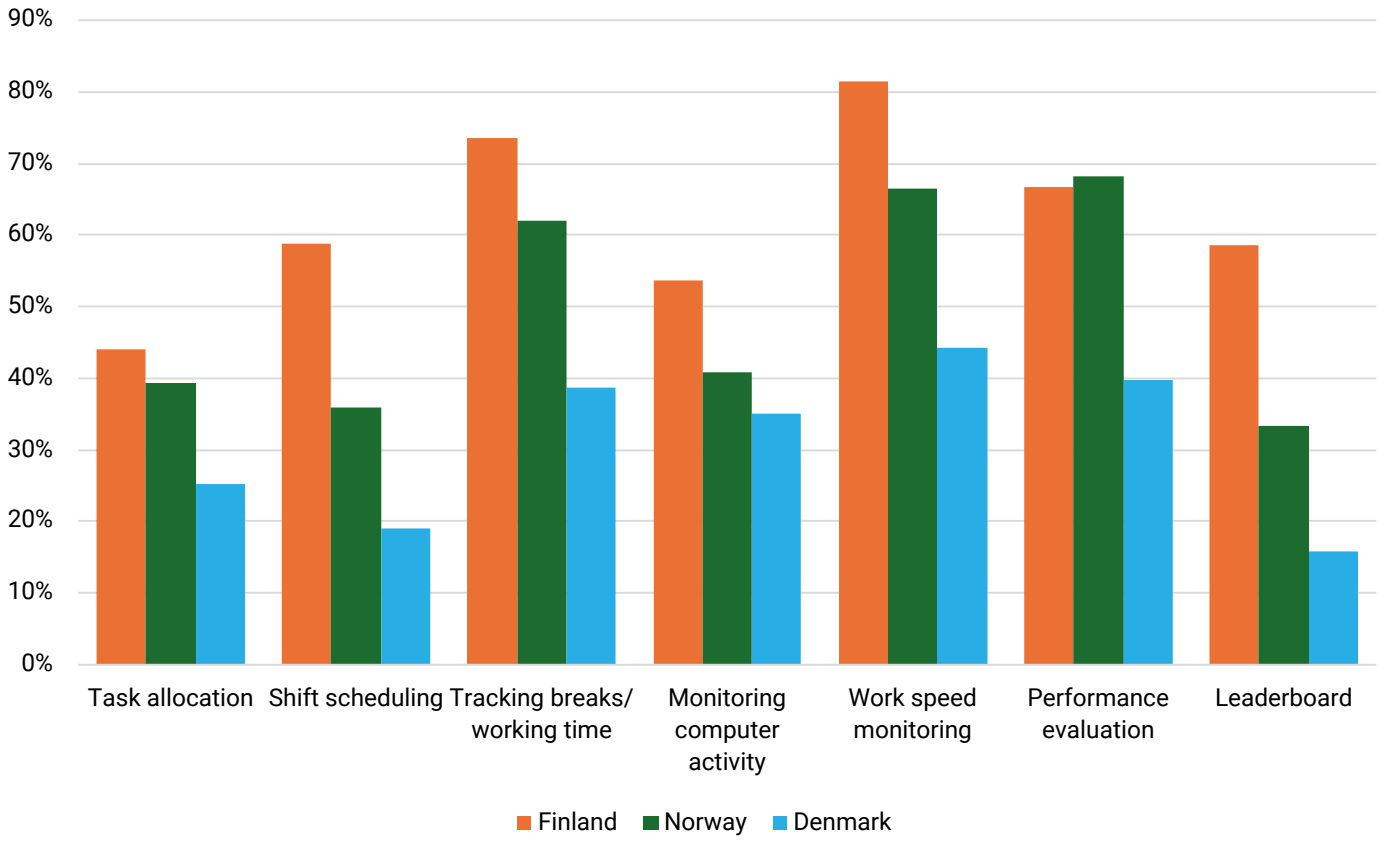
Figure 7. Proportion of warehouse workers experiencing each form of algorithmic management, by country



Note: The figure shows the proportion of warehouse workers who answered either 'Yes, definitely' or 'Yes, I think so' when asked about each form of AM.

Customer service/telemarketing employees are not included in the Swedish sample, but we can compare the other three countries here. As shown in Figure 8, the proportion of customer service/telemarketing employees experiencing AM is generally highest in Finland. For 6 out of the 7 forms of AM, Finland ranks highest – only in performance evaluation is Norway at roughly the same level. Danish customer service/telemarketing employees experience the least AM, and Denmark ranks lowest on all seven forms. Naturally, this pattern is also reflected in the average score on the AM index, which is highest in Finland (0.66), second highest in Norway (0.52), and lowest in Denmark (0.37) (see Figure B in Appendix 2).

Figure 8. Proportion of customer service/telemarketing workers experiencing each form of algorithmic management, by country



Note: The figure shows the proportion of customer service/telemarketing workers who answered either 'Yes, definitely' or 'Yes, I think so' when asked about each form of AM.

The data in Figures 7 and 8 above cannot be used to make general statements about the prevalence of AM being higher in some countries than in others. As described earlier, our samples are far from representative of the entire labour market. However, we have attempted to delineate these two target groups as consistently as possible across countries, so the numbers should be roughly comparable within each sector. When it comes to the other sectors, we cannot compare across countries, as they are only included in either Denmark (citizen service) or Norway (retail, office, aviation and financial sectors).

Source: shutterstock.com/g/shock

6. RISKS AND CONSEQUENCES

6. RISKS AND CONSEQUENCES

As described in the literature review, previous studies have pointed to a wide range of potential consequences that the implementation of algorithmic management (AM) may have for workers. This section presents the findings from our survey in six key areas that may be influenced by AM: job autonomy, trust, motivation and job satisfaction, workload, stress and job insecurity.

As already mentioned, the general AM index will be used as our primary explanatory variable when we examine the potential consequences of AM in the following sections.

6.1. Autonomy

The first potential outcome is the degree of job autonomy. To measure this, respondents were asked to respond to three statements about their work. For each statement, respondents had to say to what extent they agreed or disagreed (on a 5-point Likert-type scale):

- *The job allows me to decide on my own how to go about doing my work.*
- *The job gives me a chance to use my personal initiative or judgment in carrying out the work.*
- *The job lets me use my skills and abilities.*

Together, these statements aim to discover whether employees feel they have the freedom to decide how they do their work and if they can use their own judgement and expertise when doing their job. From the literature on work design, we know that the degree of freedom and autonomy can be crucial to how well employees thrive in their jobs. This is a key point across various classic work design models (cf. Karasek 1979; Hackman and Oldham 1976; Demerouti et al. 2001).

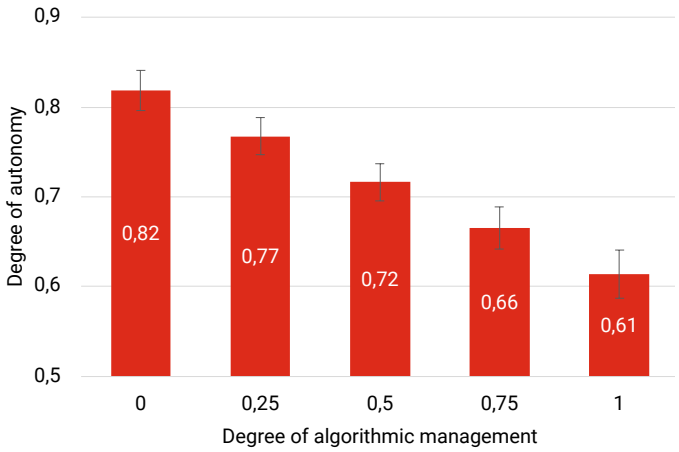
The three statements have all been used in prior research. The first two originate from Morgeson and Humphrey's widely used work design questionnaire (2006), serving as measures for 'decision-making autonomy' and 'work-methods autonomy', respectively. The third statement is commonly used to assess if a job is 'intrinsically rewarding' (see, for example, Warring 2018: 64).

The responses to these three statements were combined into an additive index, ranging from 0 to 1. There is a strong correlation between the three items (see Table A in Appendix 4).

The results reveal a strong relationship between the degree of AM and job autonomy, as shown in Figure 9. Employees not exposed to AM experience a high degree of autonomy in their jobs, averaging a score of 0.82 on the autonomy index. Those employees most exposed to AM experience significantly less autonomy, with an average score of 0.61. This equates to an effect of 0.21 on the autonomy index.

The relationship illustrated in Figure 9 has been controlled for a wide range of background variables, including gender, age, salary, education level, country, sector, the number of employees at the workplace and whether the respondent has managerial responsibilities. The effect is estimated using linear regression, and all other variables have been set to the median or modus depending on what is most appropriate. The full results of this regression are presented in Table A in Appendix 5. We employed the same method for all outcome variables shown below.

Figure 9. Predicted level of autonomy at different levels of algorithmic management



Note: The figure shows the predicted levels of autonomy at different levels of AM resulting from a linear regression model including control variables. The control variables are held at either their modus (country = Denmark, sector = Warehouse, gender = Male, education = Vocational school, managerial role = No) or their median (workplace size = 50-99 people, salary = 3,000-3,999 euros/month, age = 41-50 years). The results from the regression analysis are provided in Table A in Appendix 5.

> *When we examine self-reported levels of autonomy, we largely get the same picture: those who are most exposed to AM report the lowest levels of autonomy.*

The respondents were also asked to assess how the use of AM at their workplace affects their autonomy. Respondents exposed to one or more forms of AM were asked if they believe that it '*… reduces my freedom to decide how I do my work*'. A third (34%) agree or partially agree with the statement, while a similar proportion (34%) disagree (see Figure A in Appendix 6). Looking only at respondents experiencing a high level of AM (at least five forms), their assessment is much more negative: 50% agree that it reduces their autonomy, while 20% disagree (see Figure B in Appendix 6). Hence, when we examine self-reported levels of autonomy, we largely get the same picture: those who are most exposed to AM report the lowest levels of autonomy.

The results from both the correlational analysis and the respondents' own assessment clearly indicate that the introduction of AM not only involves computers taking over the tasks of a manager, but also restricts employees' freedom to organise their work. This suggests that the way AM is implemented in most companies means that it is not merely a neutral management tool, but seems to have negative consequences for work autonomy.

6.2. Trust

Another potential consequence of AM is the erosion of trust between employees and management: employees' trust may be weakened if they see the intensive monitoring of their work as a sign of mistrust from management.

This can be seen in conjunction with the reduced autonomy that AM potentially causes. If employees feel their freedom is reduced and their work more intensively monitored, they may see this as a sign that the management does not trust employees to do their work properly. In fact, the level of autonomy and trust correlate quite strongly among respondents (see Table B in Appendix 4).

The level of trust between employees and management is measured with two statements that respondents were asked to consider (again on a 5-point scale from 'strongly agree' to 'strongly disagree'):

- *I trust the management at the place where I work.*
- *The management trusts me and my colleagues to do our work well.*

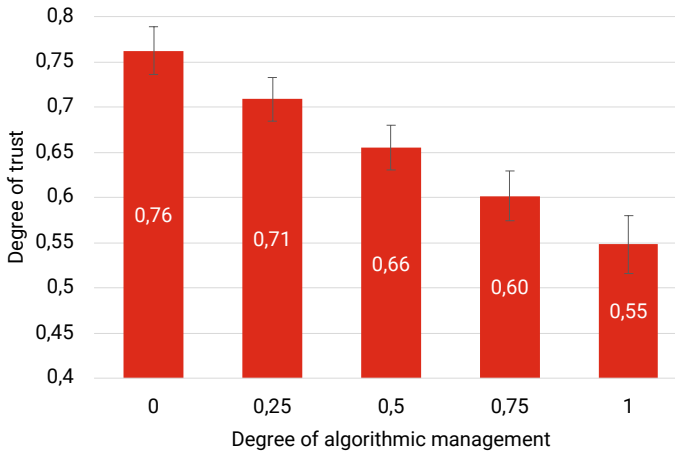
Both items have been used in previous studies. The

first was included in the American General Social Survey for several years (GSS 2017). The second is a slightly adapted version of a question from the European Working Conditions Survey (Eurofound 2021).

Again, the responses to these statements were combined into an additive trust index, ranging from 0 to 1. The correlation between the two items is very strong (see Table A in Appendix 4).

As shown in Figure 10, we find a strong relationship between AM and the level of trust. Employees who do not experience any AM express a high degree of trust between management and employees, with a score of 0.76 on the index. Moving from no AM to the maximum degree of AM, trust falls by 0.21 on the index to an average score of 0.55. Again, the relationship has been controlled for a range of background variables (see Table A in Appendix 5).

Figure 10. Predicted level of trust at different levels of algorithmic management



Note: The figure shows the predicted levels of trust at different levels of AM resulting from a linear regression model including control variables (held at the same levels as in Figure 9). The results from the regression analysis are provided in Table A in Appendix 5.

The results clearly indicate that the use of AM can contribute to the erosion of trust between employees and management. The Nordic countries and their labour markets are generally characterised by high levels of trust and collaboration. Against that backdrop, the dramatic effect that AM has on the erosion of trust is striking and somewhat worrying. This suggests that in general, the introduction of AM carries the potential to undermine one of the most cherished features of the Nordic labour markets. But as we will see in section 7 below, the erosion of trust is not an inevitable consequence of AM in the Nordics.

