Research on the Impact of Algorithm Monitoring on Job Insecurity and Work Engagement From the Perspective of Perceived Transparency of Algorithmic Monitoring

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Abstract. With the widespread application of algorithms in various fields, there is a growing and urgent demand from employees and organizations for transparency in the algorithmic generation process. Transparency significantly influences employees' productive behavior. The objective of this study is to explore the impact of algorithmic monitoring on employees' job insecurity and work engagement under the regulation of perceived transparency of algorithmic monitoring. The research findings indicate that algorithmic monitoring positively influences employees' job insecurity. Moreover, job insecurity plays a mediating role between algorithmic monitoring and work engagement. Employees' perception of the transparency of algorithmic monitoring negatively moderates the link between algorithmic monitoring and job insecurity. This study provides new insights into relevant theories and practices.

Keywords: Algorithmic monitoring, perceived transparency of algorithmic monitoring, job insecurity, work engagement

1 Introduction

An algorithm refers to a computational formula that autonomously makes decisions using statistical models or predefined rules, operating without direct human intervention [1]. An increasing number of activities within organizations are being carried out by algorithms. They are taking over the role of colleagues or supervisors responsible for communicating information: such as monitoring, goal setting, scheduling, performance management, compensation administration, and termination functions [2]. Algorithmic monitoring encompasses the methods, staff, and procedures employed to gather, store, analyze, and present the actions or achievements of individuals or groups within a work environment [3]. Compared to human supervisors, algorithms can quickly process large amounts of data in real time, allowing for more accurate monitoring at any given time.

On one hand, algorithmic monitoring can promote employee learning and performance improvement by providing more accurate feedback. On the other hand, existing research suggests that algorithmic monitoring increases employee’s work stress among employees, reduce their autonomy, and has a negative impact on their intrinsic motivation [4]. Gagné M argues that the use of algorithmic monitoring in organizations shows a lack of trust in employees,

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a behavior that is more likely to negatively affect employees' work motivation and perception of procedural justice [5].

In summary, the perceived transparency of algorithmic monitoring by employees can be used as a novel starting point for analysis. Hence the paper grounded in the conservation of resources theory, focuses on the moderating effect of employees' perceived transparency of algorithmic monitoring on both algorithmic monitoring and job insecurity. Viewed from perceived transparency of algorithmic monitoring, it explores the relationship between algorithm monitoring, job insecurity, and work engagement.

2 Literature review and hypothesis

2.1 Algorithmic monitoring

Algorithmic monitoring is prevalent in organizations, especially in the gig economy, where organizations utilize digital platforms to monitor employees' activities in real time, assess the quality of their work, and link it to their performance [6]. Employees cannot evade organizational algorithmic monitoring, rendering them akin to puppets manipulated in the pursuit of data. Consequently, employees invest more effort in scrutinizing how their behaviors are being monitored, aiming to minimize potential losses. According to the conservation of resources theory, under the influence of algorithmic monitoring, employees are more prone to experience heightened stress, and resource depletion, and activate their job insecurity. On the basis of the above, the hypotheses of this study are as follows:

H1: Algorithmic monitoring is positively related to job insecurity.

2.2 Algorithmic monitoring and work engagement

Algorithmic monitoring sends signals to employees about the potential loss or gain of resources [7]. Employees expend resources in order to ensure that their negative behavior at work will not be detected by the algorithmic surveillance. At the same time, due to the fear of facing consequences for defying algorithmic instructions (such as salary cuts or loss of bonuses), employees are inhibited from exploring alternative methods. Algorithmic monitoring further restricts employees' work engagement in terms of creativity and innovative thinking. In addition, algorithmic monitoring takes over the role previously played by human supervisors from an affective trust perspective. Communication between employees and their human counterparts is transformed into acceptance of feedback from algorithms. When interacting with algorithms, employees' distrust of algorithmic monitoring further suppresses their work engagement [8].

Due to the inherent black-box nature of algorithms, this process is inherently opaque. For employees, the monitoring system functions as an incomprehensible black box. Monitored employees confront complex algorithmic systems and lack an understanding of how algorithms process received data to generate output information [9]. This perceived loss of control over work generates feelings of distrust and unfairness toward the system, diverting employees' attention [10]. Therefore, we propose that algorithmic monitoring leads employees to reduce their work engagement to prevent the loss of work resources, and job insecurity acts as a mediator between algorithmic monitoring and work engagement. On this basis, our study suggests the below hypothesis:

H2: There is a negative correlation between algorithmic monitoring and work engagement.

H3: Job insecurity is a mediator of the relationship between algorithmic monitoring and work engagement.

