# Influence of algorithmic management practices on workplace well-being – evidence from European organisations

Hanna Kinowska
*SGH Warsaw School of Economics, Warsaw, Poland, and*
Łukasz Jakub Sienkiewicz
*Gdansk University of Technology, Gdansk, Poland*

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## Abstract

**Purpose** – Existing literature on algorithmic management practices – defined as autonomous data-driven decision making in people's management by adoption of self-learning algorithms and artificial intelligence – suggests complex relationships with employees' well-being in the workplace. While the use of algorithms can have positive impacts on people-related decisions, they may also adversely influence job autonomy, perceived justice and – as a result – workplace well-being. Literature review revealed a significant gap in empirical research on the nature and direction of these relationships. Therefore the purpose of this paper is to analyse how algorithmic management practices directly influence workplace well-being, as well as investigating its relationships with job autonomy and total rewards practices.

**Design/methodology/approach** – Conceptual model of relationships between algorithmic management practices, job autonomy, total rewards and workplace well-being has been formulated on the basis of literature review. Proposed model has been empirically verified through confirmatory analysis by means of structural equation modelling (SEM CFA) on a sample of 21,869 European organisations, using data collected by Eurofound and Cedefop in 2019, with the focus of investigating the direct and indirect influence of algorithmic management practices on workplace well-being.

**Findings** – This research confirmed a moderate, direct impact of application of algorithmic management practices on workplace well-being. More importantly the authors found out that this approach has an indirect influence, through negative impact on job autonomy and total rewards practices. The authors observed significant variation in the level of influence depending on the size of the organisation, with the decreasing impacts of algorithmic management on well-being and job autonomy for larger entities.

**Originality/value** – While the influence of algorithmic management on various workplace practices and effects is now widely discussed, the empirical evidence – especially for traditional work contexts, not only gig economy – is highly limited. The study fills this gap and suggests that algorithmic management – understood as an automated decision-making vehicle – might not always lead to better, well-being focused, people management in organisations. Academic studies and practical applications need to account for possible negative consequences of algorithmic management for the workplace well-being, by better reflecting complex nature of relationships between these variables.

**Keywords** Algorithmic management, Workplace well-being, Job autonomy, Total rewards, Human resources management

**Paper type** Research paper



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## 1. Introduction

Technological innovations, being at the forefront of the fourth industrial revolution (Tao *et al.*, 2021) lead to tremendous changes in all aspects of human society (Su *et al.*, 2020), impacting also management of businesses and organisational structures (Horvath and Szabo, 2019). Impact of technological advancements on management of human resources has recently sparked interest of researchers (Cascio and Montealegre, 2016; Kellogg *et al.*, 2020; Tambe *et al.*, 2019; Minbaeva, 2020; Park *et al.*, 2021), with a special focus on algorithmic management, as one of the most disruptive forms of technological change currently being implemented (Parent-Rocheleau and Parker, 2022).

Technological advancement, most notably in relation to digitalisation of businesses, has an increasing impact on management practices, towards intense development and application of autonomous, self-learning analytical and decision-making applications. As noted by Mann and O'Neil (2016), technological advances allow organisations to utilise artificial intelligence that simultaneously learn and solve problems in increasingly complicated domains, often towards autonomous management of business processes. Lee (2018) notes that currently "computational algorithms increasingly make decisions that human managers used to make, changing the practices of managers, policy makers, physicians, teachers, police, judges, on-demand labour platforms, online communities, and more".

Newman *et al.* (2020) argue that algorithm-supported decisions create new, previously non-available opportunities to organisations. Algorithmic applications can now automate managerial practices and complex tasks that were previously the responsibility of management (Tomprou and Lee, 2022) and enable efficient, optimised and data-driven decision making (Lee, 2018). Algorithmic approach is believed to lead to accurate outcomes in analysing and predicting complex relationships, while eliminating unconscious human bias (Cheng and Hackett, 2019), with evidence indicating that such decisions outperform human management decisions in more than 80% of cases in the common workload context (Yu *et al.*, 2017). While development of algorithms for management purposes serves the purpose of increasing organisational effectiveness and individual productivity, it also creates unprecedented challenges for organisations and employees. These might include accountability questions associated with fairness and ethical considerations (Tambe *et al.*, 2019), algorithmic opacity (Gal *et al.*, 2020), uncertainty and anxiety for workers (Rosenblat and Stark, 2016). In turn, the use of algorithms might result in de-humanisation of human resources management, negating currently well-developed interpersonal and empathetic aspects of people management (Angrave *et al.*, 2016). One of the aspects of this phenomenon, which calls for further analysis and research, is the influence of these practices on employee well-being.

Although digital transformation is a new and urgent imperative, there is a long trajectory of research that can readily be applied to grasp these emerging trends. Recent studies have primarily focused on the business and strategic levels, with only modest integration of employee-related factors (Trenerry *et al.*, 2021). Classical research has shown that the implementation of automation affects work tasks, motivation, and in general, well-being at work (Smith and Carayon, 1995). Parker and Grote (2022) argue that new technologies, depending on various factors, can both positively and negatively affect job resources and demands, including job autonomy, with consequences – among others – for employee well-being. As further indicated by Parent-Rocheleau and Parker (2022) in their model, considerable evidence shows that job resources and demands affect workers' motivation, well-being and performance.

The impact of digital transformation on workplace well-being can be explained on the basis of self-determination theory. Satisfaction of the needs for autonomy, competence and relationships is a universal requirement for psychological well-being. They enable individuals to develop their full potential (Deci and Ryan, 2000). Self-determination theory has been used in limited ways in research of the gig work, which is typically mediated by algorithmic management (Jabagi *et al.*, 2019; Rockmann and Ballinger, 2019).