6.3. Job satisfaction and motivation

The use of AM can also influence how motivated employees are and how satisfied they are with their job. This potential outcome was also explored through two questions in the survey:

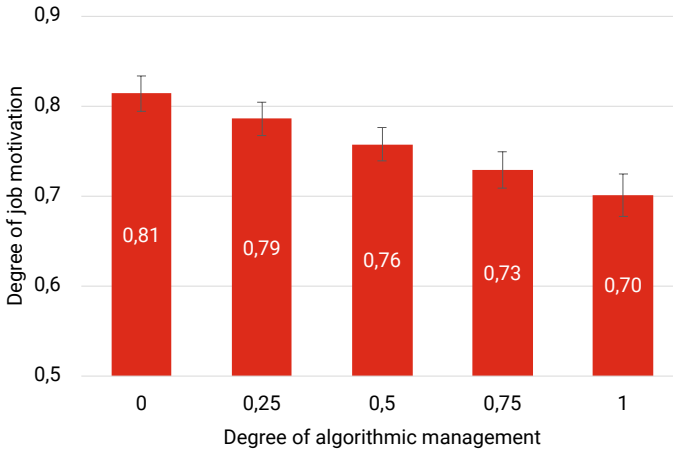
- *All things considered, how satisfied are you with your job overall?*
- *How much do you agree or disagree with the following statement: I feel a great sense of personal satisfaction when I do my job well.*

The first question was to be answered on a scale from 0 to 10, while the second was responded to on a 5-point Likert scale ('strongly agree' to 'strongly disagree'). The second question is a widely used measure of internal work motivation, which is part of the classic Job Diagnostic Survey (Hackman and Oldham 1974).

Since the two questions are closely related and have a relatively strong internal correlation (see Table A in Appendix 4), we combined them into an additive index. The job satisfaction and motivation index ranges from 0 to 1.

The results indicate a significant relationship between AM and job satisfaction and motivation (see Figure 11). Employees not exposed to AM are significantly more satisfied and motivated (average 0.81) than those employees experiencing the most AM (average 0.70). The estimated effect of 0.11 on the index is again controlled, ensuring the effect of other variables is held constant.

Figure 11. Predicted level of job satisfaction/ motivation at different levels of algorithmic management



Note: The figure shows the predicted levels of job satisfaction/ motivation at different levels of AM resulting from a linear regression model including control variables (held at the same levels as in Figure 9). The results from the regression analysis are provided in Table A in Appendix 5.

> *In light of the estimated effects of AM on autonomy and trust, it is not surprising that there is also a strong relationship between AM and job satisfaction and motivation.*

The estimated effect of AM on job satisfaction and motivation is somewhat smaller than previously shown for autonomy and trust. Still, the effect is quite substantial and highly significant. As previously described, we know from the literature on work design that both autonomy and trust are important for the level of motivation, which is also confirmed in our data by very strong correlations between both autonomy and job satisfaction and trust and job satisfaction (see Table B in Appendix 4). Hence, in light of the estimated effects of AM on autonomy and trust, it is not surprising that there is also a strong relationship between AM and job satisfaction and motivation.

This is also in line with the self-determination theory, which posits that human motivation and well-being more broadly are driven by the satisfaction of three basic needs – autonomy, competence and relatedness (Ryan and Deci 2000). The first two are closely related to our autonomy index, while the latter can also be seen as related to trust.

The respondents were asked to give their own assessment of how they feel the use of AM at their workplace affects their motivation. Respondents exposed to AM were asked if they think that this use of computer systems in their workplace *'… reduces my motivation to do a good job'*. A quarter (23%) agree with the statement, while almost half (46%) disagree (see Appendix 6). Looking only at respondents experiencing a high level of AM (at least five forms), around a third (35%) agrees while another third (33%) disagrees. This indicates that AM does not reduce motivation for all employees, but a larger proportion of the employees who are most exposed to AM feel less motivated than those who are less exposed to AM, according to their own assessment.

6.4. Workload

One of the main reasons that AM has gained traction in labour markets worldwide in recent years is probably that some of these new technological tools have the potential to optimise work processes and increase productivity (Lippert et al. 2023: 5282). If this is correct, it could also mean that the workload for employees increases and that employees have to work faster and harder. An increased workload is also one of the potential consequences of AM that has been highlighted in previous studies.

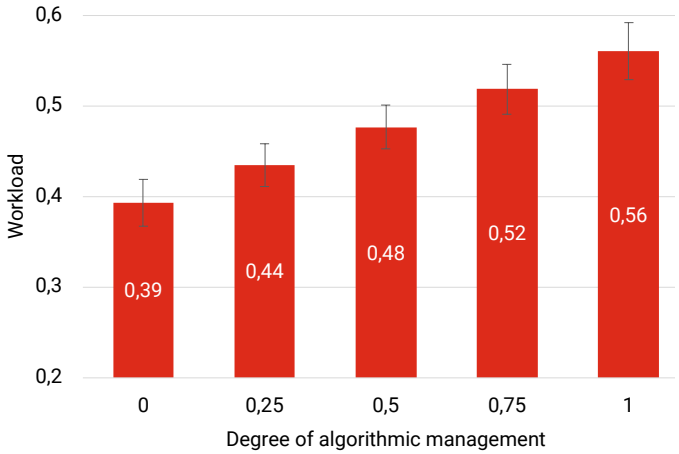
The perceived workload was measured with two statements in the survey. Respondents were asked whether they agreed or disagreed (on a 5-point scale) with these statements:

- *I generally have enough time to complete my tasks.*
- *There are often not enough people or staff to get all the work done.*

The first is an adapted version of a question included in the American General Social Survey (GSS 2017). The second is taken from the European Working Conditions Survey (Eurofound 2021). The two items are again used to construct an index ranging from 0 to 1.

As shown in Figure 12, there is a clear positive correlation between AM and the perceived workload, even when controlled for a series of background variables. Respondents who are not exposed to AM score an average of 0.39 on the workload index, while those experiencing the most AM score 0.56 on the index. Thus, the estimated effect is 0.17 on the workload index.

Figure 12. Predicted level of workload at different levels of algorithmic management



Note: The figure shows the predicted workload at different levels of AM resulting from a linear regression model including control variables (held at the same levels as in Figure 9). The results from the regression analysis are provided in Table A in Appendix 5.

The conclusion that AM can increase the workload is largely confirmed when we look at the respondents' own assessment of how they perceive the use of AM affects their workload. A total of 38% agree that the forms of AM they are exposed to make their workday busier, while 31% disagree (see Appendix 6). However, looking only at those respondents exposed to the most AM, a full 58% believe it makes their workday busier, while only 18% disagree. This shows that more employees who experience most types of AM feel that AM increase their workload, compared with employees who experience less AM.

Although it is difficult to make clear statements about causality, given the nature of our data and study design, these results do provide a clear indication that the use of AM can intensify work and thus increase the demands on employees.

6.5. Stress

Another potential consequence of AM is that it can increase the level of stress among employees exposed to it.

The stress level of employees was measured with the following two questions:

- *Have you experienced signs of stress in the past 3 months? (e.g. sleep problems, difficulty concentrating, heart palpitations or difficulty relaxing)*
- *How much do you agree or disagree with the following statement about your work: I work under a great deal of tension.*

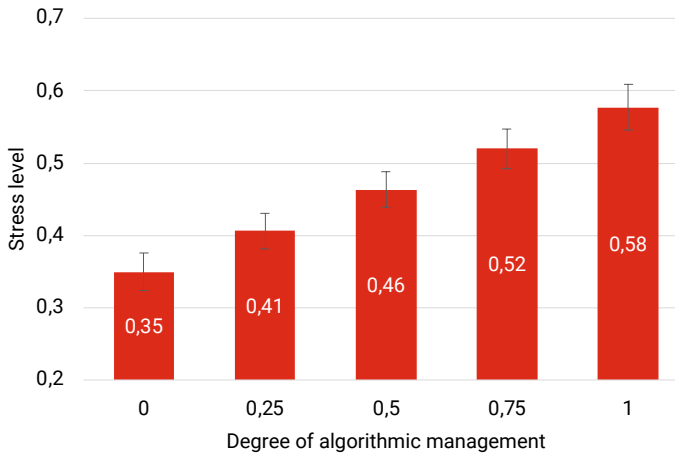
The first item taps into stress from a medical perspective. Some of the most common physical symptoms of clinical stress are provided as examples. Respondents could answer on a 5-point scale from 'No, never' to 'Yes, very often'.

The second item is a commonly used question to measure 'job tension'. It originates from the Stress-Anxiety questionnaire by House and Rizzo (1972) where it is part of a larger index. Several authors suggest that this item is a good sample item for the entire index (Steffensen et al. 2022; Mariappanadar and Hochwarter 2022). In our context, we consider this measure a less restrictive indicator of what we commonly refer to as 'stress' in everyday language.

Although the two items are somewhat different, they correlate rather closely (see Table A in Appendix 4). Therefore, they have been combined into a stress index ranging from 0 to 1.

As shown in Figure 13, there is a strong relationship between the use of AM and employees' stress levels. The stress level increases from 0.35 to 0.58 on the index when moving from no AM to maximum AM. This equates to an increase in the stress level of 0.23 on the index, again controlled for various background variables.

Figure 13. Predicted level of stress at different levels of algorithmic management



Note: The figure shows the predicted level of stress at different levels of AM resulting from a linear regression model including control variables (held at the same levels as in Figure 9). The results from the regression analysis are provided in Table A in Appendix 5.

Many of the employees exposed to AM also find that AM contributes to their stress level. Once again, respondents were asked to assess the effect themselves, with 38% stating that AM in the forms they experience at their workplace makes them more stressed (see Figure A in Appendix 6). By contrast, 35% disagree. Among those exposed to the most AM, 56% feel it makes them more stressed, while 19% disagree (see Figure B in Appendix 6). Thus, looking at both the strong correlation between AM and stress, and the employee's own assessment, we have solid evidence that the way AM is generally implemented leads to higher stress levels among employees.

Given that AM increases the workload, as described above, it is completely in line with the literature that the level of stress is enhanced as well. The central prediction of the classic Job-Demand-Resources Model is precisely that it can have adverse consequences for employees' well-being and mental health if employees are faced with excessive demands and do not have sufficient resources and autonomy to do their work. Accordingly, there is a very strong correlation in our data between workload and stress (see Table B in Appendix 4).

6.6. Job insecurity

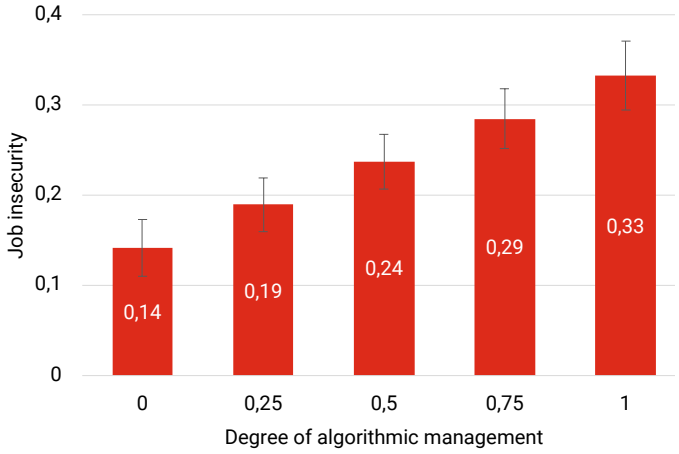
The last potential consequence of AM we explore in this report is the employee's perceived job insecurity, i.e. whether they feel there is a risk of losing their job. Job insecurity was measured on the basis of a single question in the survey:

- *How likely do you think it is that you will lose your job in the next 12 months?*

Respondents could answer on a 5-point scale (from 'very unlikely' to 'very likely'). This was converted to a score from 0 to 1 to match the other outcome variables and make the results more comparable.

Here too the effect was significant, as shown in Figure 14. Workers subjected to AM feel at greater risk of losing their job. The score increases from 0.14 to 0.33 on the scale when moving from no AM to most AM, all other things being equal. This equates to an estimated effect of 0.19 on the index.

Figure 14. Predicted level of job insecurity at different levels of algorithmic management



Note: The figure shows the predicted level of job insecurity at different levels of AM resulting from a linear regression model including control variables (held at the same levels as in Figure 9). The results from the regression analysis are provided in Table A in Appendix 5.

> *Among the respondents whose performance is evaluated by a computer, a remarkably large proportion have the impression that the assessment is used to make decisions about layoffs.*

The increased feeling of job insecurity among workers experiencing AM can be interpreted in two different ways. One possibility is that the risk of losing one's job *actually is* higher. As described earlier, the use of AM may be associated with precarious forms of employment. If a computer is used to schedule shifts to adjust the amount of labour to demand, it can create pressure for flexible forms of employment and part-time jobs, where employees are not guaranteed working hours.

