February 2025

Algorithmic Competency of On-demand Labor Platform Workers:

Scale Development, Antecedents, and Consequences

Lian Zhou, Xue Lei, Mingwei Liu, Xinran Huang, Rui Hou

Working Paper 2025.02

RUTGERS–NEW BRUNSWICK
Center for Global Work and Employment
School of Management and Labor Relations

Algorithmic Competency of On-demand Labor Platform Workers: Scale Development, Antecedents, and Consequences

Lian Zhou[1], Xue Lei[2], Mingwei Liu[3], Xinran Huang[1] and Rui Hou[1]

[1] *School of Management, Guangdong University of Technology, China*
[2] *School of Business, East China University of Science and Technology, China*
[3] *School of Management and Labor Relations, Rutgers University, USA*

Abstract

Despite the highly controlled algorithmic work environment, on-demand labor platform workers may devise strategies to enhance their Algorithmic Competency (AC), facilitating better adaptation to the system. Yet, the proactive engagement of platform workers with algorithms remains underexplored in empirical research. This study endeavors to fill this gap by developing and validating the first scale of AC, while also shedding light on its antecedents and consequences. Analysis of data from five samples of Chinese on-demand labor platform workers reveals that AC encompasses four dimensions: understanding, embracing, leveraging, and remediating algorithmic management. It is found that AC is positively influenced by social support from peers and cognitive job crafting. Furthermore, AC is shown to account for additional variance in customer-oriented service behavior and identification with gig work, beyond that explained by related constructs. The paper concludes with a discussion on the implications of China's distinctive on-demand economy context for the generalizability of the findings.

Keywords

On-demand labor platform; algorithmic management; algorithmic competency; antecedents, outcomes

The first three authors contribute equally.

Acknowledgements: This work was supported by the National Natural Science Foundation of China (72002047, 72072044, 72202064, 72372047); Social Science Foundation of Ministry of Education of China (20YJC630237); Guangdong Basic and Applied Basic Research Foundation (2024A1515011284, 2020A1515010859), and Shanghai Pujiang Talent (22PJC028).

INTRODUCTION

On-demand labor platforms, such as Uber and Lyft, implement algorithmic management (AM) to direct, evaluate, and discipline their workforce (Duggan et al., 2020; Kellogg et al., 2020). This algorithmic governance is marked by non-transparent rules, extensive surveillance, and the removal of traditional managerial roles (Rahman, 2021). While previous studies have primarily scrutinized the adverse impacts of AM on workers, such as feelings of powerlessness, diminished autonomy, and increased workload (Parent-Rocheleau et al., 2024), it is acknowledged that workers are not merely passive subjects under AM (Jarrahi & Sutherland, 2019). Instead, they may actively enhance their Algorithmic Competency (AC) to better navigate the algorithmic work landscape (Möhlmannn et al., 2023; Wu et al., 2023). AC reflects workers' knowledge and ability to interact effectively with the platform's AM (Jarrahi & Sutherland, 2019). Evidence from Cameron (2024) suggests that some workers perceive themselves as empowered and adept in leveraging the algorithmic system to their advantage. This proficiency in understanding and leveraging AM enables workers to adhere to algorithmic directives, optimize their productivity and earnings, and assert their professional autonomy (Bellesia et al., 2023; Möhlmannn et al., 2023; Wu et al., 2023).

Despite its significance, the study of AC in the context of on-demand labor platforms is nascent (Jarrahi et al., 2021). Previous research, rooted in labor process theory, has largely concentrated on workers' efforts to reclaim autonomy via algoactivism (Veen et al., 2020), a stance often characterized by resistance strategies like noncooperation and data obfuscation (Cameron & Rahman, 2022; Kellogg et al., 2020). This perspective, however, overlooks the potential for workers to adopt alternative approaches to enhance autonomy and derive value from algorithms, a gap that Meijerink and Bondarouk (2023) argue warrants further exploration. They contend that a deeper understanding of how workers engage with and benefit from AM is crucial, echoing the principles of sociotechnical systems theory (Cherns, 1976). This theory highlights the complexity of embedded technologies in the workplace and the active role of human agency in adapting and shaping technological systems (Lamers et al., 2024; Jarrahi et al., 2021). Additionally, while qualitative studies have begun to explore AC among gig workers (Jarrahi & Sutherland, 2019), the development of a psychometrically valid AC scale is lacking. This absence impedes theoretical development and understanding of AC's antecedents and consequences. Furthermore, existing studies primarily focus on Western contexts, with limited insights into how workers in the Asia Pacific adapt to algorithmic work by enhancing their AC and the factors influencing this adaptation (Wu et al., 2023).

This research aims to bridge these gaps by conceptualizing AC within on-demand labor platforms, developing and validating what we believe to be the first scale for AC, and situating our findings in the Chinese context. Drawing on five samples of Chinese platform workers, a 12-item scale is developed to measure AC, with a thorough examination of its validity, antecedents, and outcomes. This study not only advances the theoretical understanding of AC but also responds to calls for research into the proactive behaviors of platform workers in generating value from AM (Meijerink & Bondarouk, 2023). Furthermore, it enriches the empirical research of AC and highlights how social support from peers and cognitive job crafting affect AC in the context of the Chinese culture and institutional background. The development of a sound measure of AC is expected to help future research examine platform workers' experience and response to AM in a more nuanced manner (Jarrahi et al., 2021).

Conceptualizing and Understanding Algorithmic Competency

The concept of AC originated from Jarrahi and Sutherland's (2019) study on Upwork users, which emphasizes that users of digital platforms are not passive recipients of AM. Instead, they develop a nuanced understanding and operational literacy regarding algorithms, a phenomenon conceptualized as AC. AC encompasses the workers' ability to effectively engage with algorithms during task execution and to cultivate symbiotic relationships that better align technological systems with their needs and interests (Jarrahi et al., 2021). This ability aligns with sociotechnical systems theory (Cherns, 1976; Leonardi, 2011), which emphasizes the active role of social actors in shaping and enhancing technological systems. According to this theory, technologies are embedded in the workplace, and the efficacy of these systems is determined by the interaction between their technical attributes and human operators (Parent-Rocheleau & Parker, 2022). Therefore, AM should be understood as a sociotechnical process that arises from the continuous interaction between platform workers and the algorithms mediating their work (Jarrahi & Sutherland, 2019). In other words, platform workers are not passive recipients of algorithmic systems; they actively seek to understand and align these systems with their needs and interests, thereby shaping the development of AM (Meijerink & Bondarouk, 2023).