2.3 The moderating role of perceived transparency of algorithmic monitoring

In order to sustainably improve employee performance, the integration of algorithmic systems into organizational management requires an essential focus on transparency. Transparency refers to individuals' perception of the information they receive [11]. Broadly, algorithmic transparency is the disclosure of algorithm operations, processes and output results to users [12]. Algorithmic transparency aims to enhance fairness, efficiency, and employee motivation by encouraging them to improve their behavior based on openly available results. The conservation of resources theory, individuals are significantly impacted by resource losses compared to gains. People naturally fear the unknown and are averse to uncertainty in the workplace. The attitudes and actions of employees are shaped by their perceptions of the transparency of algorithmic monitoring in the workplace. When employees perceive higher transparency in algorithmic monitoring, their perceptions of procedural justice and fairness increase [13], subsequently reducing anxiety, fear and job insecurity. Conversely, an algorithmic monitoring system with a low level of transparency undermines employees' trust in the algorithmic output, increases their perception of job threat, and increases their job insecurity. Based on these premises, the following hypothesis is proposed in this study:

H4: Employees' perceived transparency of algorithmic monitoring negatively moderates the relationship between algorithmic monitoring and job insecurity.

Figure 1 below shows the conceptual model.

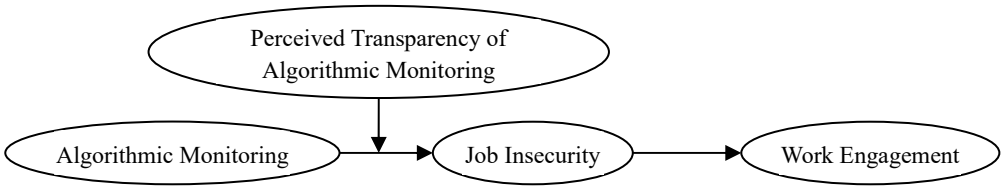

Fig 1. The conceptual model

3 Research design

3.1 Data collection and sample characteristics

As for the sample population, we selected five companies in City S that utilize algorithmic monitoring systems as our research subjects. Offline questionnaires were used for data collection. A survey was conducted on-site, with the participation of 350 employees. With the support of senior management and collaboration of the HR departments, and on a voluntary basis, the participants, approximately six people per group, were gathered in a conference room. After explaining the purpose of the study, research assistants instructed participants to respond truthfully based on their own experiences. To mitigate the effects of causal lags and common method bias, data were collected in three stages. Each stage was separated by one month.

Participants were rigorously coded to ensure correspondence. In the first stage, data on the independent variable (Algorithmic Monitoring) were collected. In the second stage, data were collected on the mediating variable (job insecurity) and the moderating variable (perceived transparency of algorithmic monitoring). Work engagement ratings were collected in the third stage.

After removing invalid samples with missing data, a total of 305 valid responses were obtained, resulting in a response rate of 87.1%. Of the participants, 52.5% were male, and 47.5% were female. In terms of age distribution, 19.02% were below 25 years old, 44.26% were between 26 and 35 years old, 28.2% fell between the ages of 36 and 45, and 8.53% were 45 years old or older. Regarding education, 39.02% had a college degree or lower, 43.93% held a bachelor's degree, and 17.05% possessed a master's degree or higher.

3.2 Procedure and measurement

Answers were collected by using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).We use the gender, age, and education level of employees as control variables. Measure of algorithmic monitoring. We employed a scale consisting of four items developed by Parent-Rocheleau et al (2023) [14]to assess the extent of algorithmic monitoring. The Cronbach's alpha of this scale was 0.848. Measure of job insecurity. Job insecurity was measured using the 5-item scale of Wang (2014) [15]. The Cronbach's alpha of this scale was 0.886. Measure of work engagement. We used a 9-item scale developed by Schaufeli et al (2022) [16] to measure the level of work engagement. The Cronbach's alpha of this scale was 0.947. Measure of perceived transparency of algorithmic monitoring. We used a 4-item scale developed by Parent-Rocheleau et al. (2022) [17] to measure the level of perceived transparency of algorithmic monitoring. The Cronbach's alpha of this scale was 0.860.

4 Result

We used SPSS26.0 as well as AMOS26.0 to process the data. Firstly, we analysed the data for reliability and validity. Secondly, we performed correlations, means, and standard deviations and the 4 variables' common method bias test. Thirdly, we used hierarchical regression analysis to examine the mediating effect of job insecurity and the moderating effect of perceived transparency of algorithmic monitoring. Finally, we used the relevant plugins of SPSS and the Bootstrap sampling approach for the test of confidence intervals.

4.1 Reliability and validity analysis

Amos26.0 software were used to perform confirmatory factor analysis to test the discriminant validity between the four variables, namely algorithmic monitoring, job insecurity, work engagement, and perceived transparency of algorithmic monitoring. The 4-factor model assumed had a better fit indices than other models. All five indicators of the four-factor model satisfied the acceptance criteria ($\chi 2$/df=1.403, RMSEA=0.036(<0.08), TLI=0.980, and CFI=0.982, IFI=0.982). Hence, these results are an indication of the good discriminant validity of our study model.