Job autonomy is one of the most important work characteristics because of its positive effects on multiple outcomes such as job performance, creativity and proactivity (Parker and Grote, 2022). Algorithmic management affects the way the work is carried-out and reduces personal influence on the process. Research indicates that there is a negative relationship between job automation and the feeling of control over work, particularly for highly skilled jobs (Holford, 2020). Such effects impact the autonomy and responsibility within the respective tasks which could affect workplace well-being (Langer *et al.*, 2020).

Research shows that when people feel like they learn and master activities (i.e. competence), when they feel volitional and can make decisions themselves (i.e. autonomy), and when they have high-quality relationships with others at work (i.e. relatedness), they are more likely to develop autonomous motivation (Van den Broeck *et al.*, 2016). Therefore, workplaces have much to gain from ensuring these needs are satisfied in their employees, in particular by the broad approach to remuneration in total rewards practices. We have limited insight into how the introduction of algorithmic management might change total remuneration.

Prior research does not sufficiently present empirical studies of either positive or negative impact of algorithmic management practices on workplace well-being both directly and indirectly by affecting work autonomy and total remuneration. Therefore, our paper contributes to the ongoing debates by providing evidence on such direct and indirect relationships, based on a large-scale sample of organisations. The contribution of this research to the literature is threefold. First, we develop a moderated mediating model to reveal the influence mechanism of algorithmic management practices on workplace well-being. Secondly, we expand the knowledge of workplace well-being by explaining the role of work autonomy in total remuneration in the workplace well-being. Finally, we demonstrated the effects of organisational size on the relationship between algorithmic management, work autonomy, total remuneration and workplace well-being.

In this paper we analyse the influence of the algorithmic management practices on the employee well-being in the workplace on the basis of the results of the European Company Survey 2019 (Eurofound and Cedefop, 2020). ECS 2019 has been carried out jointly by Eurofound (European Foundation for the Improvement of Living and Working Conditions) and Cedefop (European Centre for the Development of Vocational Training) on the sample of establishments with 10 or more employees in all sectors involved in "market activities" (NACE Rev. 2) in Europe [1]. A total of 21,869 interviews with senior managers in charge of personnel were completed. The survey covers areas of workplace practices with regard to work organisation, human resource management, skills use, skills strategies, digitalisation, direct employee participation and social dialogue. For the purpose of this article the workplace determinants affecting employee well-being have been covered, supported by the rationale provided below. All calculations have been performed by the authors on the micro-data from ECS 2019 [2].

As noted by Parent-Rocheleau and Parker (2022) in their literature review, the empirical research of algorithmic management practices and their consequences, focused to date on the context of gig work, with traditional work context being mostly overlooked. Our research, through the analysis of the cross-sectional data set aims to fill this gap.

The purpose of our paper was to analyse, how algorithmic management practices directly influence workplace well-being, as well as investigating relationships with job autonomy and total rewards practices, which should be positively related to workplace well-being. The article is structured in three sections: (1) a theoretical introduction on the essence and research models of workplace well-being, algorithmic management, job autonomy and total rewards practices, (2) a section devoted to the methodology of empirical research, including a description of the aim, assumptions, the research sample and the results of statistical analyses and (3) a section presenting the discussion, ending with conclusions.

## 2. Theoretical background

### *2.1 Workplace well-being*

The COVID-19 pandemic has generated a great deal of interest on employees' well-being (Bakker and van Wingerden, 2020). It has become one of the priorities of employers in the business sphere (Deloitte, 2020). Researchers analyse the various effects of employee well-being (Johnson *et al.*, 2018). They demonstrate that organisations with higher levels of employee well-being perform better. This provides an impetus to deepen the analysis towards factors influencing well-being.

The well-being is analysed from different perspectives. From a macro perspective, it includes measures such as life expectancy, safety indicators, poverty and environmental factors (Pinker, 2018). From an individual perspective, it involves a person's subjective sense of well-being – it measures an individual's assessment of their quality of life and work, which is determined by three main aspects: physical, social and psychological. State of well-being is associated with functioning in all spheres of life, among which work activity and occupational functioning play a special role.

Despite the wide interest, a clear definition of well-being is still lacking (Diener *et al.*, 1999; Forgeard *et al.*, 2011; Keyes *et al.*, 2002; Seligman, 2011; Simone, 2014; Zheng *et al.*, 2015). The most comprehensive definition of well-being is given by the World Health Organisation. Its essence is the state of each employee where they understand their capabilities, cope with life stresses, work productively and contribute to their community (Misselbrook, 2014).

Researchers indicate that in the work process, psychological well-being is the most important factor of well-being (Johnson *et al.*, 2018). Therefore, employee well-being is conceptualised using the construct of psychological well-being (Ryff, 1989). Psychological well-being is a multidimensional phenomenon, analysed from two perspectives, a hedonistic one, which deals with experiencing positive emotions and satisfaction, and a eudaimonic one, focused on human potential (Ryan and Deci, 2001). Eudaimonic well-being includes aspects such as positive attitudes towards oneself (self-acceptance), positive interpersonal relationships, a sense of freedom, autonomy, a sense of purpose in life and opportunities to develop one's potential (Ryff, 2013).

A separate stream of research on well-being, close to the eudaimonic perspective, has also emerged in the literature, referred to as workplace well-being (Tabor-Błażewicz, 2021). It is defined as the comprehensive experience and functioning of an employee from the perspective of both physical and psychological dimensions (Warr, 2006). These concepts have an applied significance for organisations and the management process. Therefore, they set the theoretical framework for the study presented in this article.

Well-being is a construct that is partly determined by the employee's personality, and thus represents a relatively stable disposition of the individual over the long-term over which the employer has limited influence. In addition, employee well-being is affected by many factors directly related to work. These are the most important factors from a management perspective affecting feelings at work, because their impact is direct, and because it is easier for organisations to change and improve work-related factors. The scope of the research analysed in this article was limited to determinants of well-being directly related to the workplace.