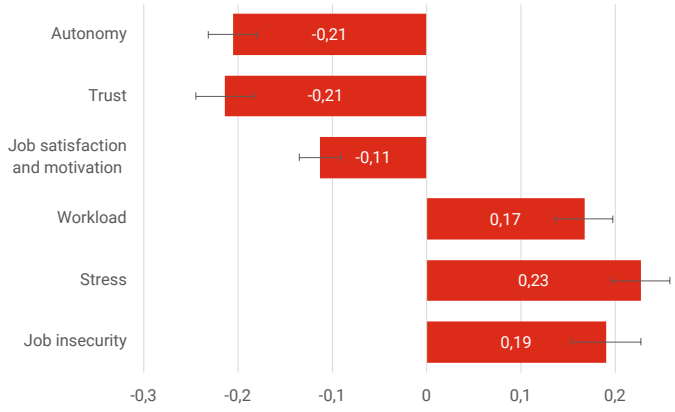
Another possibility is that the use of AM only increases the *feeling* of job insecurity. The experience of being constantly monitored and evaluated may make employees more insecure and give them the impression that they are constantly under scrutiny. Among the respondents whose performance is evaluated by a computer, a remarkably large proportion have the impression that the assessment is used to make decisions about layoffs (see also Figure 5 above).

6.7. Overview of consequences

Figure 15 provides an overview of the strength of the relationship between AM and each of the six outcomes discussed above. The effect sizes are estimated through linear regression models with all relevant control variables. Since all the outcome variables are coded from 0 to 1, the coefficients are comparable.

All the effects are substantial and highly statistically significant. AM seems to have the strongest effect on the workers' stress level, trust and autonomy, but the effect sizes are highly similar across outcomes – except for the effect on job satisfaction and motivation, which is somewhat weaker.

Figure 15. Overview of estimated effects of algorithmic management on different outcomes



Note: The figure shows the magnitude of the effect that algorithmic management has on the six outcomes, estimated by coefficients from linear regression models with control variables. The results from the regression analyses are provided in Table A in Appendix 5.

7. CONDITIONAL EFFECTS

7. CONDITIONAL EFFECTS

The results so far clearly show that a high degree of AM is associated with a range of negative consequences for employees. This is in line with the findings and propositions in most of the literature on AM. However, a few researchers argue that the implementation of AM may involve potential benefits for workers. AM may pave the way for more autonomy for workers if it is used in an enabling rather than a controlling manner, providing workers with information to help them make decisions on their own (Noponen et al. 2023). Additionally, AM can potentially increase workers' motivation by introducing game-like elements ('gamification') and giving real-time and meaningful feedback to the worker (Newman 2017; Ravid et al. 2020: 106). Some argue that algorithmic management tools are not inherently good or bad. Rather, the consequences of AM depend on how it is used and implemented (UNI Global Union 2020: 5).

The findings in this study suggests that on average, the way AM is currently implemented in the sectors we have examined in the Nordics has several negative consequences for workers. However, as argued by Noponen et al. (2023: 23), these consequences are not inevitable. In a similar vein, others suggest that the effects of AM are contingent upon context because new AM practices will always be embedded in pre-existing organisational structures and cultures (Fernández-Macias et al. 2022; Lippert et al. 2023).

Put in analytical terms, the general point made by these scholars is that the effects of AM might be moderated by several factors, as argued by Parent-Rocheleau and Parker (2022: 8). Different moderators may intensify or dampen negative effects or even cancel out negative effects and stimulate positive effects. These statements are primarily theoretical or based on cases. We are not aware of previous studies systematically examining whether the effects of AM may vary under different conditions.

We explore this empirically in the following sections. We have studied two possible moderators which the literature has highlighted – namely, the degree of employee influence and the degree of transparency in decision-making. Below, we examine whether these two factors moderate the relationships found in the previous section, and whether some of the adverse consequences can be mitigated.

7.1. Employee influence as a moderator

The degree of worker influence and involvement in company decisions may be important for how AM tools are used by managers and perceived by employees, and therefore also for the effects of AM. The argument is that the potential negative consequences of AM can be mitigated if workers are invited to contribute to the system, both in its implementation and operation (Parent-Rocheleau and Parker 2022: 11; Abey et al. 2020: 52; Nurski and Hoffmann 2022: 22).

We measured the degree of employee influence with the following two questions:

- *How much influence do you and your colleagues generally have on company decisions that influence the way you do your job?*
- *To what extent are employees involved and consulted when the company decides to implement new computer systems that affect your work?*

Both questions are answered on a 5-point scale and have been combined in an index that ranges from 0 to 1. As indicated, the two items involve the general employee influence and the specific influence on the implementation of new computer systems (such as different AM tools), respectively.

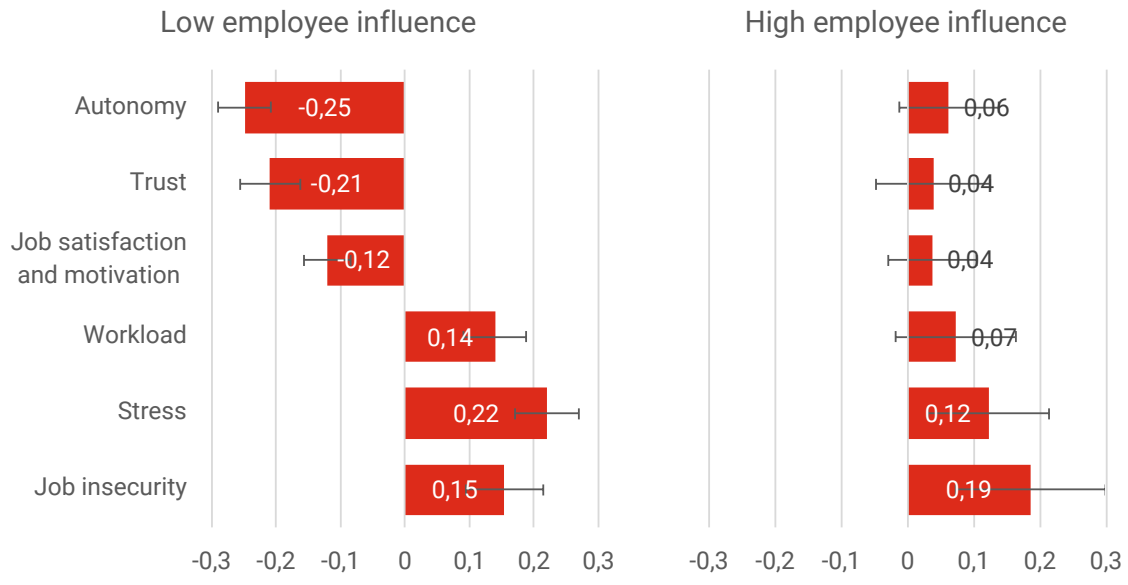
Figure 16 below shows the relationship between AM and the six outcomes for employees experiencing either no influence or maximum employee influence (score of 1 on the index). As seen, the estimated relationships at low employee influence largely mirror the general picture we described above. This is

because most respondents score relatively low on the employee influence index (median = 0.25). However, the picture looks quite different when examining employees who experience *high* influence.

There are statistically significant interaction effects in three cases – the effect of AM on autonomy, trust and job satisfaction/motivation is markedly different when employee influence is high. This means that the relationship between AM and these outcomes significantly differs in workplaces with low and high degrees of employee influence. For employees experiencing the lowest employee influence, there is a markedly negative correlation in all three cases. However, when looking at employees who report having a high influence on important company decisions that affect their work, the negative effects disappear (or are negligible). Here, when employee influence is high, there is no significant relationship between the use of AM on the one hand and the employees' perceived autonomy, the level of trust between managers and employees, and job satisfaction and motivation on the other.

For the other three outcomes – workload, stress and job insecurity – there are no significant interaction effects. This means there are no significant differences in the estimated effects of AM at different levels of employee influence. Whether there is low or high employee influence, it seems that AM leads to a higher workload, higher stress and higher job insecurity. However, the statistical uncertainty is considerably greater when looking at employees who report very high employee influence, as there are very few of them in the sample. In the case of workload, high employee influence may dampen the negative effect of AM, but the estimate is so uncertain (and confidence intervals so broad) that we cannot rule out that high employee influence has no dampening effect.

Figure 16. Estimated effects of algorithmic management at different levels of employee influence



Note: The figure illustrates the magnitude of the effect that algorithmic management has on the six outcomes when employee influence is low (index = 0) and high (index = 1), respectively, estimated by coefficients from linear regression models with interaction terms and control variables. The results from the regression analyses are provided in Table B in Appendix 5.

The results generally indicate that the degree of employee influence significantly dampens the negative consequences of AM. In companies where employees are extensively involved in company decisions and consulted when new computer systems are implemented, some of the negative consequences of using AM can be mitigated. In particular, the use of AM does not seem to decrease autonomy, erode trust between managers and employees or decrease job motivation when employee influence and involvement is high.

> *When looking at employees who report having a high influence on important company decisions that affect their work, the negative effects disappear.*

However, this moderating effect does not apply to all consequences. Regardless of whether company leaders involve their employees, AM seems to have some negative effects in the form of increased workload, increased stress and an elevated perception of the risk of job loss.

Looking at how respondents themselves evaluate the effects of AM, it is confirmed that the degree of employee influence can have a significant impact on these effects. Among employees experiencing a low degree of employee influence, significantly more say that AM has negative consequences compared with employees in workplaces with high employee influence (see Figure C in Appendix 6).

7.2. Transparency as a moderator

The degree of transparency in decision-making is another factor that can moderate the consequences of AM. If workers are informed about what is monitored and what this information is used for, Parent-Rocheleau and Parker argue, the negative consequences can be reduced or even prevented (2022: 9; see also Jeske 2022).

The degree of transparency in the company was measured with a single statement, which respondents could agree or disagree with on a 5-point scale:

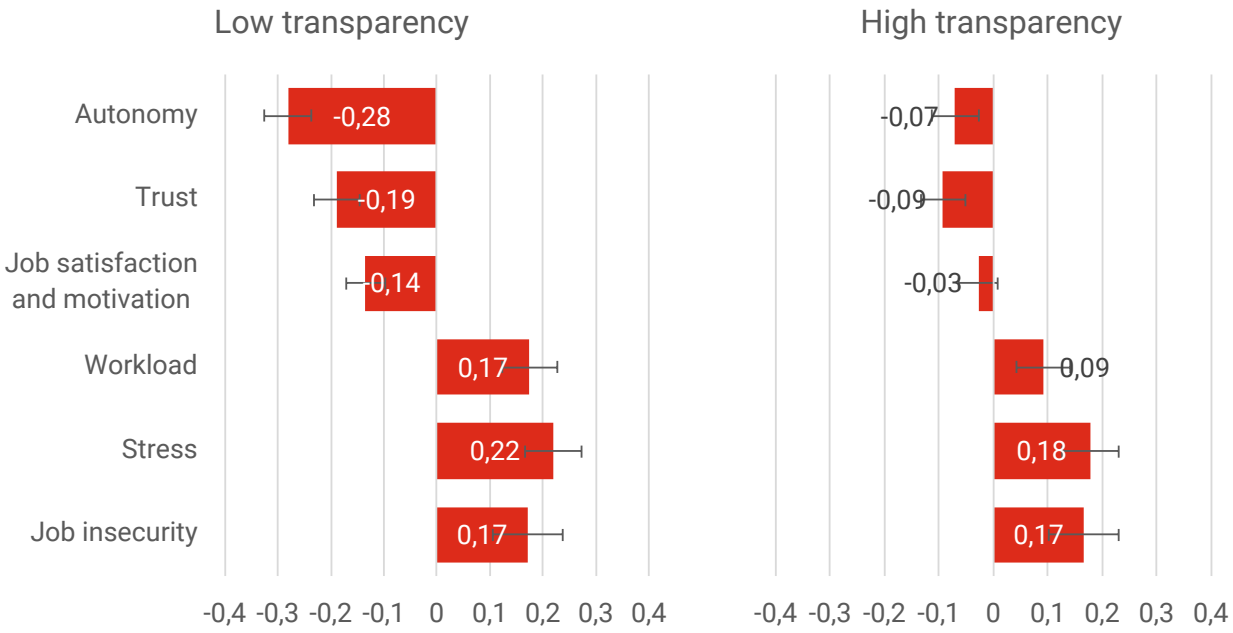
- *Management decisions that affect me are always explained and communicated clearly.*

This question concerns transparency in workplace decisions in the broad sense, and not specifically AM. This approach was chosen to ensure the question was applicable to all respondents, regardless of their exposure to AM.

Figure 17 shows the estimated relationship between AM and the six outcomes at both the lowest level of transparency (index = 0) and very high transparency (index = 1). Again, there is a significant interaction effect in three cases: AM's negative consequences on autonomy, trust and job satisfaction and motivation are significantly lower when transparency is high. However, there is still a significant negative effect on the degree of autonomy and trust in this case. Thus, it appears that high transparency in decisions can mitigate these negative effects of AM but not prevent them altogether, no matter how high the transparency.

The degree of transparency does not seem to moderate the negative effects of AM on stress and job insecurity. However, the estimated effect of AM on workload is considerably lower at high transparency, and here the interaction effect is almost significant at the 0.05 level ($p = 0.055$). This indicates that higher transparency may also dampen AM's effect on workload.

Figure 17. Estimated effects of algorithmic management at different levels of transparency



Note: The figure illustrates the magnitude of the effect that algorithmic management has on the six outcomes when transparency of management decisions is low (index = 0) and high (index = 1), respectively, estimated by coefficients from linear regression models with interaction terms and control variables. The results from the regression analyses are provided in Table C in Appendix 5.