4.2 Common method deviation test

All three stages of the survey in this study were assessed by the employees themselves, thus requiring a common method bias test. In this study, exploratory factor analysis was performed on all questionnaire entries for each variable using Harman's one-way test. The cumulative variance explained was 67.61%, with the first principal component accounting for 49.1% of the overall variance. These results adhere to the standard criteria, indicating that the influence of common method bias on the study's outcomes is negligible.

4.3 Correlations, means, and standard deviations

SPSS 26.0 was employed for the correlation analysis. Summary statistics including means, standard deviations, and correlation coefficients are presented in Table 1. The results revealed a positive relationship between algorithmic monitoring and job insecurity ($r = 0.437$, $p < 0.01$). In addition, algorithmic monitoring showed a negative relationship with work engagement ($r = -0.339$, $p < 0.01$), while job insecurity was negatively correlated with work engagement ($r = -0.597$, $p < 0.01$). These findings provided initial support for some of the hypotheses in our study.

Table1. Correlations, Means, and Standard Deviations

Variable	*M*	*SD*	1	2	3	4	5	6	7
1.Gender	1.480	0.500	1						
2.Age	3.250	0.962	.054	1					
3.Education	1.820	0.812	-.019	.103	1				
4.Algorithmic monitoring	3.718	0.769	.008	-.064	-.028	1			
5. Perceived transparency of algorithmic monitoring.	3.630	0.823	.049	-.141*	.035	-.335**	1		
6. Job insecurity	3.547	0.710	-.095	.059	-.096	.437**	-.581**	1	
7. Work engagement	3.661	0.828	.079	-.146*	.006	-.339**	.867**	-.597**	1

Note:$N = 305$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$

4.4 Hypothesis testing

Table2 Regression Analysis

	Job insecurity						Work engagement			
	Model 1		Model 2		Model 3		Model 4		Model 5	
	β	*SE*	β	*SE*	β	*SE*	β	*SE*	β	*SE*
Intercept	3.747***	0.198	2.162***	0.255	4.356***	0.308	5.297***	0.310	6.664***	0.295
Gender	-0.144	0.081	-0.151	0.073	-0.104*	0.063	0.151	0.088	0.055	0.076
Age	0.056	0.042	-0.076	0.038	0.012	0.033	-0.150**	0.046	-0.102*	0.040
Education	-0.093	0.050	-0.085	0.045	-0.063	0.039	0.016	0.055	-0.037	0.047
Algorithmic monitoring			0.407***	0.047	0.238***	0.044	-0.376***	0.057	-0.119*	0.055
Job insecurity									-0.632***	0.060
Perceived transparency of algorithmic monitoring					-0.409***	0.041				
Algorithmic					-0.095*	0.046				

monitoring× perceived transparency of algorithmic monitoring					
R^2	0.024	0.219	0.423	0.151	0.381
ΔR^2	—	0.195	0.204	—	0.230
F	2.503	20.980***	36.397***	13.360***	36.797***

Note:N = 305; *p < 0.05; **p < 0.01; ***p < 0.001;

Step 1: Examine H1.As shown in Table 2, Model 2, built upon Model 1, demonstrated an increase in the overall explanatory power by 19.5% (ΔR^2 = 0.195). Algorithmic monitoring had a significant positive effect on job insecurity (β = 0.407, p < 0.001), supporting Hypothesis 1.

Step 2: Examine H2. According to Model 4, algorithmic monitoring exhibited a significant negative effect on work engagement (β = -0.376, p < 0.001), signifying a detrimental correlation between algorithmic monitoring and work engagement. Thus, Hypothesis 2 is corroborated.

Step 3: Evaluate the mediating impact of job insecurity. In Model 5, a substantial decrease in the coefficient was observed for the influence of algorithmic monitoring on work engagement after incorporating the mediating factor job insecurity (β = -0.119, p < 0.05). This finding suggests that job insecurity serves as a mediator in the connection between algorithmic monitoring and work engagement. Consequently, Hypothesis 3 is validated.

Step 4: Examine the moderation effect of perceived transparency of algorithmic monitoring. Model 3, an extension of Model 2, demonstrated a 20.4% increase in overall explanatory power (ΔR^2 = 0.204). Additionally, the interaction term between algorithmic monitoring and perceived transparency of algorithmic monitoring was significant (β = -0.095, p < 0.05), signifying that employees' perception of transparency in algorithmic monitoring negatively moderates the association between algorithmic monitoring and job insecurity. Consequently, Hypothesis 4 is affirmed.