In the case of workplace well-being, the employer as the actor shaping the workplace, plays a significant role. In the literature, specific recommendations can be found as to what activities make up a desirable work environment. These include creating conditions in which employees are paid living wages, have control over their work, have opportunities for professional development, flexibility, are protected from adverse conditions, are subject to disease prevention and stress management, people with disabilities are supported and their return to work is facilitated (Marmot, 2010). Recommended actions for workplace well-being include ensuring: adequate resources and communication, control and autonomy, a balanced

workload, adequate job security, good relationships and working conditions (Robertson, 2016). Employers should provide employees with all the tools they need to do their jobs. They should not restrict employees' freedom to do their jobs – by delegating authority appropriately and ensuring a good work–life balance. They are responsible for ensuring that workers have transferable and up-to-date skills and are treated with dignity and respect at work. Employers should provide the best possible working conditions, including pay and benefits.

The key determinants of workplace well-being are work and its context, work–life balance, purpose and meaning of work, leadership and management (Johnson *et al.*, 2018). Tools aimed at employees and employers are used to analyse this construct. Diagnostic tools for employees cover several dimensions: quality of work life, meaning at work, likelihood of burnout, severe fatigue, work–life integration, suicidal thoughts (e.g. Employee Well-Being Index (eWBI) (Dyrbye *et al.*, 2016). In human capital management, well-being is examined using the PERMA model, which identifies five elements of a good life: P–positive emotions (e.g. joy, appreciation, comfort, inspiration, hope or curiosity), E–engagement (understood as a state of flow), R–relationships (being with people, working together), M–meaning (a sense of meaningful action), A–achievements (satisfactory work outcomes) (Seligman, 2011).

The European Company Survey, on which the analyses in this article are based, uses a tool aimed at employers. It examines workplace well-being indirectly through four questions on: management–employee relations, motivation, absenteeism and employee retention (Eurofound and Cedefop, 2020).

### *2.2 Algorithmic management practices*

Technology – most notably processes of digitalisation, use of artificial intelligence, machine learning, big data and prevalence of remote and hybrid work, is changing how organisations manage human resources. One of the increasing trends is the use of so-called algorithmic management – with the most notable feature being the use of algorithms in managerial processes, including HRM and decision making. Lee *et al.* (2015) first used the term "algorithmic, data-driven management" to describe new practices of assigning work, providing informational support and evaluation of performance of drivers in the ridesharing industry. An algorithm is a computational formula that autonomously makes decisions based on statistical models or decision rules without explicit human intervention (Eurofound, 2018). Duggan *et al.* (2020) define algorithmic management as a system of control where self-learning algorithms are given the responsibility for making and executing decisions affecting labour, thereby limiting human involvement and oversight of the labour process. As such algorithmic management automates HR-related duties and functions traditionally undertaken by human managers (Duggan *et al.*, 2020). Therefore they steer people management towards a more automated and autonomous decision-making processes, which previously managers and HR used to make. Thomas *et al.* (2018) note that as the algorithms influence real-life situations, they are vested with social power beyond their capabilities as math or code, and as such "gain materiality and agency to operate outside of and independently from the professionals who design, develop and deploy them".

Scope of algorithmic management is constantly broadening in terms of people-related management decisions, which are supported or autonomously made by self-learning algorithmic systems and applications. Most commonly they are introduced in areas such as hiring, setting tasks, measuring productivity, evaluating performance and terminating employment (Veen *et al.*, 2020). Parent-Rocheleau and Parker (2022) identified six key managerial functions and HRM activities that algorithms have been used to perform management functions, including: monitoring of people-related data during work, goal setting by assigning tasks, organising work or setting targets, performance management by

calculating ratings and providing automated feedback, scheduling by setting schedules or working times, compensation by automated calculation of pay or bonuses, and job termination by algorithmic decisions on employment termination. One of the key areas of algorithm's applications is monitoring of employees performance (Kellogg *et al.*, 2020), including surveillance of the time spent on tasks, specific behaviours related to customers of co-workers, and elements of effort and performance (Connelly *et al.*, 2021). These known areas of performance and activity monitoring are now made easier and possibly related to individual value-added (Cheng and Hackett, 2019). Cascio and Montealegre (2016) analyse the algorithmic management from the perspective of technologies used, which impact work and organisations. These include: electronic monitoring systems, robots, teleconferencing (currently understood more broadly – as remote work) and wearable computing devices. All of these have profound implications for people management practice.

Due to these developments, many management areas – previously being sole responsibility of managers (including HR managers), like employment relations, hiring, performance management, remuneration – are increasingly affected, or even taken over, by algorithmic management. Algorithmic management is different from previously used data-supported decisions through HRIS (Human Resources Information Systems), which focused primarily on descriptive analytics. While these systems provided useful data (in form of charts, data sheets, etc.), the informed decisions were taken by managers. Further advancement of computing powers and data science allowed for development of more autonomous decision-supporting algorithms and systems, towards application of predictive and prescriptive HR analytics (Fitz-Enz, 2010). Currently management algorithms allow to use statistical models and data mining techniques to predict employees future performance, competency gaps or turnover (Cheng and Hackett, 2019).

It is important to note that there are positive aspects of algorithmic management. Tomprou and Lee (2022) suggest in their review that the increasing applications of algorithmic management are primarily driven by potential benefits, including decision quality, boosting or efficiency and scalability, making the algorithms cost-effective and yielding a high return on investment. Algorithmic management can also be perceived as having higher procedural fairness, "because algorithms follow the same procedures every time, are not influenced by emotional factors, and have no agency, and thus are perceived less biased than human decision-makers" (Lee, 2018).