> *The results thus indicate that the consequences of AM are not inevitable – some of the adverse consequences for employees can be diminished or even cancelled out altogether if high employee involvement and a high degree of transparency in management decisions are ensured.*

The notion that the degree of transparency moderates some of the consequences that AM has for employees is confirmed when we look at the employees' own assessment. As described earlier, respondents were asked how they think the use of AM affects their autonomy, workload, stress level and motivation. It is clear from the answers that respondents who experience a low degree of transparency are much more likely to conclude that AM has negative consequences compared with respondents who experience a high degree of transparency (see Figure D in Appendix 6).

The results thus indicate that the consequences of AM are not inevitable – some of the adverse consequences for employees can be diminished or even cancelled out altogether if high employee involvement and a high degree of transparency in management decisions are ensured. This dampening

effect of employee involvement and transparency is not found for stress, feelings of job insecurity and workload. In these cases, AM's negative effects are apparently much harder to avoid. However, we cannot rule out that employee influence and transparency might mitigate these negative effects as well. We know that increased autonomy, trust between the employer and employees and high job satisfaction tend to reduce perceptions of workload, stress and job insecurity (see online Appendix 4). Therefore, the dampening effect of employee influence and transparency on AM's negative impact on autonomy, trust and job satisfaction may indirectly reduce workload, stress and job insecurity as well.

This suggests there is leeway for labour unions and others to influence the implementation of AM positively. It will be difficult to stop these fast-paced technological developments, which include more and more advanced tools for management. However, it is crucial to ensure that they do not compromise workers' rights and well-being. This study shows that transparency and employee involvement are key measures to prevent some of these adverse consequences.

Source: shutterstock.com/g/ZoltanPapp

PART III

8. CONCLUSION AND POLICY PERSPECTIVES

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This report provides strong evidence that AM has a range of negative consequences for employees. The more employees are exposed to AM, the less work autonomy they feel they have in their jobs, the less trust they feel from and towards their employer, and the greater the workload they bear. AM also appears to have an impact on employees' well-being at work: when AM is widely used, employees are less satisfied with their jobs and less motivated, and feel significantly more stressed and more insecure about their jobs. The study provides clear evidence that AM has these adverse consequences. Although we have controlled for potential confounders in our analyses, the study is solely based on correlational evidence, so we cannot definitively claim causal effects. It is the first of its kind to systematically investigate these relationships, contributing crucial new insights into the potential consequences of AM.

The way AM is currently implemented – at least in the Nordic countries in the sectors we studied – it often seems to be used in a controlling and exploitative manner with a series of negative consequences for employees as a result. This does not necessarily mean that AM does not work as intended.

When these technological tools are implemented, the aim is usually to increase productivity and make employees work faster. It is quite possible that this objective is met. Employee workload is the flipside of the productivity coin, and in this study many respondents do experience an increased workload as a result of AM. However, it is important to remember that the interests of employers and employees are far from always aligned. AM might have adverse consequences for employees and desirable outcomes for employers at the same time. In that way, AM can alter the balance between employer prerogatives and employee rights and enable managers to control employees in ways we could not even imagine 10 or 20 years ago.

Fortunately, this study also shows that the wide array of negative consequences are not all inevitable. As some argue, AM tools may simply be seen as tools that are neither inherently good nor bad (UNI Global Union 2020: 5). From this perspective, the negative consequences highlighted in this report might be better understood as risks when AM is poorly implemented.

When a company implements AM without consulting employees, and without giving them influence over and insights into how the systems are used, and how management decisions are made, AM seems to have particularly harmful effects for employees. If a high degree of employee influence and high transparency are ensured, it appears that at least some of the negative consequences can be avoided.

From an employee perspective, it is crucial to ensure that AM does not merely become a tool that employers can use to accelerate monitoring and control of employees to make them work faster and harder. We should emphasise that it is possible to use these tools in less exploitative ways.

We cannot and should not try to stop technological advancement. Still, we do need to prevent this technology from circumventing labour law, driving down working conditions by intensifying competition among workers and facilitating workers' surveillance. Artificial intelligence and other algorithmic systems offer new tools for managers and employees alike. The aim should not be to cancel this development – instead, we must ensure that the potential benefits of AM are evenly distributed, and that the introduction of AM does not compromise the quality of jobs and employees' well-being. Both employers and regulators need to be mindful of how we may harness technology to protect and improve human work rather than dehumanise it. As this study has clearly shown, challenges still lie ahead if algorithmic management is to be implemented and exploited in ways that benefit all.

9. POLICY IMPLICATIONS AND RECOMMENDATIONS

9. POLICY IMPLICATIONS AND RECOMMENDATIONS

This study shows that the use of algorithmic management in the workplace creates significant challenges for employees. We are not talking about some distant and hypothetical development, nor about a fringe event. When three-quarters of the workers in the sectors investigated are confronted by at least one algorithmic tool, we know that these practices are quickly becoming mainstream, at least in the Nordic countries, but most likely in other EU Member States too. As many companies operate cross-border, we can expect these practices to spread around Europe without much delay.

When it comes to workers' rights, there are already several safeguards in place that should prevent European workers from becoming the guinea pigs in the innovation process. Most existing legislation, both national and in the EU, has a technologically neutral approach that should, at least in principle, offer protection for employees and set boundaries on what levels of employee surveillance and control are acceptable. The findings of this study suggest that the existing legislation does not always deliver the right level of protection. The rules must be applied and potentially adjusted to a new, more digitalised reality posing new challenges.

The results of this workers' survey point to the negative effects of AM systems on working conditions and the role that transparency, co-determination and worker involvement can play to partly mediate those effects. Since labour relations are a complex interplay between stakeholders, including trade unions and national and European legislators, more research is needed on how exactly to achieve a more favourable outcome. In theory, technology-neutral legislation that focuses on working conditions and co-determination with strong social partners and collective bargaining could be sufficient to handle this technological change. But in reality, as we can see from this study, the introduction of new algorithmic management systems in the Nordic countries has come at the price of worsening conditions for the workers exposed to them.

One could therefore conclude that the existing legislation is insufficient and that there may be a need for new rules, directives and agreements at both the EU and national level. But the problem is not so much the existing rules themselves, but rather how they are used. Or worse, how they are not applied or enforced. There are labour laws in the different Nordic countries that should address many of the problems associated with AM systems, yet we still find the negative effects this study clearly identifies. We must deepen our understanding of how the negative consequences of this technological change can be mediated. At its core, this is a question of justice, on how the spoils of technological advancement should also come to workers, instead of worsening their conditions.

> *We must deepen our understanding of how the negative consequences of this technological change can be mediated.*

It will be interesting to see what the recently adopted EU AI Act will bring and if it will be able to steer the development of AI in a human-centric direction. The employment and management of workers are identified as high-risk use cases, which means that AI systems deployed in the work context will be subject to strict obligations before they can be put on the market. To mention a few: adequate risk assessment and mitigation systems; high quality of the datasets feed-

ing the system to minimise risks and discriminatory outcomes; logging of activity to ensure traceability of results; detailed documentation providing all information necessary on the system and its purpose for authorities to assess its compliance; clear and adequate information to the deployer; appropriate human oversight measures to minimise risk; and a high level of robustness, security and accuracy.[2]

In the subfield of algorithmic management, the European Commission has announced that it will start looking into specific regulation of AI in the workplace by ordering an extensive study into the current practices and the risks and opportunities for both workers and companies of algorithmic management tools.[3] This investigation will be the first of many steps in a lengthy European legislative process that could lead to a directive or even a regulation. And although there seems to be a broad consensus amongst policymakers on the need for this regulation, we will have to wait for the European elections and the new commissioner for social affairs to put forward a Commission proposal.

In the meantime, one piece of legislation recently adopted – the Platform Work Directive, with a chapter on the algorithmic management of platform workers – will serve as a strong precedent.[4] Provisions on the transparency of algorithmic tools, the ban on the use of specific private data in algorithmic decision-making, the requirement for human recourse on algorithmic decisions and the requirement for companies to pay for the costs of external experts on algorithmic tools hired by workers' representatives are all equally relevant in traditional sectors that are or will be confronted with these developments. Below is a summary of the different aspects of the chapter on algorithmic management contained in the Platform Work Directive.

Table 3. A summary of chapter III of the Platform Work Directive on algorithmic management

1. Limitations on processing of personal data by means of automated monitoring or decision-making systems (Article 7), banning the use of any personal data on the emotional or psychological state of the person, monitoring private conversations, collecting data while the person is not working, data to predict the exercise of fundamental rights, including the right of association and collective bargaining, data to infer for example racial or ethnic origin, migration status, political opinions, disability, state of health or trade union membership, and any biometric data to establish the identity of the worker.

2. Transparency on automated monitoring or decision-making systems (Article 9) to inform platform workers, their representatives and competent national authorities of the use of automated monitoring or decision-making systems. That information shall concern, amongst others, all types of decisions supported or taken by automated decision-making systems, the fact that such systems are in use or are in the process of being introduced, the categories of data and actions monitored, supervised or evaluated by such systems, including evaluation by the recipient of the service, the aim of the monitoring and how the system is to achieve it, and the grounds for decisions to restrict, suspend or terminate the account of the person performing platform work or to refuse payment for the work performed, as well as for decisions on their contractual status.

3. Human oversight of automated systems (Article 10) obliging digital labour platforms to oversee, with the involvement of workers' representatives, and regularly evaluate the impact of individual decisions taken or supported by automated monitoring and decision-making systems on workers, their working conditions and equal treatment at work. Information on the evaluation shall be transmitted to platform workers' representatives and the competent national authorities upon their request. Any decision to restrict, suspend or terminate the contractual relationship or the account of a person performing platform work must be taken by a human being.

2 https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai

3 https://www.visionary.lt/spotlight/va-kicks-off-an-algorithmic-management-study/

4 https://www.consilium.europa.eu/en/policies/platform-work-eu/

4. Human review (Article 11) requiring persons performing platform work to have the right to obtain an explanation from the digital labour platform for any decision taken or supported by an automated decision-making system without undue delay. The explanation shall be presented in a transparent manner, using clear and plain language. The platforms must provide workers with access to a contact person designated by the digital labour platform to discuss and to clarify the facts, circumstances and reasons having led to the decision. Such contact person must have the necessary competence, training and authority to exercise that function.

5. Safety and health (Article 12) requiring the platform to evaluate the risks of automated monitoring or decision-making systems to the safety and health of workers, as regards possible risks of work-related accidents and psychosocial and ergonomic risks, to assess whether the safeguards of those systems are appropriate for the risks identified in view of the specific characteristics of the work environment and to introduce appropriate preventive and protective measures. In relation to these requirements, platforms must ensure effective information, consultation and participation of workers and/or their representatives. The use of automated monitoring or decision-making systems may not in any manner put undue pressure on platform workers or otherwise put at risk the safety and the physical and mental health of platform workers.

6. Information and consultation (Article 13) of workers' representatives by platforms, as defined in Directive 2002/14/EC, must also cover decisions likely to lead to the introduction of or to substantial changes in the use of automated monitoring or decision-making systems and shall be carried out under the same modalities concerning the exercise of information and consultation rights. The platform workers' representatives may be assisted by an expert of their choice, in so far as this is necessary for them to examine the matter that is the subject of information and consultation and formulate an opinion. The expenses for the expert shall be borne by the platform, if they are proportionate.

Our study shows that without the right guard rails, algorithmic management tools can have a devastating effect on workers' job quality. The negative effects on the autonomy, trust, job satisfaction and motivation are significant, but we have also seen that more transparency can dilute these negative effects and that high employee influence on the adoption of algorithmic management can even reverse these negative effects completely. By contrast, we do not find the same effects for the workload, stress and job insecurity factors. High levels of employee influence do improve the situation marginally, but more transparency does not seem to resolve the issues encountered in relation to occupational health and safety, the way it does with softer work quality metrics like trust and autonomy. It does show that from a policy perspective, there is considerable potential for applying social dialogue and co-determination to implementation and implementing algorithmic and automated management tools to achieve a successful outcome regarding workers' autonomy, trust and job satisfaction and motivation.

“The negative effects on the autonomy, trust, job satisfaction and motivation are significant, but we have also seen that more transparency can dilute these negative effects and that high employee influence on the adoption of algorithmic management can even reverse these negative effects completely.”

In the Nordic countries where this research took place, this issue can be regulated through collective agreements. In Denmark, for instance, there is a collective agreement on control measures that limits how employers are allowed to surveil and control employees. In Norway, the role of a dedicated 'data shop steward/data trade union

representative' is recognised in the Main Agreement (2022-2025) between the Norwegian Confederation of Trade Unions and the Confederation of Norwegian Enterprise.[5] Meanwhile in Sweden, the Co-Determination Act (MBL), the Work Environment Act (AML) and regulations in collective agreements all provide opportunities for trade unions to have influence over and insight into how new digital systems are implemented and used. The MBL stipulates that before employers decide on major changes to their operations, they must negotiate with the trade union on their own initiative, and it is the union's role to insist that the introduction of new technology is regarded as a major operational change. In addition to the MBL, the Work Environment Act (AML) also contains rules on the influence of both individual employees and safety representatives/ protection committees.