Subsequent research underscores the pivotal role of AC in fostering new work paradigms propelled by AM. Heinrich et al. (2022) define AC as a combination of data-centered analytical abilities and the proficiency to comprehend, scrutinize, and modify algorithms, noting that disparities in such knowledge could engender power imbalances among workers. Cotter (2022) explores how the pervasive nature of

algorithms in daily life profoundly influences aspects such as user behavior, experience, autonomy, fairness, and trust in systems. Moreover, contemporary discussions increasingly focus on how workers can exercise their agency to mitigate the inequities inherent in algorithm-driven contexts and secure favorable outcomes (Cameron, 2024). For instance, the work of Meijerink and Bondarouk (2023) illustrates the active role of platform workers in creating value out of AM and triggering the redesign of AM. Similarly, Bellesia et al. (2023) highlight platform workers' agency in interpreting and understanding AM which helps them engage positively with algorithms. The attempts to understand AM have also been confirmed by Möhlmann et al. (2023), who delve into "algorithm sensemaking," where platform workers decode the intricacies of AM, thereby maintaining pace with its demands.

Building on the above studies and the sociotechnical systems theory, we define AC of on-demand labor-platform workers as *their understanding of platform algorithms that assign and evaluate their work and their ability to adapt to and navigate those algorithms*. Rather than narrowing workers' skills and maximizing work breakdown, the sociotechnical systems perspective encourages the development of multiple broad skills in workers to help them manage uncertainties and variance in the technology-integrated environment (Trist, 1981). Specifically, drawing on the concept of digital competence (Janssen et al., 2013) and algorithm literacy (Dogruel et al., 2021)—which includes essential skills, knowledge, and attitudes—we argue that AC comprises cognitive, attitudinal, and behavioral elements that enable workers to autonomously understand, evaluate, influence, and maneuver within algorithmic environments. Notably, fostering a balanced perspective towards technology is crucial for developing such competencies, advocating for an equilibrium between skepticism and wholesale acceptance (Janssen et al., 2013).

We further argue that AC and algoactivism — defined as the tactics used by workers to resist AM (Kellogg et al., 2020)—may share some behavioral manifestations but differ significantly in motivation and goals. Drawing from labor process theory, algoactivism arises from a desire to circumvent the platform's overbearing control and surveillance (Meijerink & Bondarouk, 2023), driven by a strong impetus to rectify the power disparity between platforms and workers (Rahman et al., 2024). Although these studies acknowledge human agency in technological relations, they primarily focus on material agency, framing human agency solely as a resistant force against material agency, such as algorithmic control (Lamers et al., 2024). In contrast, based on sociotechnical systems theory, AC emphasizes the central role of human agency in shaping and appropriating technological systems. AC reflects platform workers' knowledge, confidence, and capability to fulfill their roles within the platform, aiming to align

the AM more closely with their needs and interests (Jarrahi & Sutherland, 2019). This competency not only provides gig workers with a competitive edge in the global marketplace but also distinguishes them within the vast pool of online labor (Jarrahi et al., 2021). Overall, while algoactivism is characterized by targeted anti-algorithmic actions (Newlands, 2021), AC encompasses a broader spectrum of cognitive, attitudinal, and behavioral dimensions, including an informed stance on AM, a balanced attitude toward it, and the agency to address its limitations.

Developing a Measure of Algorithmic Competency

Phase 1: Identification of algorithmic competency dimensions

The concept of AC is recognized as inherently multidimensional due to the diversity of its components. To delineate the specific dimensions of AC, we adopted both deductive and inductive approaches as outlined by Hinkin (1998). First, the initial three dimensions of AC were derived from Jarrahi and Sutherland (2019), who identified sensemaking, circumventing, and manipulating as key activities associated with AC through their qualitative inquiry among Upwork users. Sensemaking is demonstrated by the substantial time and effort platform workers invest in developing a more nuanced understanding of AM. Circumventing suggests that platform workers seek ways to bypass or supplement algorithmic processes with outside tools when necessary. Manipulating describes how platform workers manipulate various algorithms and alter AM outputs by providing different inputs to the data collection process.

As Jarrahi and Sutherland's (2019) three categories of AC were based on Upwork workers in Western cultures, we conducted interviews with on-demand labor platform workers in the Asia-Pacific region to explore whether the results are similar. Unlike Upwork, AM within on-demand labor platforms (e.g., Uber and Lyft) has a greater impact on workers (Wei & Thomas MacDonald, 2022). We recruited 99 ride-hailing drivers and food-delivery workers in China (Sample 1) through convenient sampling via ride-hailing and food-ordering. Of this sample, 98.99% were male, and 79.80% reported that platform work was their main source of income, with an average tenure of 2.54 years. The interviews were semi-structured and lasted approximately 30 minutes each, allowing us to deepen our understanding of the dimensions of AC. The questions included: "What do you know about the platform AM? How would you describe your current platform work and your level of adaptation to AM? What factors contribute to your sense of adaptability or maladaptation? Which perspectives, attitudes, knowledge sets, skills, or competencies help you effectively adjust to the platform AM?" Follow-up questions were asked to facilitate the interview. The entire interviews were recorded and transcribed. These transcripts were then

content-analyzed following the procedures outlined by Harold et al. (2022). Specifically, the first two authors independently coded the full text of the interviews by assigning codes to each statement and creating new codes in an iterative process. Then the authors discussed the coding discrepancies and categorized them to four broader themes.

Notably, we made two major revisions to Jarrahi and Sutherland's (2019) three activities associated with AC. One revision involved redefining the three initial dimensions as Understanding, Leveraging, and Remediating AM, based on our conceptualization of AC, insights from the interview data, and relevant literature (e.g., Cameron, 2022, 2024).

(1) We opted for "Understanding AM" instead of "Sensemaking" because Understanding AM focuses on comprehending clear and structured information. In contrast, sensemaking is a process used to navigate ambiguity, complexity, and uncertainty, helping to create a structure or narrative that makes a situation comprehensible. Sensemaking represents a journey toward understanding. This distinction is illustrated by one example from our interview data: "I know that data from the heat map changes constantly, and the actual data can be delayed by five minutes." Indeed, Jarrahi and Sutherland (2019) emphasized understanding as a key word when describing sensemaking activities related to AM.