However, existing research on algorithmic management tends to suggest that it generates more negative than positive outcomes for workers, in particularly being associated with a reduction in workers autonomy (Parent-Rocheleau and Parker, 2022). As suggested by some authors with the use of algorithmic management, the traditional "tyranny of the clock" has been replaced with "tyranny of the algorithm" (Lehdonvirta, 2018). As noted by Duggan *et al.* (2020) "algorithmic management tracks, disciplines, and sets expectations for workers without human supervision or recourse", eliminating the more interpersonal and empathetic aspects of people management. Research of Park *et al.* (2021) indicates that employees feel six types of burdens – emotional, mental, bias, manipulation, privacy and social – associated with increased use of algorithms and AI in human resource management (HRM). These can in turn have adverse effects on workplace well-being.

Therefore, the increased use of algorithmic management poses a number of associated risks and challenges, including depersonalising management systems and entrenching pre-existing biases (Veen *et al.*, 2020). As a consequence, what was supposed to be a more objective process of decision making by the use of computational algorithm, becomes "a black-box" (Veen *et al.*, 2020), that hides the decision-making process and rules, leading to the power imbalance between management and workers. Jago (2019) notes that people believe technological agents lack the same level of moral authenticity as human agents. As noted by Sutherland and Jarrahi (2018), some workers are feeling helpless and powerless in the face of

this new use of technology. Algorithmic management might lead to an increased feeling of injustice and lowered job autonomy. As a consequence this "pressurised working environments" (Duggan *et al.*, 2020) might result in reduced sense of well-being (Wood *et al.*, 2019). As already mentioned Parent-Rocheleau and Parker (2022) suggest in their model that there is indirect link between algorithmic management and employee well-being (as well as motivation and performance). However, this theoretical model has not been empirically verified and we identified a significant research gap. Therefore, referencing the analysis of literature describing the link between algorithmic management and workplace well-being, the following hypothesis was posited:

*H1.* The algorithmic management practices are negatively related to workplace well-being.

### *2.3 Job autonomy practices*

Autonomy can be defined as the degree to which a job provides an employee with significant freedom, independence and discretion to plan out their work and determine their procedures in the job (Hackman and Oldham, 1975).

The perceived ability to exert some influence over one's work environment makes it more rewarding and less threatening (Ganster, 1989). The research literature shows the evidence that high levels of worker control are associated with low levels of stress-related outcomes, including anxiety, psychological distress, burnout, irritability, psychosomatic health complaints and alcohol consumption (Terry and Jimmieson, 1999).

Autonomy in the workplace refers to volition and self-determination. It involves the need to feel self-directed and self-endorsed. Those who feel autonomous are motivated by personal values and interests, rather than feeling pressured or constrained. Autonomously functioning individuals feel free to express who they really are. They need not rely solely on perceiving their self-worth as contingent upon social approval and meeting expectations. Autonomy is the focus of self-determination theory (Deci and Ryan, 2000). Research conducted on the basis of this theory has discovered the universal importance of autonomy in the flourishing of human motivation and psychological health (Deci and Ryan, 2000; Deci *et al.*, 2001; Sheldon and Niemiec, 2006; Chatzisarantis *et al.*, 2012; Vansteenkiste and Ryan, 2013).

Self-determination theory (Deci and Ryan, 2000; Vansteenkiste *et al.*, 2010) assumes an active, growth-oriented human nature, which leads to happiness when appropriately functioning. The theory also proposes that people need to feel autonomous, related and competent in order to function optimally and behave in congruence with their innate growth tendency. Deci and Ryan (2000) theorised that the satisfaction of these needs is essential for well-being. The identified needs include autonomy, relatedness and competence. Autonomy is described as self-governance, or the need to organise one's experiences in a self-congruent manner and to feel volitional in regulating one's behaviour. Relatedness reflects the need to form meaningful and intimate social relationships, to care for and be cared for. Competence is the ability to have an effect on the environment as well as to attain valued outcomes within it (Deci and Ryan, 2000). Further research on workplace well-being supports the idea that autonomy is identified as its' essential component (Marmot, 2010; Robertson, 2016).

Work autonomy and workplace well-being have a complex relationship (Meijerink and Bondarouk, 2021). Researchers have shown that algorithmic management limits autonomy (Gandini, 2019; Kellogg *et al.*, 2020; Newlands, 2021; Goods *et al.*, 2019; Zuboff, 2019). There is also research in the literature on the positive impact of algorithms, e.g. software algorithms embed organisational resources such as data, rules and procedures that limit employee autonomy (Orlikowski and Scott, 2015; Strohmeier, 2020) while offering employees the freedom to create value (Meijerink and Bondarouk, 2021). Research shows that not all activities performed by employees can be monitored by algorithmic management systems

(Gal *et al.*, 2020; Newlands, 2021; Wood *et al.*, 2019). This means that, despite the use of algorithmic management, employees may have some freedom to feel autonomous.

Referencing the analysis of literature describing the link between autonomy, workplace well-being and algorithmic management, the following hypotheses are posited:

*H2.* The job autonomy practices are positively related to workplace well-being.

*H2a.* The algorithmic management practices are negatively related to workplace well-being through negative influence on job autonomy practices.

### *2.4 Total rewards practices*

The broad meaning given to rewards in modern management gives it a special role in shaping well-being at the workplace. Remuneration is equated with the total return to the employee for the effort put into providing work. Total rewards or total return on efforts can be divided into two major categories such as total compensation and relational returns (Milkovich *et al.*, 2014). The first category includes direct and indirect pay and incentives. The second category includes recognition, challenging work, job security and learning and growth opportunities. Total rewards may be categorised into three major categories such as financial rewards, material rewards and psychological rewards (De Gieter *et al.*, 2006). The first category includes only monetary payments, the second – material rewards such as benefits, training and growth opportunities and finally the third – non-monetary rewards such as recognition, growth and affiliation.

Research shows that employees feel positive about the workplace when they receive material rewards (e.g. training, benefits, career growth opportunities), social rewards (e.g. good relationship with other) (Abid *et al.*, 2015). Employee behaviour is positively influenced by feedback and other non-monetary rewards (Carpentier and Mageau, 2013). Financial remuneration, in particular the perception of its fairness in a context of unjustified inequality, is also relevant to well-being (Oishi *et al.*, 2011).