Applying the Nordic model to this new wave of digitalisation of the shopfloor might be the answer to getting AI in the workplace right across Europe. This does require us to revisit and reinforce the transparency and reporting requirements on algorithmic management tools for workers' representatives to be able to perform their duties, as was done in the Platform Work Directive.[6]

However, when it comes to the health and safety of workers, for example, due to increasing workloads and stress levels, co-determination is not a panacea. These aspects should be dealt with by applying the existing national and EU health and safety rules to the new and changing circumstances of the digitalised workplace, such as Council Directive 89/391/ EEC on the introduction of measures to encourage improvements in the safety and health of workers at work[7], and the various national health and safety regulations that make the employer responsible for ensuring that employees do not become ill due to influences in the psychological work environment. Yet it is also these aspects that could require new rules on AI in the workplace in traditional sectors, which – as with platform workers – explicitly prohibit putting undue pressure on workers or otherwise putting at risk the safety and the physical and mental health of these workers through algorithmic management tools.[8]

Another aspect relates to the data generated at the workplace. To be effective, algorithmic and automated management systems rely on the quality and quantity of the available data that feed into the algorithm. This might be workers' personal data, or aggregated data on the interactions between workers and the processes on the shopfloor.

For personal data, we should look at the relevant aspects of the GDPR[9], which also apply in the work environment. According to Articles 13 and 14 of the GDPR, the employer must inform employees about personal data collection and the existence of automated decision-making systems. Also, Article 22 GDPR applies in the work context and gives the worker 'the right not to be subject to a decision based solely on automated processing', which produces legal effects concerning him or her or similarly significantly affects him or her. To a large extent, the issues concerning algorithmic management could be mitigated by a strict application of the GDPR, but in the everyday reality there has been a lack of enforcement of these general data protection rules. Therefore, Member States could consider actively transposing Article 80(2) GDPR, which would allow unions to bring ´own-initiative´ complaints and cases for non-compliance with the GDPR.

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5 Read more about this in the FEPS policy study 'Algorithms by and for the workers: Towards a fair, democratic, and humane digitalisation of the workplace', https://feps-europe.eu/publication/algorithms-by-and-for-the-workers/

6 Article 9 and 13 of the Platform Work Directive, https://data.consilium.europa.eu/doc/document/ST-7212-2024-ADD-1/en/pdf

7 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, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A31989L0391

8 Article 12 of the Platform Work Directive, https://data.consilium.europa.eu/doc/document/ST-7212-2024-ADD-1/en/pdf

9 https://eur-lex.europa.eu/eli/reg/2016/679/oj

> *To a large extent, the issues concerning algorithmic management could be mitigated by a strict application of the GDPR, but in the everyday reality there has been a lack of enforcement of these general data protection rules.*

In addition, the employment relationship requires specific data protection rules, in light of its hierarchical nature. For instance, the notion of consenting to the use of one's data, a central concept of the GDPR, is ill-suited for the hierarchical employment context, where a person's work is dependent on using the digital tools that are gathering data on them, and where they cannot be said to ´freely´ consent. Therefore, Article 88 GDPR allows Member States to provide specific data protection rules for the employment context, by law or under collective agreements, as Finland has done and as Germany is planning on doing as well. This could be a good way for Member States to clarify data protection norms in the workplace, adapted to their national employment law frameworks and traditions.

That said, the GDPR has its limits when it comes to the collective dimension of the workplace and is not equipped to deal with the upswing in algorithmic management tools in that setting. Here, the Platform Work Directive (PWD) could lead the way as it sets more explicit limitations on the processing of personal data by means of automated monitoring or decision-making systems. It also makes several references to the role of worker representatives in accessing information held in algorithmic systems. Article 13 PWD sets out the information and consultation rights of workers' representatives, including decisions on the introduction of or changes in the use of automated monitoring or decision-making systems. The platform workers' representatives can call on an expert to help them examine the proposed systems and formulate an opinion, at the platform's expense if it has more than 250 platform workers in that Member State. After the transposition of the PWD into the national law of the Member States, we will see if the application of these rules is enough to develop a successful, sustainable and worker-centric application of AI in the platform workers' workplace. This will also depend on the governance structure and the funding for platform workers' representatives to effectively safeguard the workers' collective rights, the right to organise and the role of worker representatives to negotiate the use of shopfloor data to run algorithmic tools. The scope of the PWD is limited to a subsegment of the labour market – i.e. platform workers – but its provisions in the chapter on algorithmic management do set a clear precedent for future European legislation for workers in more traditional sectors.

> *Workers and their trade union representatives should get access to the data that the management has, which is often not the case.*

Workers and their trade union representatives should get access to the data that the management has, which is often not the case. They should be able to understand and comprehend the functioning of the automated and algorithmic tools and their impact on their work and the workers they represent. This will require expert advice – paid for by the employer – to support co-determination on a more equal footing. Besides the PWD, we find this notion in Sweden in the context of a collective agreement, where the Development Agreement between LO, PTK and the Confederation of Swedish Enterprise regulates the introduction of new technology in the workplace. This agreement gives local union representatives the right to hire an employee consultant

at the company's expense when a company is facing a change that has a significant impact on the workers' employment. It could be used in situations where new technologies that change the way work is done are to be introduced. The employee consultant should be an expert with the appropriate skills to analyse the consequences of the change, with the aim of enabling trade unions to analyse the employer's evidence and to consider the issues raised by the change, as well as to identify alternative ways forward. Another example comes from the recent adaptation of the German law on works councils. The German Works Constitution Act was recently amended to take account of developments in AI, by inserting in Section 80 (3) BetrVG the right for a works council to call on expert advice when it comes to the introduction or application of AI in the workplace. These examples show that the data-heavy and highly technical processes involved in algorithmic management are aggravating the information imbalance between workers and the employer and should be mitigated.

These examples show that the data-heavy and highly technical processes involved in algorithmic management are aggravating the information imbalance between workers and the employer and should be mitigated.

This is why a legislative initiative by the European Commission is expected and carries wide cross-party support. Since labour legislation is largely a Member State competence, we should expect this to be a directive that gives the national legislator freedom to implement the rules according to the national context and specific labour law system. For the Nordic states, this will have to respect the role of the social partners, the co-determination process and the collective agreements that regulate the workplace within the Nordic model. It is also hoped that the EU as a whole will significantly expand the role of collective agreements, given the political agreement to strive for 80% of collective bargaining rates in the recently agreed Minimum Wage Directive. But even in this context, a clear legal framework on the translation of the long-established workers' rights in a new digital context will support the trade unions in agreeing the right terms for their members in the application of algorithms in the workplace.

It is clear that trade unions and workers' representatives will have to play a central role in this respect and need to be supported in getting all the information they need.

Hence, on the basis of this study, we recommend investing effort in enhancing transparency and employee influence in all companies and all workplaces to counter the potentially detrimental side effects of algorithmic management on workers' autonomy, trust and motivation. It is clear that trade unions and workers' representatives will have to play a central role in this respect and need to be supported in getting all the information they need. This should include expert advice to be able to assess the algorithmic tools and advise their members.

However, it is equally clear from the results of this study that co-determination and transparency are not enough. If we want to prevent a negative impact on the workload, stress and job insecurity of workers, we need to set boundaries for the application of algorithmic management for occupational health and safety reasons. These data-heavy processes are raising questions about the use of personal and collective data to run algorithms. We need to enforce

data rights under the GDPR, but also go further by introducing specific rules on worker surveillance and setting boundaries to prevent dystopian outcomes.

All of these aspects could find their way into a legislative proposal by the European Commission on AI in the workplace. We have concluded that the chapter on algorithmic management in the Platform Work Directive could be the starting point for the discussion. Still, when regulating workplaces in traditional sectors, there is an even bigger need to be attentive to the national labour law implications of a European legislative initiative. In the Nordic context, this means the new rules should support the co-determination process, and certainly not undermine it. In traditional sectors across Europe, the role of trade unions is more established than in platform work. Therefore, we should look to the social partners and collective agreements as part of the solution. The Nordic countries already offer some good examples that could serve as a worker-centric model for the implementation of AI on the shopfloor across the EU.

When regulating workplaces in traditional sectors, there is an even bigger need to be attentive to the national labour law implications of a European legislative initiative. In the Nordic context, this means the new rules should support the co-determination process, and certainly not undermine it.

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11. APPENDICES

11. APPENDICES

Appendix 1. Response rates and sample size

Table A. Response rate across countries, age groups and genders

	Completed	Partial answers	Not completed
Denmark	13.1%	3.6%	83.4%
Finland	13.2%	2.5%	84.3%
Norway	9.0%	3.0%	88.1%
Sweden	10.8%	6.9%	82.4%
Female	13.2%	3.6%	83.2%
Male	10.4%	3.7%	85.9%
30 or younger	5.3%	2.6%	92.0%
31-40	9.1%	3.3%	87.6%
41-50	13.4%	4.1%	82.5%
51-60	16.8%	4.4%	78.8%
Over 60	16.3%	4.0%	79.7%
Total	**11.7%**	**3.6%**	**84.7%**

Note: Respondents who said that they did not currently have a job (0.4%) are counted as completed, even though they were not asked any further questions.

Table B. Sample size across sectors and countries

	Denmark	Finland	Norway	Sweden	Total
Warehouse worker	680	998	128	820	2626
Customer service/telemarketing	343	154	130	-	627
Other, computer-based work	473	29	69	-	571
Other, not computer-based work	353	79	39	52	523
Citizen service	985	-	-	-	985
Retail sales	-	-	473	-	473
Office	-	-	279	-	279
Aviation	-	-	123	-	123
Financial sector	-	-	117	-	117
Total	2834	1260	1358	872	6324
Not employed	87	121	9	24	241
Unknown sector	7	0	35	162	204
Total incl. unemployed and unknown	**2928**	**1381**	**1402**	**1058**	**6769**

Note: Unemployed respondents and respondents who did not say which sector they work in are not included in the analyses in the report.

Appendix 2. Exposure to algorithmic management by sector and country

Table A. Proportion of respondents experiencing each form of AM by sector

	Task allocation	Shift scheduling	Tracking working time	Location tracking	Monitoring computer activity	Work speed monitoring	Perfor-mance evaluation	Leader-board
Warehouse	44%	31%	48%	26%	-	61%	50%	14%
Customer service telemarketing	33%	32%	52%	-	41%	58%	52%	30%
Citizen service	22%	15%	24%	-	49%	23%	29%	14%
Retail sales	26%	52%	45%	15%	-	19%	26%	18%
Office	16%	12%	16%	-	29%	11%	20%	9%
Aviation	51%	57%	43%	-*	-*	34%	54%	5%
Financial sector	34%	11%	22%	-	46%	32%	36%	15%

Note: The table shows the proportion of respondents who answered either 'Yes, definitely' or 'Yes, I think so' when asked about each form of AM. *The proportion of aviation workers (Norway only) experiencing location tracking and computer activity monitoring is not reported, because of too few respondents. These respondents were asked one of these two questions depending on whether they said that they primarily worked at a computer.