(2) We chose "Leveraging AM" instead of "Manipulating" to avoid the neutral or negative implications associated with manipulation and to convey the adept use of AM for one's benefit in a neutral or positive manner. For instance, manipulation suggests resistance to AM in a deceitful or unfair way, such as creating multiple fake accounts to earn more (Kadolkar et al., 2024). In contrast, "Leveraging AM" indicates a strategic or advantageous use of resources without negative connotations. This is illustrated by an example from our interview data: "To get high ratings, I am polite to customers, introduce them to scenic spots, and help them with their luggage." Findings from Cameron (2024) also supports the concept of "Leveraging AM," as some drivers can make the matching algorithm work in their favor by using the "Get Rides to Destination" feature.

(3) We opted for "Remediating AM" instead of "Circumventing" because the former suggests the ability to address AM's shortcomings, indicating active engagement rather than merely bypassing the algorithmic process (i.e., the time tracker on Upwork), as implied by circumvention. "Remediating AM" aligns with our definition of AC, which emphasizes workers' agency to address the limitations of AM. This is supported by our interview data, such as one participant's comment: "I can proactively address the missing information in AM based on my own experience". Prior literature also supports the concept

of "Remediating AM," as experienced riders often know what happens at specific times and which restaurants are highly frequented, recognizing that they are not always located in the [hot zone center] suggested by AM (Heiland, 2023).

The other revision involved adding "Embracing AM" as a dimension of AC. We found that workers who are confident in the algorithmic system's precision and efficiency in pairing them with customers tend to view the system as equitable and report more favorable interactions with it. Such workers exhibit greater patience towards algorithms, are less inclined to fault the system, and are more receptive to its imperfections. This new dimension is also supported by literature, where some drivers praise algorithms for effectively matching independent drivers with customers and providing detailed, useful navigational instructions. As a result, they trust that AM decisions align with their own interests and view themselves as competent in platform work (e.g., Cameron, 2022).

In summary, our literature review and interviews have unveiled four dimensions of AC: understanding AM, embracing AM, leveraging AM, and remediating AM, with Table 1 offering comprehensive descriptions and examples of each dimension derived from our dataset. Understanding AM refers to platform workers having a sophisticated comprehension of how AM operates and the ability to navigate its dynamic nature. Embracing AM pertains to platform workers' willingness to trust in the efficiency and accuracy of AM for matching and other functionalities. Leveraging AM denotes platform workers' capacity to utilize AM strategically or advantageously for their benefit. Remediating AM involves platform workers' ability to address or supplement the deficiencies of AM.

PHASE 2: Item generation and content validation

Based on the themes identified during Phase 1, we formulated items following the procedures detailed by Hinkin (1998) and other researchers (e.g., Harold et al., 2022). Input from relevant literature (e.g., Cameron, 2022, Jarrahi & Sutherland, 2019; Meijerink & Bondarouk, 2023) and interviews from Sample 1 guided us in creating 14 items that correspond to the four dimensions of AC. Similar codes were combined to form these 14 items, representing various manifestations of each dimension of AC and ensuring comprehensive coverage of the construct. After formulating the 14 items, we solicited feedback from three professors specializing in human resource management and ten platform-based ride-hailing drivers and food delivery workers in China (recruited from Credamo, an online survey platform in China; 60% male; M_{age} = 31.4 years; $M_{platform\ tenure}$ = 2.5 years; $M_{daily\ working\ hours}$ = 7 hours) to assess the content validity of our measure. Following Schriesheim and Hinkin's (1990) methodology, we provided them

with definitions of AC and its four dimensions, along with the 14 items presented in random order. We then asked them to classify each item into one of five categories: the four AC dimensions and a fifth category labelled "other dimensions" to avoid forcing items into any of the four core dimensions. We calculated the percentage of total points for each item in each category, with results indicating that the agreement rate across the 14 items ranged from 76.9% to 100%. This exceeds the criteria of 60% (Schriesheim & Hinkin, 1990), confirming that the 14 items appropriately measure their respective dimensions. Among these items, 4 pertained to Understanding AM, 3 related to Embracing AM, 3 to Leveraging AM, and 4 to Remediating AM.

PHASE 3: Exploratory factor analysis (EFA, Sample 2)

We first conducted EFA to refine the factor structure of AC. We recruited 312 online labor platform workers to participate in our survey through ride-hailing and food-ordering services, as well as by contacting workers at food delivery stations. These participants were selected because they worked for major platforms such as DiDi (the Chinese equivalent of Uber), Ele.me, and Meituan, all of which extensively use algorithms to direct, evaluate, and discipline their workers (Huang, 2023). Each participant was compensated with RMB ¥10 (approximately US$1.42). Exclusions were made for participants who either failed an attention check or submitted incomplete responses, resulting in a final sample of 275 valid questionnaires (sample 2). This corresponds to a response rate of 88.14%. The demographic breakdown revealed that 97.1% of the participants were male, with an average age of 28.58 years (SD = 7.16), and 88% were between 20 and 40 years old. Their average tenure in platform work was 1.87 years (SD = 1.89), with 60% having worked on the platform for more than one year. Additionally, 78.7% had high school education or less, and 82.8% were full-time workers (i.e., platform work was their main source of income). Notably, the demographic characteristics of our participants closely resembled those of workers on major online labor platforms in China. For example, from 2018 to 2019, Meituan drivers were 93.3% male, 83.7% aged 20–40, 42.9% had worked for more than one year, 82% had a high school education or less, and 74.5% were full-time workers (MRI, 2020; Zhou, 2020)[1].

The EFA revealed a four-factor solution, effectively distinguishing between the four dimensions of AC. Two items were removed: one due to cross-loadings and the other for failing to load on the anticipated factor. The remaining 12 items aligned well with their expected factors, providing preliminary support for the measure's four-factor structure (see Table 2).

[1] The demographic characteristics of sample 3, sample 4, and sample5 also closely resembled those of workers on major online labor platforms in China.

PHASE 4: Confirmatory factor analysis (CFA, Sample 3)

Subsequently, a CFA was undertaken to validate the factor structure identified in the EFA phase. This involved reaching out to a new cohort of 223 online labor platform workers, mirroring the recruitment procedure of the EFA phase. This effort yielded 213 valid questionnaires (sample 3), marking a response rate of 91.81%. This sample consisted predominantly of male workers (92.0%), with an average age of 28.76 years (SD = 7.54) and 83.8% aged 20-40. Their average tenure in platform work was 1.69 years (SD = 1.72), with 70.2% having worked for more than one year, 71.7% having high school education or less, and 81% being full-time platform workers.