Despite many studies, the question of whether money improves quality of life is still open (Kasser and Ryan, 1993; Srivastava *et al.*, 2001; Ashkanasy, 2011; Blanchflower and Oswald, 2011; Sacks *et al.*, 2012; Diener *et al.*, 2013; Gulyani and Sharma, 2018).

Research shows that algorithmic management reduces total rewards through the limitation of the possibility of receiving additional remuneration (e.g. in the form of tips) (Van Doorn, 2019), creating information asymmetries that limit employees' freedom to make decisions (Rosenblat, 2018; Shapiro, 2017), reducing the meaning of work (Leicht-Deobald *et al.*, 2019) and disciplining without room for personal growth and development (Kellogg *et al.*, 2020).

Referencing the analysis of literature describing the link between total rewards practices, workplace well-being and algorithmic management, the following hypotheses are posited:

*H3.* The total reward practices are positively related to workplace well-being.

*H3a.* The algorithmic management practices are negatively related to workplace well-being through negative influence on total rewards practices.

## 3. Methodology

### *3.1 Sample and procedures*

The main data source was the 2019 ECS carried out jointly by Eurofound and Cedefop. The purpose of the survey was to map, assess and quantify information on company policies and practices across Europe. The ECS collected information in total from 21,869 human resources managers and 3,073 employee representatives in the 27 EU Member States and the United

Kingdom. The unit of enquiry for the survey is the establishment: the local unit or site. For the purposes of our research, we analysed the answers to survey questions given by people representing employers (human resources managers). We chose questions that diagnose the constructs of interest: workplace well-being, algorithmic management practices job autonomy and total rewards. As a first step, we performed a qualitative analysis of the research questionnaire and selected questions related to the issues under study.

The ECS includes detailed information on workplace well-being, digitalisation, job autonomy and pay practices. However, various data analysis procedures on the original files were required in order to establish relevant categories for the empirical investigation.

Selected questions diagnosing the studied construct were answered on different scales. In the first step, the variables were standardised (with Z-score standardisation). Then, data gaps were filled in with the mean values to specific questions for individual countries.

### *3.2 Variables and measures*

The dependent variable in our model was "*Workplace well-being*". In ECS a continuous variable for workplace well-being was derived from the variables capturing issues with absenteeism, low motivation, employee retention and the variable capturing relationships between management and employees. The variables were rescaled to range between 0 and 1, where 1 is the highest positive score. Subsequently, the mean across these variables was calculated (allowing for a missing value on any one of the four variables). The resulting variable was transformed into z-scores by subtracting the weighted EU27 mean and dividing by the weighted EU27 standard deviation (Eurofound and Cedefop, 2020). For consistency with the ECS "*Workplace well-being*" variable in our model was created using the same constructs. For the purpose of our research, we used a different statistical procedure. The variable "*Workplace well-being*" was calculated with the SEM model with four reflective indicators (identical to the original constructs in the ECS). The SEM approach is more robust than rescaling and adding indicators – in SEM approach the weight of each variable is calculated on the basis of the real dataset. Moreover, constructing a SEM gave us an opportunity to check the composition of "*Workplace well-being*" with the impact of other explanatory variables, described below.

The explanatory variables were measured as follows:

(1) "*Algorithmic management*" – The variable was diagnosed using four items describing: use of data analytics for monitoring employee performance and use of data analytics for processes or service delivery improvement, use of robots, determining the pace of human work by machines or computers.

(2) "*Job autonomy*" – The variable was diagnosed using seven items describing: independently organising time and scheduling tasks, level of direct influence of employees on management decision making (five items) and managers' approach to autonomy of employees.

(3) "*Total rewards*" – The variable was diagnosed using four items regarding motivation and rewards practices: offering monetary rewards, communicating a strong mission and vision, providing interesting and stimulating work and opportunities for training and development.

All variables were constructed in reflective way. The hypothesised relationships between the dependent variable "*Workplace well-being*" and independent variable "*Algorithmic management*" involve both direct effect and indirect influence through "*Job autonomy*" and "*Total rewards*".

Items diagnosing each variable are presented in Table 1.

| Variable | Item | Loading factor |
|---|---|---|
| Workplace well-being | Do you think the level of sickness leave in this establishment is too high? | 0.26 |
| | Overall, how motivated do you think employees in this establishment are? | 0.74 |
| | How difficult is it for this establishment to retain employees? | 0.31 |
| | How would you describe the relations between management and employees in this establishment in general? | 0.64 |
| Algorithmic management | Does this establishment use data analytics to monitor employee performance? | 0.55 |
| | Does this establishment use data analytics to improve the processes of production or service delivery? | 0.78 |
| | Robots carry complex series of actions automatically, which may include the interaction with people. Does this establishment use robots? | 0.20 |
| | For how many employees is the pace of work determined by machines or computers? | 0.16 |
| Job autonomy | For how many employees their job includes organising their own time and scheduling their own tasks? | 0.13 |
| | The organisation and efficiency of work processes – since 2016, employees directly influenced management decisions | 0.75 |
| | Dismissals – since 2016, employees directly influenced management decisions | 0.34 |
| | Training and skill development – since 2016, employees directly influenced management decisions | 0.68 |
| | Working time arrangements – since 2016, employees directly influenced management decisions | 0.61 |
| | Payment schemes – since 2016, employees directly influenced management decisions | 0.45 |
| | Which of these two statements best describes the general approach to management at this establishment? | 0.17 |
| Total rewards | Variable extra pay linked to the performance of the team, working group–employees received variable pay | 0.17 |
| | Offering monetary rewards – to motivate and retain employees | 0.30 |
| | Communicating a strong mission and vision – to motivate and retain employees | 0.69 |
| | Providing interesting and stimulating work – to motivate and retain employees | 0.72 |
| | Providing opportunities for training and development – to motivate and retain employees | 0.60 |

**Table 1.**
Variables in the model

Company characteristics such as sector (industry, construction, commerce and hospitality, transport, financial services and other services), size (number of employees in the establishment divided into three classes: establishments with 10–49 employees labelled "small", establishments with 50–249 employees labelled "medium-sized", and establishments with 250 workers or more labelled "large"; those with fewer than 10 employees, were not included in the survey) and country of operation (EU 10, EU 15, EU 27) were also analysed to understand the characteristics of the sample. The effects of these variables were kept controlled to capture the independent effect of predictor and dependent variables.