Figure A. Average score on AM index by sector

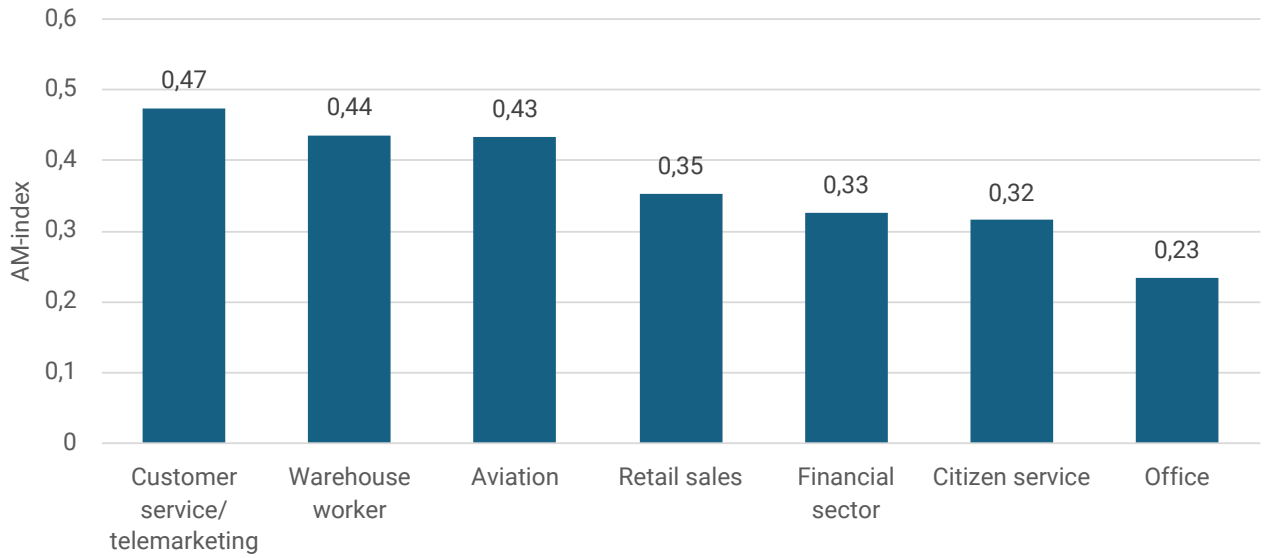
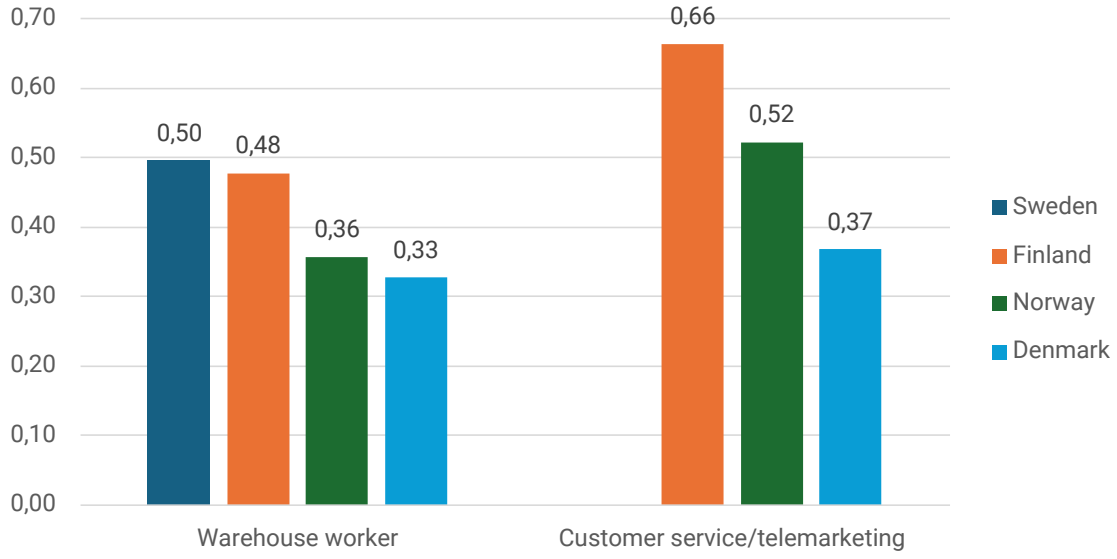
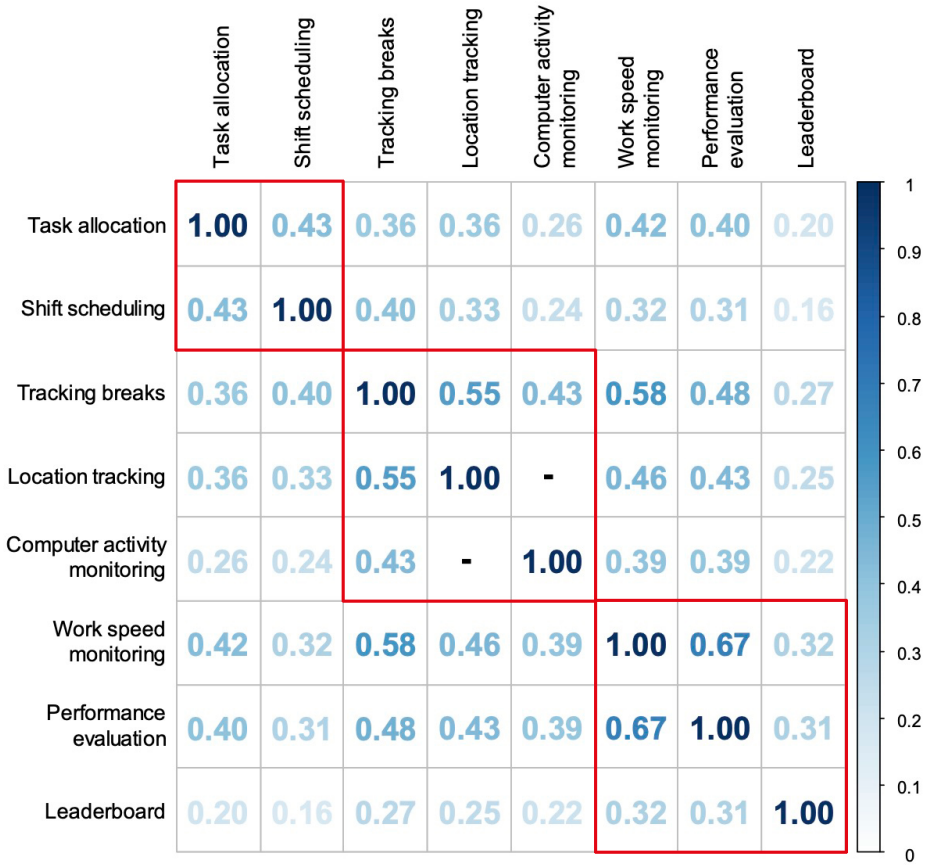


Figure B. Average score on AM index by country and sector



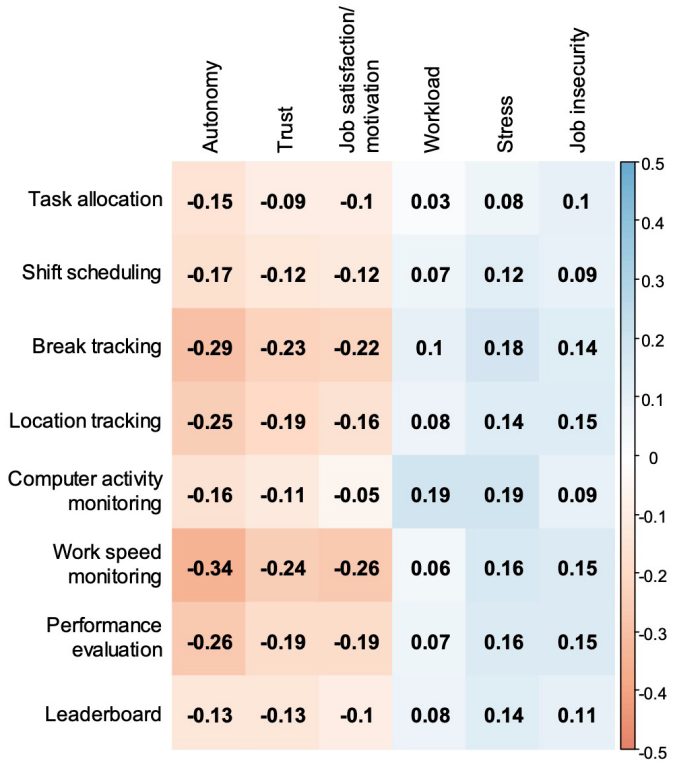
Appendix 3. Analyses regarding the construction of the AM index

Figure A. Correlations between different forms of algorithmic management



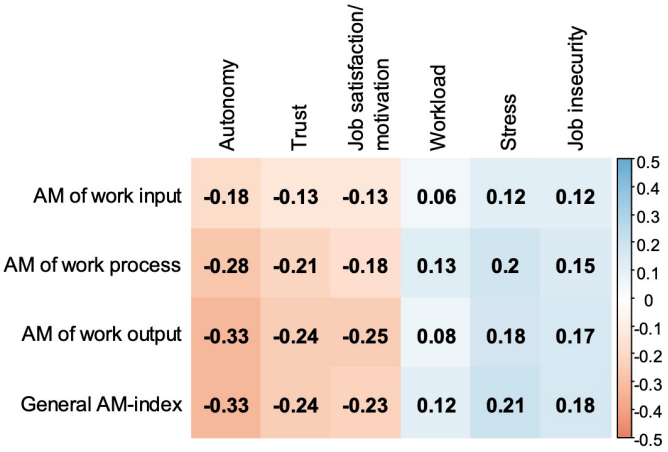
Note: The three dimensions of AM – management of the input, process and output – are outlined in red. As shown, each form of AM correlates slightly more strongly with other forms of AM within the same dimension, but all indicators intercorrelate across the three dimensions. No correlation has been calculated between 'location tracking' and 'computer activity monitoring', since respondents were only asked one of these two questions.

Figure B. Correlations between forms of AM and outcomes



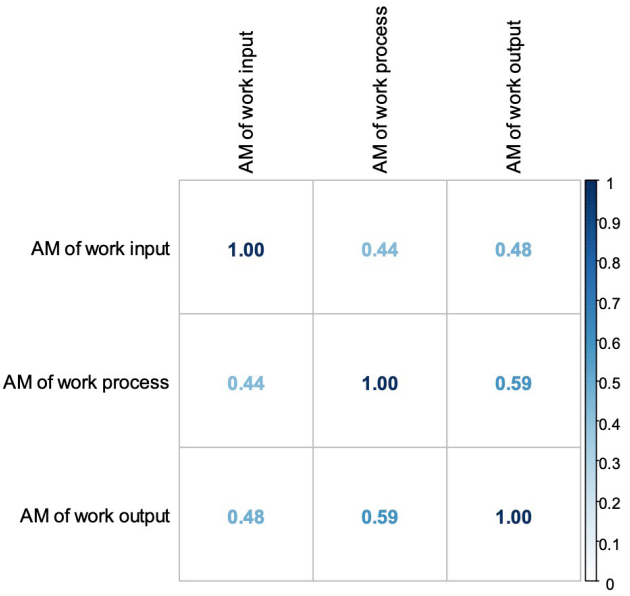
Note: The figure shows the bivariate correlations measured using Pearson's r.

Figure C. Correlations between dimensions of AM and outcomes



Note: The figure shows the bivariate correlations measured using Pearson's r. The three AM-dimension indices are constructed in the same way as the general AM index, but include only a subset of the eight AM forms: 'AM of work input' includes the task allocation and shift scheduling variables; 'AM of work process' includes tracking of working time, tracking of location and monitoring of computer activity; and 'AM of work output' includes work speed monitoring, work performance monitoring and leaderboard.

Figure D. Internal correlations between dimensions of AM



Note: The figure shows the bivariate correlations measured using Pearson's r. See the note to Figure A.

Appendix 4. Internal correlations of indices for outcome variables

All indices were constructed as additive indices, where all sub-indicators were scaled from 0 to 1, after which an average score for the sub-indicators was calculated. For the questions that were based on 5-point Likert scales, this means, for example, that 'mainly agree' yields a value of 0.75.

Below, the internal correlations between the items in each index are listed. Since the variables are measured on an ordinal scale the correlations are measured using Goodman-Kruskals Gamma.

Table A. Bivariate correlations between items

	Correlations between items
Autonomy index (three items)	Decision-making vs. personal initiative: 0.80 Decision-making vs. skill use: 0.54 Personal initiative vs. skill use: 0.66
Trust index (two items)	0.75
Motivation and satisfaction index (two items)	0.49
Workload index (two items)	0.40
Stress index (two items)	0.50
Job insecurity (one item)	-

Table B. Bivariate correlations between outcome variable indices

Appendix 5. Regression tables

Table A. Linear regression models for each of the six outcomes

	Autonomy index	Trust index	Job motivation index	Workload index	Stress index	Job insecurity
AM index	-0.205***	-0.214***	-0.113***	0.168***	0.228***	0.190***
	(0.013)	(0.016)	(0.012)	(0.015)	(0.016)	(0.019)
Country (ref=Denmark)						
Finland	-0.026**	-0.022*	-0.035***	-0.032**	0.030**	-0.021
	(0.011)	(0.013)	(0.010)	(0.013)	(0.013)	(0.016)
Norway	0.008	-0.043**	-0.058***	0.067***	0.136***	-0.063***
	(0.014)	(0.017)	(0.012)	(0.016)	(0.017)	(0.020)
Sweden	-0.088***	-0.068***	-0.090***	0.004	0.111***	-0.018
	(0.013)	(0.016)	(0.012)	(0.015)	(0.016)	(0.019)
Sector (ref=warehouse)						
Aviation	-0.054*	-0.027	0.071***	0.065**	0.035	0.015
	(0.028)	(0.032)	(0.024)	(0.032)	(0.032)	(0.039)
Citizen service	0.017	0.037***	0.032***	0.069***	0.033**	0.025
	(0.012)	(0.014)	(0.010)	(0.014)	(0.014)	(0.017)
Customer service/ telemarketing	-0.010	0.038***	0.005	0.017	0.009	0.026
	(0.012)	(0.014)	(0.010)	(0.014)	(0.014)	(0.017)
Financial sector	0.061**	0.182***	0.072***	-0.031	-0.071**	-0.041
	(0.027)	(0.032)	(0.023)	(0.031)	(0.031)	(0.037)
Office	0.051**	0.038	0.023	-0.032	-0.004	0.069**
	(0.021)	(0.024)	(0.018)	(0.024)	(0.024)	(0.029)
Other, computer	0.032**	0.035**	0.029***	0.046***	0.030*	0.053***
	(0.013)	(0.016)	(0.011)	(0.015)	(0.015)	(0.019)
Other, not computer	-0.027*	0.030*	0.021	0.018	-0.004	0.009
	(0.015)	(0.018)	(0.013)	(0.018)	(0.018)	(0.022)
Retail sales	-0.039**	-0.029	-0.010	0.114***	0.058***	-0.037
	(0.018)	(0.022)	(0.016)	(0.021)	(0.021)	(0.026)
Gender (ref=Female)	0.008	-0.014*	-0.033***	-0.002	-0.039***	0.025**
	(0.007)	(0.008)	(0.006)	(0.008)	(0.008)	(0.010)