The CFA analysis indicated that the four-factor model fits better than the alternative one-factor, two-factor, and three-factor models (see Table 3 for the details). Furthermore, the second-order four-factor model was not significantly better than the first-order four-factor model, based on the chi-square difference ($\Delta\ \chi^2(2) = 5.09$, $p > .05$). However, given that the two models were mathematically equivalent, and the second-order model allowed the covariation among first-order factors (Zhang et al., 2015), the second-order four-factor model was preferred (χ^2 (50) =71.95; comparative fit index (CFI) = .98; root-mean-square error of approximation (RMSEA) = .05; standardized root-mean-square residual (SRMR) = .04). The factor loadings of the second-order four-factor AC model were presented in Table 2.

PHASE 5: Convergent and discriminant validity (Sample 4)

In this stage, we aimed to assess the convergent and discriminant validity. We recruited another sample of 319 platform workers using the same procedure as in the EFA. The final valid sample (Sample 4, comprising 230 respondents, with a response rate of 72.10 %) was 89.5% male, with an average age of 29.03 years (69.4% aged 20-40), and an average platform work experience of 1.69 years (61.5% had worked for more than one year). Of this sample, 57.8% had high school education or less, and 61.3% were full-time platform workers.

Convergent validity. Convergent validity is demonstrated when a construct correlates with other constructs to which it is theoretically related. In this regard, we investigated the associations between AC, its four dimensions, and constructs of digital competence alongside competence need satisfaction (i.e., the perception of being effective and able in achieving desired outcomes within platform work, as posited by Chen et al., 2015) since both are pertinent to competence in the context of platform AM. Digital competence was assessed using a six-item scale from Wang et al. (2021), while competence need

satisfaction was measured with a nine-item scale by Chen et al. (2015). As illustrated in Table 4, AC and its dimensions—with one exception—showed significant positive correlations with both digital competence and competence need satisfaction, with coefficients ranging from .28 to .54. The results suggest that our measure has good convergent validity. The sole exception was the non-significant correlation between digital competence and embracing AM (r = .04, ns). A potential explanation for the low correlation may be that measures of digital competence (e.g., Wang et al., 2021) often overlook the attitudinal dimension toward technology, while our definition of "embracing AM" is closely related to attitudes toward algorithmic technologies. The attitudinal aspect of digital competence is frequently neglected, as some researchers argue that digital competence should focus solely on knowledge and skills that can be "taught, measured, and assessed", thereby excluding attitudes. However, based on the findings of a Delphi study, Janssen et al. (2013) identified attitude as an important aspect of digital competence. For example, a digitally competent individual demonstrates an informed, open-minded, and balanced approach to digital technology use. Given the long tradition of learning, changing, and measuring attitudes, our study aligns with Janssen et al. (2013) by identifying "embracing AM" as the attitudinal dimension of AC.

Discriminant validity. Discriminant validity is demonstrated when a construct is not similar to other constructs from which it should theoretically differ. We verified the correlations between AC and perceived AM, defined as "perceptions of the use of programmed algorithms by an organization to partially or completely execute workforce management functions" (Parent-Rocheleau, et al., 2024, p. 25). We expected AM to show low to moderate correlations with AC, because perceived AM refers to the perception of AM system, whereas AC comprises cognitive, attitudinal, and behavioral elements that enable workers to autonomously understand, evaluate, and influence AM system. Results in Table 4 are in line with these expectations, with a correlation of .17 between AC and perceived AM, and correlations ranging from -.02 to .20 (mean = .12) between specific AC dimensions and perceived AM.

PHASE 6: antecedents and outcomes of algorithmic competency

In the final step, we examined the relations between AC and its theoretically relevant antecedents, as well as whether AC explains incremental variance in theoretically relevant outcomes beyond those similar constructs.

(1) Antecedents of algorithmic competency

The sociotechnical literature suggests that beliefs, shared values, and norms drive human agency toward

technical systems. Individuals' adoption of technology depends on their attitudes and beliefs about it, which are shaped by conversations with coworkers and others whose opinions matter (Leonardi, 2011). Building on this literature, we investigate social support from peers and cognitive job crafting as antecedents of AC. We argue that social support provides platform workers with shared values, knowledge and practices (Ihl et al., 2020), while cognitive job crafting involves actively shaping cognitive frames for platform tasks (Cropanzano et al., 2023).

Social support from peers includes both emotional (e.g., expressions of care, encouragement, empathy) and material (e.g., practical advice, assistance, information) support from fellow platform workers, accessible online and offline, which helps them navigate challenging situations (Ihl et al., 2020). This support is expected to strengthen AC by fostering shared values, knowledge, and practices among platform workers, enhancing their personal resources to manage the demanding algorithmic work environment (Cropanzano et al., 2023). Because platform workers share common goals and challenges, peer support facilitates social learning by translating shared information and experiences into their ability to adapt to AM. For instance, high-performing workers often share insights and offer practical support to peers, including strategies for understanding AM, interacting with clients, and securing high-quality orders (Wu et al., 2019; Sun, 2019). Such support enables workers to develop a comprehensive understanding of AM, improves their skills, aids in task completion, and ultimately strengthens their AC (Jarrahi & Sutherland, 2019). Additionally, peer support acts as a buffer against the stresses of algorithmic work and promotes positive outcome expectations, further enhancing AC. For example, it aids emotional regulation and fosters a sense of meaningfulness and identification with gig work, enabling faster adaptation to AM (Ihl et al., 2020; Wu et al., 2023). Based on these insights, we propose:

Hypothesis 1: Social support from peers is positively correlated with algorithmic competency.