### *3.3 Data analysis and results*

The research objective was to examine the quality of a conceptual model assuming relationships between workplace well-being, algorithmic management, job autonomy and

total remuneration. Latent variables, i.e. variables that cannot be directly observed but can be detected through other variables that can be observed, were included in the model. The study of the relationship between latent variables is possible through the use of structural equation modelling (SEM). Using confirmatory factor analysis (CFA), a verification of the factor structure of the observed variables was conducted. CFA allowed us to test whether there is a relationship between the observed variables and the underlying latent constructs. The objective of identifying and assessing the relationship between the identified latent variables was achieved through the use of path analysis, that is a subset of SEM.

*3.3.1 Measurement validation.* In preliminary analysis, the association of all the variables, under investigation, with each other was checked by looking at their correlation coefficients. Due to the SEM imputing algorithm the variables are saved in the database as a *Z*-score, therefore their means are equal to zero. All the main constructs were found to be significantly correlating with each other (Table 2).

In the next step, the proposed measurement framework and the construct validity (reliability, convergent and discriminant validity) of all the constructs were examined through CFA using IBM SPSS AMOS software (version 27).

The CFA was conducted in two stages. In the first stage CFA was done for each individual construct to check its factor structure. Loading factors for each variable are presented in Table 1.

In the second stage of the CFA analysis, all the latent constructs were allowed to covary with each other in the overall measurement model. This is to check whether the sample covariance model fits well with the data and is approximately close to the population covariance. Fit indices were obtained to assess the fit of the measurement model. A model is considered a good fit if the absolute and incremental fit indices, namely, goodness-of-fit index (GFI) has a value greater then 0.9 and root mean square error of approximation (RMSEA) has a value less than 0.08. The overall measurement model has a good fit with the data (AGFI = 0.914, CFI = 0.796, RMSEA = 0.064).

As part of the analyses, the reliability of the measures used was checked. Due to the good fit of the model with the data, the analysis was treated as complementary. Its aim was to answer the question about the possibility of using the items in subsequent research. To examine the construct validity and the convergent validity the composite reliability (CR) was calculated. The value of CR should be near to or more than 0.7 to consider a scale reliable. The CR values of two of the latent constructs ("*Job autonomy*" and "*Total rewards*") were close to 0.7. "*Workplace well-being*" was slightly below the suggested limit and amounted to 0.6. The lowest CR was for the "*Algorithmic management*" variable and amounted to 0.5. CR also provides evidence for convergent validity of the construct. For the purposes of structural modelling both construct validity and convergent validity were considered satisfactory due to the fact that the research tool used was relatively new and the study based on primary data. Apart from CR, average variance extracted (AVE) was also calculated as an additional measure of the convergent validity of the research tool. AVE values of all the latent constructs were less than 0.50 but taking into the consideration the CR values the convergent validity for

| Variable | Mean | SD | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 1. Workplace well-being | 0 | 0.225 | – | | | |
| 2. Algorithmic management | 0 | 0.643 | −0.152* | – | | |
| 3. Job autonomy | 0 | 0.116 | 0.427* | −0.284* | – | |
| 4. Total rewards | 0 | 0.523 | 0.705* | −0.219* | 0.418* | – |

**Note(s):** *$p < 0.001$

**Table 2.** Descriptive statistics and correlations

the purpose of the SEM was treated as sufficient. Similarly, to assess the discriminant validity between the constructs, maximum shared squared variance (MSV) was calculated. It should be less than the AVE values. It was true for the variable "*Algorithmic management*". The reliability indicators are presented in Table 3. Despite the deviations in the heights of the indices from the recommended values for the research tool, the SEM was carried out on the basis of satisfactory indicators of the model fit. However, based on the reliability statistics, further research is recommended before using the research items derived from the ECS for more detailed analyses, in particular with smaller samples. Moreover, the reliability statistics can be computed only for the covariant version of the model (with no direct causal relations), while the proposed model (see Figure 1) is not the covariant type. Therefore, this paper is focusing more on the goodness-of-fit indices for the proposed model (RMSEA, CFI, AGFI) than reliability statistics.

*3.3.2 Structural model estimation.* Figure 1 shows the conceptual model which was tested in this study through structural modelling in SEM.

The variables in the analysed model explained over 59% ($R^2 = 0.592$) of the variance in the "*Workplace well-being*". "*Algorithmic management*" explained 2.3% ($R^2 = 0.023$) variance in "*Workplace well-being*", over 8% ($R^2 = 0.081$) variance in "*Job autonomy*" and almost 5% ($R^2 = 0.048$) variance in "*Total rewards*". "*Job autonomy*" explained over 18% ($R^2 = 0.182$) variance in "*Workplace well-being*" and "*Total rewards*" explained 50% ($R^2 = 0.498$) variance in "*Workplace well-being*".