Age (ref=30 years or less)						
31-40 years	-0.014	-0.055***	-0.006	0.052***	0.001	0.018
	(0.012)	(0.015)	(0.011)	(0.014)	(0.014)	(0.017)
41-50 years	0.027**	-0.013	0.044***	0.043***	-0.009	-0.016
	(0.012)	(0.014)	(0.010)	(0.014)	(0.014)	(0.017)
51-60 years	0.022*	-0.007	0.048***	0.039***	-0.019	0.013
	(0.012)	(0.014)	(0.010)	(0.013)	(0.014)	(0.016)
Over 60 years	0.027**	0.011	0.058***	0.009	-0.039**	0.003
	(0.013)	(0.016)	(0.012)	(0.015)	(0.016)	(0.019)
Education (ref=elementary school)						
High school or equivalent	-0.024**	-0.015	-0.008	-0.005	-0.015	-0.021
	(0.012)	(0.015)	(0.011)	(0.014)	(0.014)	(0.017)
Vocational education	-0.018	-0.008	-0.001	-0.005	-0.016	-0.015
	(0.012)	(0.014)	(0.010)	(0.013)	(0.014)	(0.016)
Advanced degree	-0.042***	-0.032**	-0.026**	0.010	0.014	0.021
	(0.012)	(0.015)	(0.011)	(0.014)	(0.015)	(0.018)
Workplace size	-0.009***	-0.006***	-0.003**	-0.002	-0.001	-0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Managerial role	0.058***	0.061***	0.030***	0.042***	0.032**	0.003
	(0.013)	(0.015)	(0.011)	(0.014)	(0.015)	(0.018)
Salary	0.016***	0.001	0.009***	0.004	0.005	-0.025***
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)
Constant	0.749***	0.809***	0.768***	0.342***	0.391***	0.305***
	(0.020)	(0.024)	(0.018)	(0.024)	(0.024)	(0.029)
Observations	4,380	4,316	4,363	4,360	4,357	4,075
R2	0.186	0.112	0.160	0.084	0.122	0.070
Adjusted R2	0.182	0.107	0.155	0.079	0.117	0.065
Residual Std. Error	0.204 (df = 4356)	0.240 (df = 4292)	0.177 (df = 4339)	0.235 (df = 4336)	0.239 (df = 4333)	0.278 (df = 4051)
F Statistic	43.403*** (df = 23; 4356)	23.494*** (df = 23; 4292)	35.888*** (df = 23; 4339)	17.211*** (df = 23; 4336)	26.215*** (df = 23; 4333)	13.254*** (df = 23; 4051)

Table B. Regression models with interaction between AM and employee influence

Below is an excerpt from the regression table. For the full results, please refer to Table A in the online Appendix 1.

	Autonomy index	Trust index	Job motivation index	Workload	Stress	Job insecurity
AM index	-0.249***	-0.210***	-0.121***	0.140***	0.221***	0.154***
	(0.021)	(0.024)	(0.018)	(0.025)	(0.025)	(0.031)
Employee influence index	0.224***	0.405***	0.206***	-0.262***	-0.215***	-0.176***
	(0.024)	(0.027)	(0.021)	(0.029)	(0.029)	(0.035)
AM index*Employee influence index	0.311***	0.249***	0.158***	-0.066	-0.099	0.031
	(0.052)	(0.059)	(0.046)	(0.063)	(0.064)	(0.077)
Constant	0.649***	0.646***	0.688***	0.446***	0.475***	0.353***
	(0.022)	(0.025)	(0.019)	(0.026)	(0.027)	(0.033)
Controls	✓	✓	✓	✓	✓	✓
Observations	3,909	3,858	3,891	3,893	3,889	3,667
R2	0.297	0.288	0.251	0.144	0.169	0.087
Adjusted R2	0.292	0.284	0.246	0.138	0.164	0.080
Residual Std. Error	0.191 (df = 3883)	0.217 (df = 3832)	0.168 (df = 3865)	0.228 (df = 3867)	0.233 (df = 3863)	0.274 (df = 3641)
F Statistic	65.609*** (df = 25; 3883)	62.064*** (df = 25; 3832)	51.759*** (df = 25; 3865)	25.957*** (df = 25; 3867)	31.492*** (df = 25; 3863)	13.807*** (df = 25; 3641)

Note: All models include controls for gender, age, salary, education level, country, sector, workplace size and managerial role.
*p<0.1; **p<0.05; ***p<0.01

Table C. Regression tables with interaction between AM and transparency

Below is an excerpt from the regression table. For the full results, please refer to Table B in the online Appendix 1.

	Autonomy index	Trust index	Job motivation index	Workload	Stress	Job insecurity
AM index	-0.281***	-0.188***	-0.135***	0.175***	0.219***	0.171***
	(0.022)	(0.022)	(0.019)	(0.026)	(0.027)	(0.033)
Transparency index	0.154***	0.489***	0.211***	-0.205***	-0.200***	-0.165***
	(0.017)	(0.017)	(0.015)	(0.020)	(0.021)	(0.026)
AM index* Transparency index	0.211***	0.096***	0.108***	-0.083*	-0.042	-0.004
	(0.036)	(0.035)	(0.031)	(0.043)	(0.044)	(0.054)
Constant	0.653***	0.522***	0.645***	0.461***	0.505***	0.398***
	(0.021)	(0.020)	(0.018)	(0.025)	(0.026)	(0.032)
Controls	✓	✓	✓	✓	✓	✓
Observations	4,358	4,300	4,340	4,340	4,334	4,056
R2	0.288	0.488	0.314	0.167	0.186	0.100
Adjusted R2	0.284	0.485	0.310	0.162	0.181	0.094
Residual Std. Error	0.191 (df = 4332)	0.183 (df = 4274)	0.160 (df = 4314)	0.224 (df = 4314)	0.231 (df = 4308)	0.274 (df = 4030)
F Statistic	70.257*** (df = 25; 4332)	163.097*** (df = 25; 4274)	79.152*** (df = 25; 4314)	34.635*** (df = 25; 4314)	39.396*** (df = 25; 4308)	17.891*** (df = 25; 4030)

Note: All models include controls for gender, age, salary, education level, country, sector, workplace size and managerial role.
*p<0.1; **p<0.05; ***p<0.01

Appendix 6. Respondents' own assessment of the effects of algorithmic management

After the respondents had indicated whether computer systems were used to perform different management tasks in their workplace, they were asked how this affects their work. Only respondents who had reported the use of at least one type of AM at their workplace were asked this question. Below is the exact question, which included information on how individual respondents had answered on previous AM-related questions:

The following questions are about what impact it has on your work that computer systems are used to perform certain tasks.

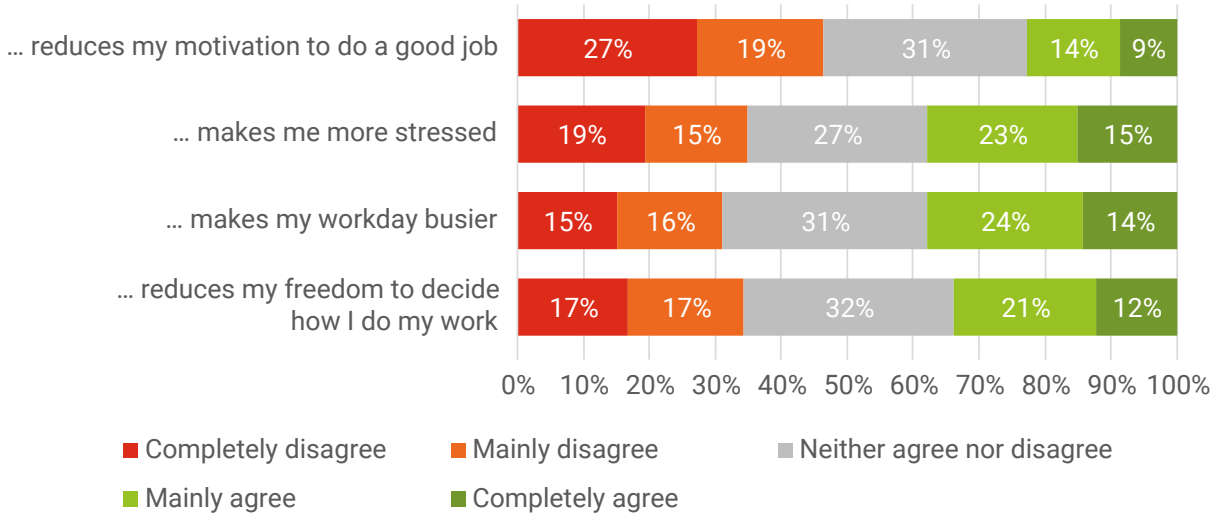
You have indicated that computer systems are used for the following in your workplace:

- *[assigning tasks]*
- *[determining work schedules]*
- *[monitoring when you are working and taking breaks]*
- *[monitoring your whereabouts]*
- *[monitoring your computer activity]*
- *[monitoring how fast you work]*
- *[monitoring the quality of your performance]*

How much do you agree or disagree with the following statements:

This use of computer systems in my workplace…

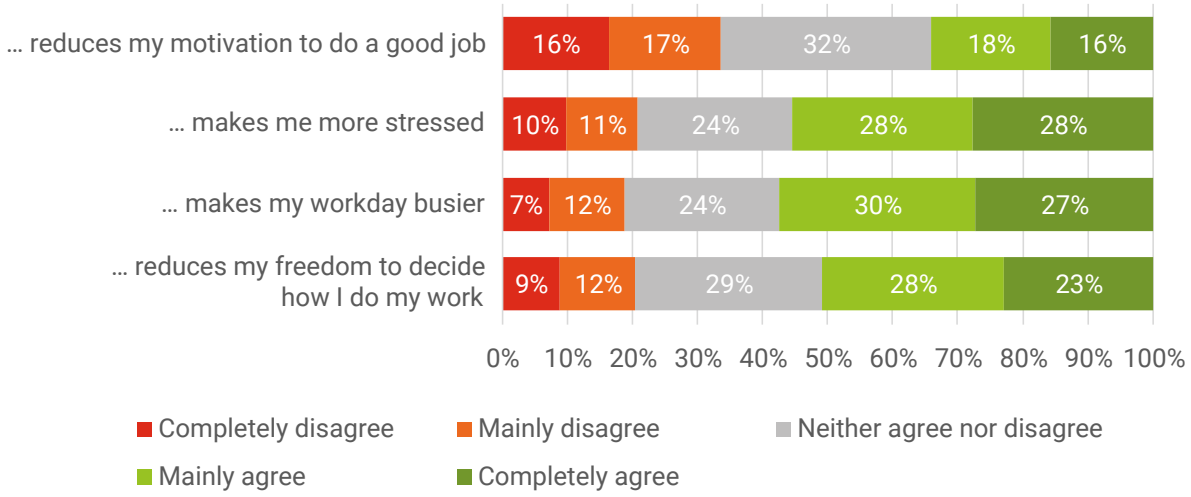
Figure A. How employees assess the effects of AM



Note: 'Don't know' responses (5-7%) are not included in the figure.

Only looking at the 25% of respondents with the highest exposure to AM (AM index of at least 0.6), the answers are distributed as follows:

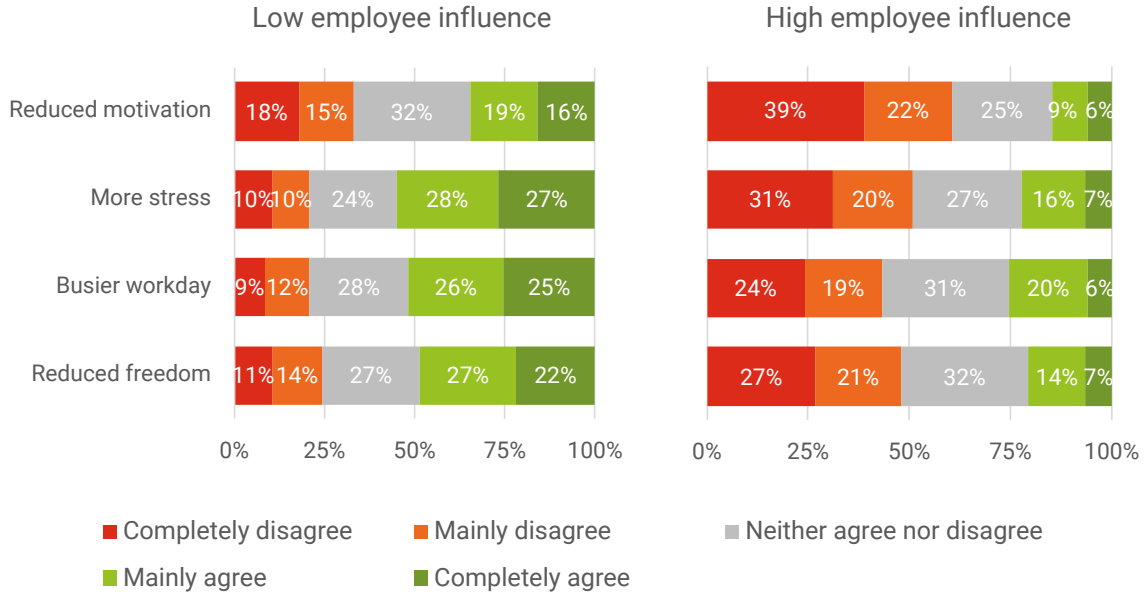
Figure B. How employees with high exposure to AM assess the effects of AM



Note: 'Don't know' responses are not included in the figure.