Cognitive job crafting represents active cognitive changes individuals make to their jobs (Wrzesniewski & Dutton, 2001), involving autonomous, task-related cognitive activities such as organizing, sensemaking, and managing one's psychological states (Bruning & Campion, 2018). We argue that cognitive job crafting positively influences AC for two main reasons. First, active cognitive frames help platform workers form positive beliefs about what AM can offer them, thereby facilitating AC. For example, when workers shift their perception of AM from being a 'barrier' to an 'opportunity,' they are more likely to engage with and influence AM by adopting moulding behaviors to take control of AM, and leveraging it to their advantage (Bellesia, 2023). Cram et al. (2022) also found that when Uber drivers viewed algorithmic oversight as a stimulating challenge, they were inclined to leverage

algorithms to enhance their capabilities and performance. Second, cognitive job crafting enables workers to gain a comprehensive understanding of their tasks, leading to improved decision-making in platform tasks and the development of a positive workplace identity (Cropanzano et al., 2023), which boosts their self-efficacy in adapting to AM. For instance, platform workers with a positive view of platform work are more likely to understand and trust the algorithmic navigation system, which helps them achieve their goals and perceive themselves as competent (Cameron, 2022). Moreover, by crafting positive interactions with customers, platform workers create a meaningful sense of their work and feel efficacious in completing their algorithmic tasks (Cameron, 2022). Thus, we posit:

Hypothesis 2: Cognitive job crafting is positively correlated with algorithmic competency.

(2) Expected outcomes of algorithmic competency

According to sociotechnical systems theory, AM should be seen as a sociotechnical process emerging from the interaction between platform algorithms and platform workers (Jarrahi et al., 2021). Therefore, the expected algorithmic outcomes should depend on AC and the agency of platform workers in shaping them (Jarrahi & Sutherland, 2019). This is because AC enhances workers' sense of autonomy and their ability to make informed decisions about platform work (Jarrahi et al., 2021), allowing algorithms and humans to form "an assemblage of human and algorithmic intelligence" (Bader & Kaiser, 2019). Consequently, we hypothesize that AC positively influences desired outcomes of platform AM, such as customer-oriented service behavior and identification with gig work (Cameron, 2022; Lu et al., 2024). Customer-oriented service behavior refers to "the extent to which workers engage in continuous improvement and exert effort on the job for the benefit of customers" (Peccei & Rosenthal, 1997, p. 69), while identification with gig work represents a form of occupational identity in which an individual deeply integrates the role of "gig worker" into their self-concept.

Developing AC is essential for enhancing platform workers' customer-oriented service behavior. Workers proficient in AC understand the workings of AM, including how task assignments and ratings depend on service quality, thus recognizing the importance of providing excellent customer service (Wu et al., 2023). Additionally, workers with heightened AC skillfully use their knowledge of algorithmic processes to improve task completion. For example, they secure favorable customer ratings by offering additional services or thoughtful gestures (Cameron, 2022). Based on these insights, we hypothesize:

Hypothesis 3: Algorithmic competency is positively associated with customer-oriented service behavior.

Platform workers with high AC, indicating proficiency and capability in their roles (Jarrahi & Sutherland, 2019), are more likely to identify with gig work. This is because the efficacy motive, which underlies the formation of social identity and is linked to the aspiration for competence and control (Ashforth et al., 2016; Breakwell, 1993), is closely tied to AC. As a core human motivation (Deci et al., 2017), feelings of competence enhance the sense of accomplishment in fulfilling role expectations, which fosters positive emotions and facilitates the internalization of the role into one's identity. Additionally, workers with a deep understanding of and trust in AM align with the belonging aspect of identity (i.e., the desire for connection with others in the ecosystem, Vignoles et al., 2006). For example, when platform workers embrace AM without developing aversion or indifference, they experience closer relationships with both the platform and customers, making them more likely to identify with gig work (Bellesia et al., 2023). Accordingly, we propose:

Hypothesis 4: Algorithmic competency is positively associated with identification with gig work.

(3) Method (Sample 5)

Our study probed the hypotheses through a three-wave survey administered to platform-based ride-hailing drivers and food-delivery riders in China. We went to the sites where platform workers gathered (i.e., the shopping mall and the car-charging station) to contact 312 participants. Each participant was compensated CNY60 (approximately USD8.57) upon completing the survey series. Anonymity and confidentiality were assured throughout the study. We measured social support from peers and cognitive job crafting at Time 1. Two weeks later, we measured AC, digital competence and competence need satisfaction. Finally, we measured customer-oriented service behavior and identification with gig work at Time 3 (two weeks later). We eventually obtained 223 valid surveys (Sample 5) after deleting the participants who missed an attention check item or provided incomplete data, resulting in a final response rate of 71.47 %. The respondents were predominantly male (89.3%), with an average age of 29.05 years (68.9% aged 20-40) and an average tenure of 1.79 years on their current platforms (65.8% worked for more than one year). The majority had high school education or less (57.8%), and 61.8% considering their platform work a full-time occupation.

Social support from peers (e.g., 'platform workers in the WeChat group connecting familiar or nearby platform workers give useful advice on my platform job problems') was measured using a nine-item scale adapted from Ihl et al. (2020). *Cognitive jobb crafting* (e.g., 'I use my thoughts to put myself into a good mood at platform work') was measured using a five-item scale from Bruning and Campion (2018).

Customer-oriented service behavior (e.g., 'I put a lot of effort into the platform work to try to satisfy customers') was assessed using the six-item scale from Peccei and Rosenthal (2000). In addition, *identification with gig work* (e.g., 'I am proud that I am a ride-hailing driver/food-delivery rider') was adapted from the six-item social identification scale (Johnson et al., 2012). Gender, age, education, platform tenure, full time vs part time, daily working hours, household registration, marital status and platform type (ride-hailing vs. food delivery) were controlled. Digital competence and competency need satisfaction were also included as control variables with the aim of testing the incremental validity of AC. Translation and back-translation procedure (Brislin, 1980) was performed to translate all English items into Chinese. Unless otherwise specified, all scales were rated using a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

(4) Results

Table 5 presents the means, standard deviations, reliabilities and correlations among the variables. Table 6 presents result from a hierarchical regression analysis examining the antecedents of AC. The results indicated that social support from peers and cognitive job crafting explained a 33% variance in AC beyond demographic information. Furthermore, social support from peers (b =.23, p < .001) and cognitive job crafting (b = .41, p < .001) significantly predicted AC, thus supporting Hypotheses 1 and 2.

Next, we explored the incremental validity of AC whilst controlling for gender, age, education, platform tenure, full time, daily working hours, household registration, marital status and platform type (entered in Step 1), as well as digital competence and competence need satisfaction (entered in Step 2). As shown in Table 7, AC explained the significant incremental variance in customer-oriented service behaviour (b = .50, R^2 = .40, p < .001) and identification with gig work (b = .22, R^2 = .21, p < .01) beyond the effect of the control variables. Thus, Hypotheses 3 and 4 were supported.