Hypotheses about the direct (H1) ($\beta = -0.09$, $p < 0.001$) and indirect via "*Job autonomy*" (H2a) ($\beta = -0.18$, $p < 0.001$) and "*Total rewards*" (H3a) ($\beta = -0.04$, $p < 0.001$) negative impact of "*Algorithmic management*" on "*Workplace well-being*" were supported (total effect: $\beta = -0.14$, $p < 0.001$). The obtained results supported also two other hypotheses. "*Job autonomy*" (H2) ($\beta = 0.59$, $p < 0.001$) and "*Total rewards*" (H3) ($\beta = 0.41$, $p < 0.001$) had significant positive influence on "*Workplace well-being*".

*3.3.3 Influence of company characteristics.* The existence of associations between the analysed organisational characteristics and "*Workplace well-being*" was established using logistic regression, in which the exploratory variable was "*Workplace well-being*", and the explanatory variables, in addition to the latent variables in the model, were company characteristics: organisation size, sector and country of origin. Statistical significance was only obtained for organisation size (split into three groups), so a separate SEM model was calculated for each group. The results are presented in Table 4.

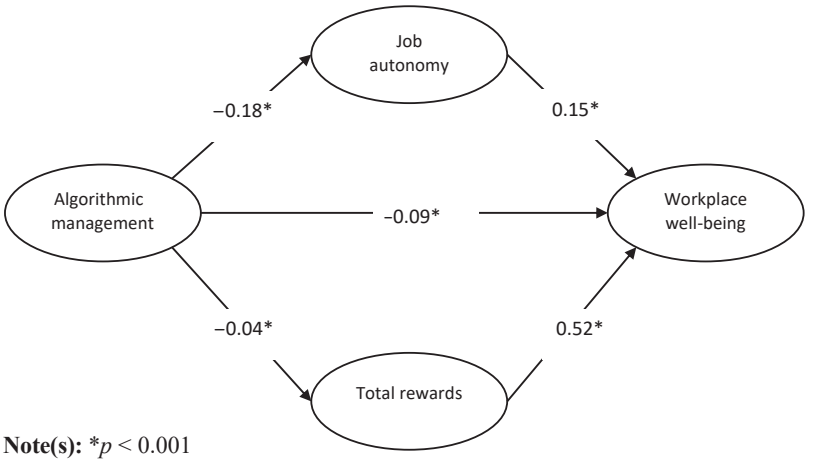
The values in Table 4 indicate a good fit of all three models to the data.

The variables in the analysed model explained over 52% ($R^2 = 0.518$) for small and medium, and 56% ($R^2 = 0.558$) for large organisations of the variance in "*Workplace well-being*". "*Algorithmic management*" explained:

(1) The variance in "*Workplace well-being*": 4% ($R^2 = 0.036$) for small, 3% ($R^2 = 0.029$) for medium and 2% ($R^2 = 0.019$) for large organisations;

**Table 3.** Reliability statistics

| | Composite reliability (CR) | Average variance explained (AVE) | Maximum shared variance (MSV) |
|---|---|---|---|
| Workplace well-being | 0.563 | 0.280 | 0.357 |
| Algorithmic management | 0.495 | 0.241 | 0.082 |
| Job autonomy | 0.668 | 0.255 | 0.326 |
| Total rewards | 0.645 | 0.299 | 0.357 |




**Note(s):** *$p < 0.001$

**Figure 1.** Results of the hypothesised framework

| Structural paths | "Small" organisations | "Medium" organisations | "Large" organisations |
|---|---|---|---|
| Algorithmic management → Workplace well-being (direct/total effect) | −0.12*/−0.18* | −0.09*/−0.14* | −0.07*/−0.12* |
| Algorithmic management → Job autonomy | −0.23* | −0.18* | −0.16* |
| Algorithmic management → Total rewards | −0.04* | −0.04* | −0.04* |
| Job autonomy → Workplace well-being | 0.13* | 0.15* | 0.18* |
| Total rewards → Workplace well-being | 0.52* | 0.58* | 0.60* |
| RMSEA | 0.063 | 0.062 | 0.065 |
| CFI | 0.800 | 0.808 | 0.794 |
| AGFI | 0.918 | 0.917 | 0.905 |

**Note(s):** *$p < 0.001$

**Table 4.** Structural analysis results for three categories of organisation size

(2) The variance in "*Job autonomy*": 10% ($R^2 = 0.097$) for small, 7% ($R^2 = 0.068$) for medium and 7% ($R^2 = 0.065$) for large organisations;

(3) The variance in "*Total rewards*": 5% ($R^2 = 0.052$) for small, 4% ($R^2 = 0.037$) for medium and 3% ($R^2 = 0.031$) for large organisations.

"*Job autonomy*" explained 18% ($R^2 = 0.182$) of the variance in "*Workplace well-being*" for small organisations and 19% ($R^2 = 0.187$) for medium and large companies. "*Total rewards*" explained the 50% ($R^2 = 0.498$) of variance in "*Workplace well-being*" for small firms 53% ($R^2 = 0.526$) for medium and 54% ($R^2 = 0.536$) for large.

The results supported all hypotheses for each of the three distinguished categories of organisation size. "*Algorithmic management*" practices had both direct (H1) and indirect – through "*Job autonomy*" (H2a) and "*Total rewards*" (H3a) - negative influence on "*Workplace well-being*". "*Job autonomy*" and "*Total rewards*" had positive impacts on "*Workplace well-being*". The path coefficients indicating the association of each of these variables with "*Workplace well-being*" increased with the size of the establishment.

Path coefficients connecting "*Algorithmic management*" with "*Workplace well-being*" varied by company size category. The highest negative coefficient (total effect) of

"*Algorithmic management*" influence on "*Workplace well-being*" was recorded for small organisations ($\beta = -0.18$, $p < 0.001$), the lowest for large ones ($\beta = -0.12$, $p < 0.001$). An analogous trend became apparent for the impact of "*Algorithmic management*" on "*Job autonomy*" – path coefficients decrease as the organisation grows (for small organisations $\beta = -0.23$, $p < 0.001$ and for large organisations $\beta = -0.16$, $p < 0.001$).