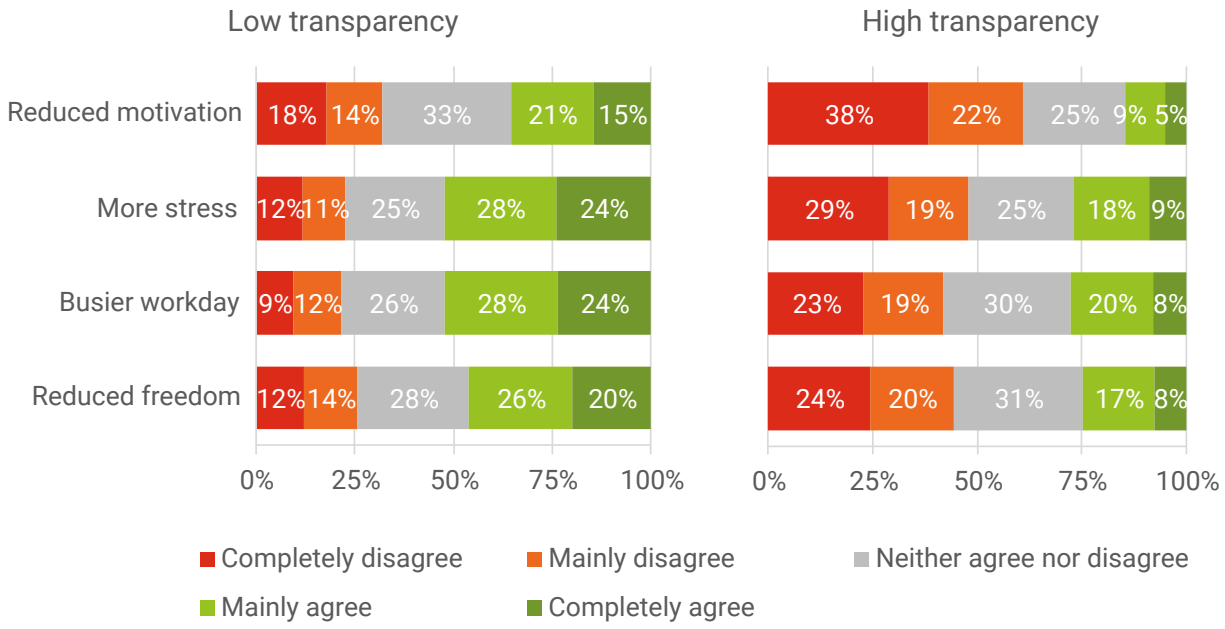
Looking at respondents with high and low employee influence, the answers are distributed as follows:

Figure C. How employees with low and high employee influence assess the effects of AM



Note: 'Don't know' answers are not included in the figure. 'Low employee influence' values are lower than the median of the employee influence index (0.25). 'High employee influence' values are 0.5 or higher (38% of respondents).

Figure D. How employees with low and high transparency assess the effects of AM



Note: 'Don't know' responses are not included in the figure. 'Low transparency' values are lower than the median of the employee influence index (0.5). 'High transparency' values are higher than the median.

12. ABOUT THE FEPS-NORDIC DIGITAL PROGRAMME: ALGORITHMS AT THE WORKPLACE

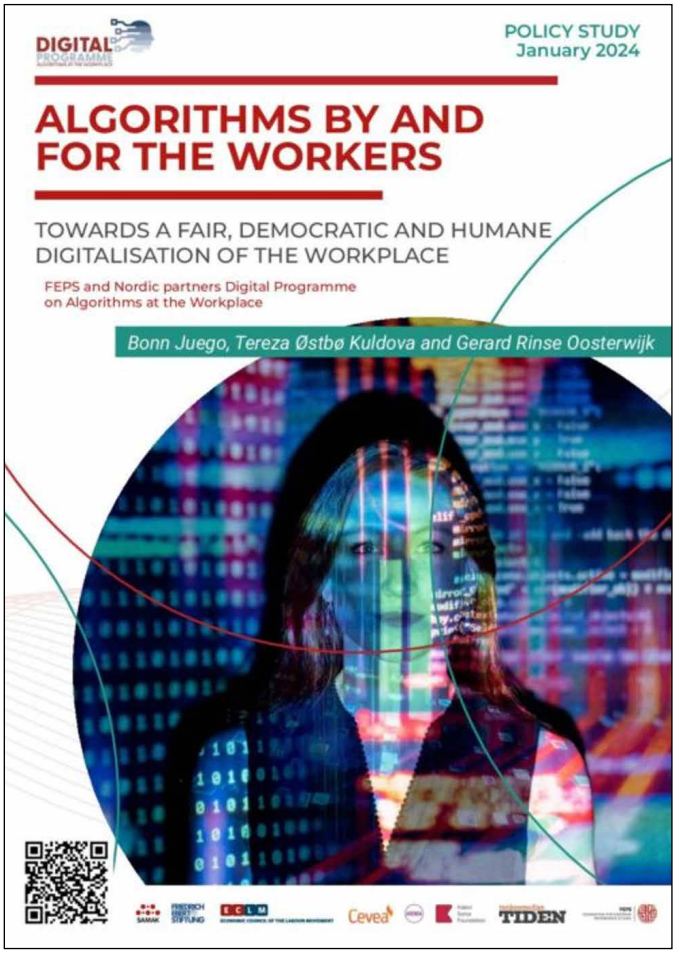
ABOUT FEPS-NORDIC DIGITAL PROGRAMME: ALGORITHMS AT THE WORKPLACE

FEPS, together with our Nordic partners, Tankesmedjan Tiden, Kalevi Sorsa Saatio, Tankesmien Agenda, CEVEA, Arbejderbevægelsens Erhvervsråd (ECLM), Friedrich-Ebert-Stiftung Nordics, Cooperation Committee of the Nordic Labour Movement (SAMAK), and with the support of Nordics Trade Unions, came together for a Digital Research Programme to investigate these developments and their effects.

Over a period of two years, we worked together on three different research strands: one on company case studies of algorithmic management, where workers' performance is tracked and rated; another on online platforms, employment terms and algorithms; and research that led to this policy study on workers' experience in algorithmic management from surveys. Below, you will find more information on two previous publications of the FEPS-Nordics Digital Programme.

Algorithms by and for the workers Towards a fair, democratic, and humane digitalisation of the workplace

Bonn Juego, Tereza Østbø Kuldova, Gerard Rinse Oosterwijk, January 2024



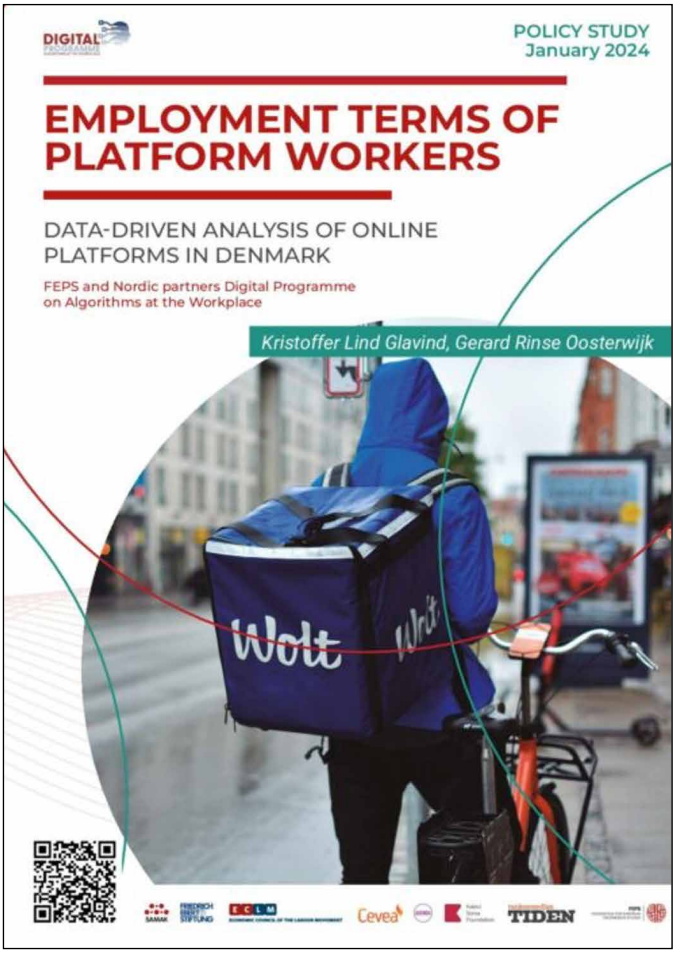
This policy study reflects on the complex interplay between technology and work, focusing on the impacts of algorithmic management (AM) techniques on workers' rights, dignity, and well-being. Drawing on preliminary findings from an ongoing study of FEPS in collaboration with Nordic-based partners, the policy study highlights the complexities and contradictions of AM and the limitations of current policies and institutions in dealing with the fast-paced digital transformation. It emphasises the importance of worker agency and participation in the innovation process.

It proposes the need to create socio-institutional frameworks to direct a pro-labour digital transition and institutionalise co-determination as a viable solution for workers to engage actively with incessant technical changes. It concludes with a forward-looking perspective, advocating for research methodologies and problem-solving approaches that cater to the needs of diverse working contexts. The purpose is to contribute to informed policymaking that ensures a fair, democratic, and humane work environment in the digital age.

Read it at https://feps-europe.eu/publication/algorithms-by-and-for-the-workers/

Employment terms of platform workers Data-driven analysis of online platforms in Denmark

Kristoffer Lind Glavind, Gerard Rinse Oosterwijk, January 2024



The European Commission estimates that around 28 million people in the EU work through one or more digital labour platforms, known as the "gig economy". There are serious concerns about working conditions and social rights, as many platforms claim that their role is not of traditional employers but as intermediaries between customers and self-employed service providers. This has led many platform companies to compensate workers through remuneration rather than a fixed salary. Some even require workers to establish their own companies to which the salary is then paid.

Administrative data shows an apparent rise in the number of renumerated workers within specific sectors in Denmark. Notably, the transport, information, and communication industries exhibit a significant surge, predominantly comprising young, non-Danish workers with limited educational backgrounds.

Employing quantitative data sources, this policy study underscores that, even within one of Europe's most organised labour markets, platform companies are trying to circumvent labour and tax regulations by hiring platform workers through remuneration contracts. This knowledge is crucial for informing the policy discourse at both the European and Danish levels, contributing to the clarification of distinctions between employed and self-employed workers. All workers should be guaranteed basic employment terms, with guaranteed job security such as a labour contract, and the platform should apply basic social security and tax regulations to platform workers.

Read it at https://feps-europe.eu/publication/employment-terms-of-platform-workers/

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ABOUT THE FOUNDATION FOR EUROPEAN PROGRESSIVE STUDIES (FEPS)

The Foundation for European Progressive Studies (FEPS) is the think tank of the progressive political family at EU level. Its mission is to develop innovative research, policy advice, training and debates to inspire and inform progressive politics and policies across Europe.

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Tankesmedjan Tiden's mission is to contribute to the development of long-term progressive political thinking. The think tank aims to promote debate and formulate concrete proposals regarding issues related to equality, globalization, human rights and welfare, as well as stimulate the ideological and political development of the labor movement and the left.

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The Danish think tank Cevea is created as a politically oriented centre-left institution with the aim to innovate the political debate in Denmark through the publication of books, reports, analysis, articles, and the organization of public debates and conferences.

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ABOUT SAMAK

The Cooperation Committee of the Nordic Labour Movement, better known by its abbreviation SAMAK, is an alliance of social democratic parties and labour councils in the Nordic countries.

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The integration of new technology in the workplace continues to spark intense debate. For years the debate has centered on the fear that robots and computers will displace human workers. Recently, the focus of the debate has shifted: rather than being replaced by computers, more and more employees find themselves managed by computers. Tasks that were once the domain of human managers are now performed by computer systems – a phenomenon known as 'algorithmic management'.

This report uncovers the adverse consequences of algorithmic management for workers and explores ways to dampen these effects. The study is the first of its kind to systematically examine the consequences of algorithmic management.

The study is based on a large survey conducted among union members in the warehousing and customer service/telemarketing sectors in Denmark, Sweden, Norway, and Finland. The labour markets in the Nordics are characterized by collaboration, strong worker rights and healthy work environments, but even in this context the study shows that algorithmic management poses a great challenge to workers' well-being.

Algorithmic management is quite widespread in sectors such as warehousing and customer service/telemarketing. In these fields, a significant number of employees reports that computer systems are used to assign shifts and tasks, monitor activities, and evaluate performance.

This use of algorithmic management has several adverse consequences for employees. Workers exposed to algorithmic management experience less job autonomy, increased workloads, and heightened stress levels. Additionally, the study shows that algorithmic management is associated with less trust between employees and management, lower levels of job motivation and satisfaction, and a heightened fear of losing your job.

Importantly, the study shows that these adverse consequences are not unavoidable altogether. High levels of employee influence in the workplace and transparency of company decisions significantly reduce the negative effects of algorithmic management. This is crucial insight for policymakers, unions, and others who want to ensure that the digitalization of work does not compromise job quality and workers' well-being.

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