DISCUSSION

This study is dedicated to methodically developing and validating a measurement tool for assessing AC, which we have delineated across four dimensions: understanding, embracing, leveraging, and remediating AM. Our empirical investigation reveals that social support from peers and cognitive job crafting serve as predictors of AC, which, in turn, significantly contributes to variances in customer-oriented service behavior and identification with gig work, beyond what is explained by related constructs. This paper deliberates on the theoretical and practical implications of our construct validation

study and outlines future research avenues to enrich the discourse on AC.

Theoretical implications

Firstly, the measurement of AC offers a nuanced lens for examining platform workers' active interactions and adaptive strategies towards AM. Due to the inherent power and information asymmetries associated with AM (Fieseler et al., 2019), prior research has primarily focused on the limited agency of workers when encountering with AM (Bellesia et al., 2023). Drawing on the sociotechnical systems theory, our research highlights the role of platform workers as active agents in creating value out of AM by enhancing their AC (Lamers et al., 2024). By doing so, our research also responds to calls for research into the proactive behaviors of platform workers in generating value from AM (Meijerink & Bondarouk, 2023). In addition, by examining the positive influence of AC on customer service and identification with gig work, our findings emphasize the significance of AC in harmonizing human and algorithmic elements, underscoring the co-creation of value that is central to AM (Jarrahi et al., 2021). We hope that this study encourages more research on this important topic and ultimately results in a more comprehensive understanding of the outcomes of AC.

Secondly, we provide arguably the first psychometrically sound measure of AC that can be used for future empirical investigations of AC. Previous studies of AC have primarily taken a qualitative or theoretical approach, with little effort expended for developing a tool for measuring AC. By refining the conceptualization of AC, we develop a validated scale to assess it. The validation of AC scale facilitates further exploration of its wider nomological network. For example, it is likely that AC predicts platform workers' well-being and performance (e.g., work engagement and financial performance). This quantitative approach also responds to earlier calls for research into the personal resources—such as knowledge, abilities, and skills—that workers leverage to derive value from AM (Meijerink & Bondarouk, 2023).

Our work also extends the existing AC literature by incorporating "embracing AM" as a key attitudinal dimension of AC. This is significant because previous research on AC or digital competence has primarily focused on knowledge and skills that can be "taught, measured, and assessed". In line with Janssen et al.'s (2013) qualitative findings, which emphasize the importance of the attitudinal dimension in digital competence, our empirical research suggests that "embracing AM" represents the attitudinal dimension of AC.

Thirdly, our investigation into the impact of social support from peers and cognitive job crafting on AC,

guided by sociotechnical systems theory, addresses earlier calls for research into the drivers of platform workers' proactive engagement in value creation through AM (Meijerink & Bondarouk, 2023). While a key tenet of sociotechnical systems theory emphasizes the active role of human agency in influencing technical systems, few efforts have been made to investigate the antecedents that drive platform workers' agency in adapting to and influencing AM (Bucher et al., 2021). We contribute to this literature by examining social support from peers and cognitive job crafting as important drivers of AC. Furthermore, by framing cognitive job crafting as active cognitive frames to platform tasks, our findings enhance the understanding of how workers' positive interpretations of AM (Bellesia et al., 2023; Cameron, 2022) bolster their agency in engaging with it. The influence of social support from peers also enriches our understanding of how platform workers can develop their agency over AM through shared values, beliefs, knowledge and practices (Bucher et al., 2021).

We also advocate for future studies to delve deeper into the precursors of AC from the job-demand resources perspective (Bakker & Demerouti, 2007), as job resources are vital for platform workers to navigate the demanding algorithmic environment effectively. For instance, it would be worthwhile to explore whether platform-provided non-algorithmic resources (e.g., AM-specific training) and certain personality traits (e.g., conscientiousness) among platform workers correlate with enhanced AC. Moreover, platform workers with higher education levels or backgrounds in computer science or programming are posited to exhibit stronger AC (Langer, 2021). However, we did not find a positive influence of education on AC in our Chinese sample. We encourage future research to explore this relationship in other contexts.

Practical implications

First, our research may aid the platform and platform workers in developing a broader understanding of the importance of AC. Our findings suggest that AC are important for value co-creation process underlying the goal of the platform business model. Thus, moving beyond employing opaque AM merely as a control to prioritize platform interests (Rahman, 2021), the platform should help the workers to enhance their AC so that they can provide better customer service and are motivated to work longer at the platform. Platform workers, for their part, are encouraged to actively refine their AC to harness the full potential of AM in value creation.

Second, our measure of AC provides a valid and easy-to-understand tool for assessing platform workers' adaptability to AM. This tool enables platforms to effectively gauge the collective AC among their workforce, facilitating the development of customized support strategies. For instance, if platform

workers exhibit a low level of embracing AM, the platform should engage in effective communication and allow them to voice their concerns.

Lastly, we explore avenues for the enhancement of AC. From the platform workers' viewpoint, there exists a proactive approach to strengthen AC by seeking peer support and engaging in cognitive job crafting. These strategies empower workers to navigate and thrive amidst the challenges of algorithmic work more effectively. Conversely, platforms have the opportunity to foster a supportive community, offering both informational and emotional support to workers confronting the complexities associated with algorithmic work.

The Chinese context and generalizability of our findings

We developed an AC scale and its nomological network based on five samples from China. However, the adaptation of platform workers to algorithmic work is influenced by China's distinct cultural and institutional context, which differs from that of Western countries. Thus, we encourage future research to explore whether our measurement and empirical results remain valid across different cultural and institutional backgrounds.

First, the development of AC appears to be notably advanced among platform workers in China, a phenomenon possibly attributed to their active and positive adaptation to AM (Wu et al., 2023). This is because many of them have chosen platform work as a crucial means of sustaining their livelihoods, rather than merely a part-time job (Feng et al., 2024; Wei & Thomas MacDonald, 2022). This shift toward platform economy is partially motivated by a desire to escape the stringent conditions typical of traditional manufacturing sectors—characterized by restrictive factory environments (Lei, 2021)—in favor of better earnings and work flexibility, despite longer hours (Zhou, 2020). Additionally, compared to their Western counterparts, Asian individuals tend to be more open to algorithms and more likely to trust AM (Yam et al., 2023). Consistent with this view, our research identifies "embracing AM" as a new dimension of AC, representing platform workers' willingness to trust the efficiency and accuracy of AM.