The only relationship among those studied for which the path coefficient remained the same ($\beta = -0.04$, $p < 0.001$) for all three organisation size categories was the relationship between "*Algorithmic management*" and "*Total rewards*".

## 4. Discussion and conclusions

Conceptual model developed on the basis of literature review and proposed in this paper has been empirically verified and confirmed the relationships between the algorithmic management practices and workplace well-being. Adoption of more automated and autonomous practices we have tested for using available data (i.e. use of data analytics for monitoring employee performance and for processes or service delivery improvement, use of robots, determining the pace of human work by machines or computers) in management of work influences negatively the employees' well-being. However, this direct influence – although significant – is rather moderate. As such one can argue that the application of algorithmic management practices itself does not worsen the working conditions, workplace relations, motivation and other factors that contribute to the feeling and indicators of well-being of employees. On the other hand, our study supports the argument that treating algorithmic management as an automated decision-making vehicle, leading to better, well-being focused, people management in organisations might be questioned. Empirical data suggests that the use of these practices as a key determining factor for employee attitudes and work-related effects (either positive or negative) might not lead to expected outcomes.

As noted by Parker and Grote (2022) it is crucial to ensure that the design of digital work promotes human well-being. Our research seems to corroborate this statement. We have confirmed that application of algorithmic management practices significantly influences job autonomy and to some extent also the total rewards practices. These in turn have important impacts on workplace well-being, leading to indirect – practically uncontrolled and undesirable – effects for important organisational outcomes, including well-being, but also possibly lowered motivation or performance.

Therefore, while interest in automated approaches to human resources management is growing globally, boosting expectations and business applications, careful reconsideration of spin-off effects on employee well-being must be considered. Gal *et al.* (2020) note that algorithmic management is expected to support evidence-based, bias-free and objective decisions, while in reality faces serious challenges, including lack of contextual information on factors affecting employee well-being, unconsciously embedded heuristics, or bias and limited transparency. This might lead to possible adverse employee reactions to management decisions via data-based algorithms (Tambe *et al.*, 2019). Based on the results of our research we call for a more holistic analysis and consideration of these adverse effects, with the workers well-being as the focal point for future developments. It is vital to ensure that application of algorithmic management does not significantly limit the feeling of job autonomy and a sense of having meaningful work. To do this, organisations and managers should regularly monitor and analyse employees' attitudes and opinions towards algorithmic-defined work (including workloads, emotional burdens, employees' sense of agency, etc.).

It is also important to note differences in our study according to organisation size. The literature indicates that organisations' workplace well-being support activities vary according to their size. Prior research has shown that engagement in workplace well-being

programs decreases with the size of the workplace (Hannon *et al.*, 2012). This is due to many reasons including: lack of interest, lack of knowledge, financial costs, lack of appropriate resources, too many daily activities of running their business (Goetzel and Ozminkowski, 2008; Heinen and Darling, 2009; Panagiotakopoulos, 2011; Newman *et al.*, 2015). Our research indicates that the influence of algorithmic management practices varies according to the size of the organisation. The impact on well-being and job autonomy decreased with the size of the organisation – it was highest in small organisations and lowest in large organisations, but the influence of job autonomy and total rewards practices on workplace well-being increased with organisation size. Only the impact of algorithmic management practices on total reward practices was the same for all organisation sizes. This might be explained by the fact that the size, structure and nature of small and medium enterprises means that these organisations have limited capacities and resources to adopt and integrate workplace well-being support. Large organisations, especially multinational corporations, support workplace well-being by numerous programmes and carefully monitor and analyse influencing factors. The results of our study indicate the relevance of separate research on the determinants of workplace well-being depending on the size of the organisation, as well as the development of practical supporting tools for the smaller entities.

## 5. Limitations and direction for future research

The study captured algorithmic management practices and workplace well-being relationship directly and via total rewards and job autonomy but could not examine these relationships longitudinally. As these factors are time specific and variable in nature, there is possibility of changes in these factors with the evolution of organisations. The pandemic accelerated and forced a process of digitising (including algorithmic management). Further research is needed to take into account the changes made to adapt working conditions during and after the pandemic. Lockdowns associated with pandemics in global economy affected employee's well-being. This effect has not been covered by the data gathered through ECS 2019 survey and might influence our research findings. Additionally, workplace well-being may change after a period of time after implementation of algorithmic management practices. Therefore, it is recommended to study them longitudinally.

This research is measuring employers' practices in European countries. Thus, the findings of this study cannot be generalised to perceptions of employees working in other parts of the world. We have not confirmed statistical significance of the country of origin as the explanatory variable for workplace well-being, using logistic regression. Further, more detailed research would be needed to cover other countries, so that they might show statistically significant differences, especially outside the European context.

Workplace well-being research should consider both perspectives – employees and employers. The study diagnosed the relationship between the constructs in a sample of employers. In order to get a complete picture, it would be recommended to conduct it also from the employees' perspective. Additionally, this study gauges the constructs through employers' self-report survey design. It is recommended to conduct research validating the findings through other rating sources including employees or other stakeholders.

Exploratory research has shown a low AVE for the research tools used in the ECS survey. The existence of a relationship between workplace well-being and algorithmic management practices indicates the need for further research to develop reliable survey tools measuring the constructs under investigation.

Future studies could examine related variables and more detailed components of algorithmic management practices that influence workplace well-being. Additionally, more mediators and moderators could emerge among the workplace well-being and algorithmic management practices relationship that future studies may investigate.

## Notes

1. Detailed information on the Survey methodology, along with questionnaires can be retrieved from: https://www.eurofound.europa.eu/surveys/2019/european-company-survey-2019.
2. Datasets for ECS 2019 have been retrieved from UK Data Service, where they have been made available for non-commercial scientific purposes free of charge.



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**Corresponding author**
Hanna Kinowska can be contacted at: hanna.kinowska@sgh.waw.pl