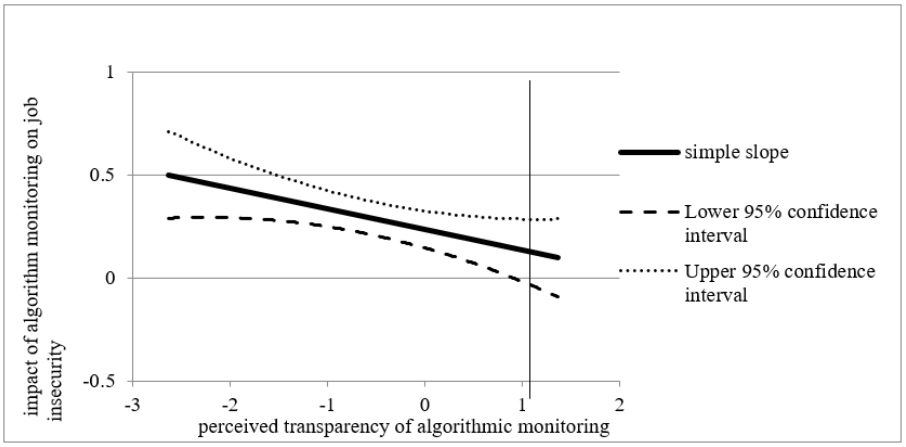

Fig 2. The Research Model

Step 5: Further examine H3 and H4. The indirect effect value of job insecurity was -0.150 (confidence interval [-0.211, -0.086]), the confidence interval did not include 0. Thus,

hypothesis 3 is again supported. We examined the difference in the indirect effect of algorithmic monitoring to job insecurity at low (Mean-1SD) and high (Mean+1SD) level of perceived transparency of algorithmic monitoring, using the interval estimation Bootstrap method. As shown in table 3, when perceived transparency of algorithmic monitoring is low, the indirect effect is 0.317 and 95% confidence interval [0.213, 0.420] excludes 0. When perceived transparency of algorithmic monitoring is high, the indirect effect of perceived transparency of algorithmic monitoring is 0.160 and 95% confidence interval [0.035, 0.284] excludes 0. Therefore, hypothesis 4 is again supported.

Furthermore, the Johnson-Neyman (J-N) method is used to investigate the specific form of the regulatory effect. The J-N method overcomes the shortcomings of the traditional point-tracing method. (i.e. mean ± 1 standard deviation), and provides more accurate information by describing the confidence band of simple slope. As shown in Fig 2, in the part where perceived transparency of algorithmic monitoring (centralization) is less than 0.9, the confidence interval of the simple slope line does not include 0, indicating statistical significance. Moreover, the slope line exhibits a decreasing trend along the X axis, indicating that perceived transparency of algorithmic monitoring negatively adjusts the relationship between algorithmic monitoring and job insecurity, i.e.as the level of perceived transparency of algorithmic monitoring increases, the positive influence of algorithmic monitoring on job insecurity becomes weaker.

Table3 Results of moderating effect analysis (perceived transparency of algorithmic monitoring)

moderating variable		Estimation of indirect effects	standard error	95% confidence interval
perceived transparency of algorithmic monitoring	(Mean-1SD)	0.317***	0.053	[0.213，0.420]
	difference	0.238***	0.044	[0.151，0.325]
	(Mean+1SD)	0.160*	0.062	[0.035，0.284]

5 Conclusions

The results show that algorithmic monitoring has a positive impact on employees' job insecurity. Furthermore, job insecurity is negatively related to employees' work engagement. Additionally, job insecurity acts as a mediator in the connection between algorithmic monitoring and work engagement. Finally, employees' perceived transparency of algorithmic monitoring moderates the link between algorithmic monitoring and job insecurity. As employees' perceived transparency of algorithmic monitoring increases, the job insecurity caused by algorithm monitoring to employees will decrease. Based on conservation of resources theory, transparency of algorithmic monitoring relieves people of the pressure of being monitored. Effectively alleviates the loss of resources in the work of employees, which is benefit to employee's work engagement. Our findings provide theoretical guidance and practical support for organizations using algorithmic monitoring.

This study offers several managerial implications. Firstly, organizations can improve employees' perceived transparency of algorithmic monitoring, which is closely linked to reducing employees' job insecurity. Job insecurity is a significant factor influencing employees' intention to leave, and in today's high employee turnover society, focusing on

employees' perception of algorithmic transparency is paramount. Secondly, respecting the role of employees and fostering a sense of empowerment is crucial to avoid employees becoming mere puppets to be manipulated by algorithmic management. Lastly, in the age of algorithms, flexible management strategies should be adopted. Employees should not be treated as a part of mechanical components within algorithmic management. Instead, organizations should provide employees with sufficient care and attention, mitigate the perceived threats caused by algorithms opacity, and foster an atmosphere of humanistic care within the organization.

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