Second, the benefits of social support from peers and job crafting on AC may be particularly pronounced in China. In Asian collectivist cultures, individuals tend to place a high value on social support (Zhang et al., 2019), making social support more likely to significantly enhances AC among Asian workers (Cropanzano et al., 202). Workers in these cultures often identify themselves as part of a collective and foster complex relational networks (Zhang et al., 2019). Consequently, social support from peers, including shared values, knowledge, and practices, has a crucial role among such workers. Strong

collectivism leads individuals to appreciate and prioritize social support, prompting them to engage more deeply with the knowledge gained from these interactions. This reliance on social support not only enriches their algorithmic literacy but also mitigates vulnerabilities associated in precarious work conditions (Sun, 2019; Wu et al., 2023). For instance, platform workers in China commonly participate in multiple WeChat groups with workers from the same province to exchange experiences, express concerns, and seek assistance (Sun, 2019). To further investigate this dynamic, we analyzed data from Sample 5 to assess the interaction effect of peer social support and collectivism on AC as a supplementary analysis. A hierarchical regression analysis was performed while controlling for variables such as gender, age, education, platform tenure, daily working hours, full-time employment status, household registration, marital status, and platform type. The results revealed that social support from peers significantly and positively interacted with collectivism to predict AC ($b = .09$, $p < .05$). This finding suggests that the positive relationship between social support and AC is stronger for platform workers with high collectivism compared to those with low collectivism. Additionally, unlike in many Western countries, platform workers in China face a lack of independent labor unions or worker organizations (Heiland, 2020), which further heightens the importance and influence of peer social support within this context (Lei, 2021; Liu & Friedman, 2021).

Regarding cognitive job crafting, platform workers in China are more likely to craft algorithmic platform work actively and positively (Wu et al., 2023). This tendency may be attributed, in part, to a generally more favorable perception of algorithms among Asians compared to their Western counterparts (Yam et al., 2023). Additionally, the encouragement by the Chinese government of digital labor platform development as a means to promote economic growth and create employment opportunities (Sun et al., 2021; Wei & Thomas MacDonald, 2022; Liu et al., 2024) further explains this proactive engagement. Considering the predominantly positive perceptions of platforms and related technologies, the influence of cognitive job crafting on AC may be more pronounced in China than in Western contexts.

Finally, the development of AC in China may vary among food-delivery workers, primarily divided into two groups: those crowdsourced and those subcontracted via a third party, as Lei (2021) outlined. Crowdsourced workers are mainly regulated by AM, similar to their international peers. In contrast, subcontracted workers, who are employed full-time by a third entity (e.g., subcontracted delivery stations within the food-delivery sector), are subject to oversight by both AM and third-party supervisors. An analysis of the disparities between subcontracted and crowdsourced workers in terms of their AC

was conducted. Incorporating data from samples 2 and 3[2], a hierarchical regression analysis was performed. The analysis, controlling for variables such as gender, age, education level, daily working hours, tenure on the platform, marital status, and household registration, revealed that employment status (subcontracted= 1, crowdsourced=0) significantly influences AC (b = .13, p < .05). This suggests that subcontracted workers might benefit from enhanced peer social support and supervision compared to crowdsourced workers, who primarily interact with algorithms. This interaction potentially enables subcontracted workers to better understand and adapt to AM. Moreover, subcontracted workers may use the oversight and constraints from third-party supervisors to negotiate better uses of algorithm. For instance, the combination of manual order allocation by supervisors with algorithmic dispatching may offer subcontracted workers more flexibility to overcome or work around the limitations of AM (Lei, 2021; Shu et al., 2023).

KEY POINTS

- We developed the first measure to assess algorithmic competency of on-demand labor platform workers.
- Algorithmic competency comprises four dimensions: understanding, embracing, leveraging, and remediating algorithmic management.
- Social support from peers and cognitive job crafting significantly impact algorithmic competency.
- Algorithmic competency contributes to enhanced customer-oriented service behavior and identification with gig work.

REFERENCES

Ashforth BE and BS Schinoff (2016) Identity under construction: how individuals come to define themselves in organizations. *Annual Review of Organizational Psychology and Organizational Behavior* 3(1), 111-137.

[2] We only collected data about employment status of food-delivery workers (crowdsourced or subcontracted) in Sample 2 and Sample 3.

Bakker AB and E Demerouti (2007) The job demands–resources model: state of the art. *Journal of Managerial Psychology* 22(3), 309–328.

Bellesia F, E Mattarelli and F Bertolotti (2023) Algorithms and their affordances: how crowdworkers manage algorithmic scores in online labour markets. *Journal of Management Studies* 60(1), 1-37.

Breakwell GM (1993) Social representations and social identity. *Papers on Social Representations* 2, 198–217

Brislin RW (1980) Translation and content analysis of oral and written material. *Handbook of Cross-Cultural Psychology* 2(2), 349-444.

Bruning PF and MA Campion (2018) A role–resource approach–avoidance model of job crafting: a multimethod integration and extension of job crafting theory. *Academy of Management Journal* 61(2), 499-522.

Bucher EL, PK Schou and M Waldkirch (2021) Pacifying the algorithm–anticipatory compliance in the face of algorithmic management in the gig economy. *Organization* 28(1), 44-67.

Cameron LD and H Rahman (2022) Expanding the locus of resistance: understanding the co-constitution of control and resistance in the gig economy. *Organization Science* 33(1), 38-58.

Cameron LD (2024) The making of the "good bad" job: how algorithmic management manufactures consent through constant and confined choices. *Administrative Science Quarterly* 69(2), 458-514.

Chen B, M Vansteenkiste, W Beyers, L Boone, EL Deci, J Van der Kaap-Deeder et al (2015) Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion* 39, 216-236.

Cherns A (1976) The principles of sociotechnical design. *Human Relations* 29(8), 783-792.

Cotter K (2022) Practical knowledge of algorithms: the case of BreadTube. *New Media & Society* 26(4), 2131-2150.

Cram WA, M Wiener, M Tarafdar and A Benlian (2022) Examining the impact of algorithmic control on Uber drivers' technostress. *Journal of Management Information Systems* 39(2), 426-453.

Cropanzano R, K Keplinger, BK Lambert, B Caza, and SJ Ashford (2023) The organizational psychology of gig work: an integrative conceptual review. *Journal of Applied Psychology* 108(3), 492-519.

Deci EL, AH Olafsen and RM Ryan (2017) Self-Determination theory in work organizations: the state of a science. *Annual Review of Organizational Psychology and Organizational Behavior* 4(1), 19-43.

Dogruel L, P Masur and S Joeckel (2021) Development and validation of an algorithm literacy scale for internet users. *Communication Methods and Measures* 16(2), 115-133.

Duggan J, U Sherman, R Carbery and A McDonnell (2020) Algorithmic management and app-work in the gig economy: a research agenda for employment relations and HRM. *Human Resource Management Journal* 30(1), 114-132.

Feng X, FL Cooke and C Zhao (2024) Fragmentation of employment relationships, fragmentation of working time: the nature of work and employment of platform takeaway riders and implications for decent work in China. *Asia Pacific Journal of Human Resources* 62(2): e12398.

Fieseler C, E Bucher and CP Hoffmann (2019) Unfairness by design? The perceived fairness of digital labor on crowdworking platforms. *Journal of Business Ethics* 156, 987-1005.

Harold, CM, B Hu and J Koopman (2022) Employee time theft: conceptualization, measure development, and validation. *Personnel Psychology* 75(2), 347-382.

Heinrich K, MA Vu and A Vysochyna (2022) Algorithms as a manager: a critical literature review of algorithm management. ICIS 2022 Proceedings. 9.

Heiland H (2020) Workers' voice in platform labour: an overview, *WSI Study*, 21, Hans-Böckler-Stiftung, Wirtschafts- und Sozialwissenschaftliches Institut(WSI), Düsseldorf.

Heiland H (2023) The social construction of algorithms: a reassessment of algorithmic management in food delivery gig work. *New Technology, Work and Employment*, 1–19.

Hinkin TR (1998) A brief tutorial on the development of measures for use in survey questionnaires. *Organizational research methods* 1(1), 104-121.

Huang H (2023) Algorithmic management in food - delivery platform economy in China. *New Technology, Work and Employment* 38(2), 185-205.

Ihl A, KS Strunk and M Fiedler (2020) The mediated effects of social support in professional online communities on crowdworker engagement in micro-task crowdworking. *Computers in Human Behavior* 113, 106482.

Janssen J, S Stoyanov, A Ferrari, Y Punie, K Pannekeet and P Sloep (2013) Experts' views on digital competence: commonalities and differences. *Computers & Education* 68, 473–481.

Jarrahi MH, G Newlands, MK Lee, CT Wolf, E Kinder and W Sutherland (2021) Algorithmic management in a work context. *Big Data & Society* 8(2), 1246080891.

Jarrahi MH and W Sutherland (2019) Algorithmic management and algorithmic competencies: understanding and appropriating algorithms in gig work. In: Taylor, N., Christian-Lamb, C., Martin, M., Nardi, B. (eds) *Information in Contemporary Society.* iConference 2019. Lecture Notes in Computer Science, vol 11420. Springer, Cham.

Johnson MD, FP Morgeson and DR Hekman (2012) Cognitive and affective identification: exploring the links between different forms of social identification and personality with work attitudes and behavior. *Journal of Organizational Behavior* 33(8), 1142-1167.

Kadolkar I, S Kepes and M Subramony (2024) Algorithmic management in the gig economy: a systematic review and research integration. *Journal of Organizational Behavior*. http://doi.org/10.1002/job.2831

Kellogg KC, MA Valentine and A Christin (2020) Algorithms at work: the new contested terrain of control. *Academy of Management Annals* 14(1), 366-410.

Lamers L, J Meijerink and G Rettagliata (2024) Blinded by "algo economicus": reflecting on the assumptions of algorithmic management research to move forward. *Human Resource Management* 63(3), 413-426.

Langer M and RN Landers (2021) The future of artificial intelligence at work: a review on effects of decision automation and augmentation on workers targeted by algorithms and third-party observers. *Computers in Human Behavior* 123, 106878.

Lei Y (2021) Delivering solidarity: platform architecture and collective contention in China's platform economy. *American Sociological Review* 86(2), 279-309.

Leonardi PM (2011) When flexible routines meet flexible technologies: affordance, constraint, and the imbrication of human and material agencies. *Mis Quarterly* 35(1), 147-167.

Liu C and E Friedman (2021) Resistance under the radar: organization of work and collective action in China's food delivery industry. *The China Journal* 86(1), 68-89.

Liu M, H Zhang and Y Sui (2024) Workplace artificial intelligence regulation in China: between efficiency and social stability. *ILR Review* 77(5), 813-824.

Lu Y, MM Yang, J Zhu and Y Wang (2024) Dark side of algorithmic management on platform worker behaviors: a mixed-method study. *Human Resource Management* 63(3), 477-498.

Meijerink J and T Bondarouk (2023) The duality of algorithmic management: toward a research agenda on HRM algorithms, autonomy and value creation. *Human Resource Management Review* 33(1),

100876.

Möhlmannn M, C Alves de Lima Salge and M Marabelli (2023) Algorithm sensemaking: how platform workers make sense of algorithmic management. *Journal of the Association for Information Systems* 24(1), 35-64.

MRI (Meituan Research Institute) (2020). Meituan rider employment report during the epidemic in 2019 and 2020. https://mri.meituan.com/research/report?typeCodeOne=5 (accessed 10 March 2020).

Newlands G (2021) Algorithmic surveillance in the gig economy: the organization of work through Lefebvrian conceived space. *Organization Studies* 42(5), 719-737.

Parent-Rocheleau X and SK Parker (2022) Algorithms as work designers: how algorithmic management influences the design of jobs. *Human Resource Management Review* 32(8), 100838.

Parent-Rocheleau X, SK Parker, A Bujold and MC Gaudet (2024) Creation of the algorithmic management questionnaire: a six-phase scale development process. *Human Resource Management* 63(1), 25-44.

Peccei R and P Rosenthal (1997) The antecedents of employee commitment to customer service: evidence from a UK. *The International Journal of Human Resource Management 8*(1), 66-86.

Peccei R and P Rosenthal (2000) Front-line responses to customer orientation programmes: a theoretical and empirical analysis. *International Journal of Human Resource Management* 11(3), 562-590.

Rahman HA (2021) The invisible cage: workers' reactivity to opaque algorithmic evaluations. *Administrative Science Quarterly* 66(4), 945-988.

Rahman HA, A Karunakaran and LD Cameron (2024) Taming platform power: taking accountability into account in the management of platforms. *Academy of Management Annals* 18(1), 251-294.

Schriesheim CA and TR Hinkin (1990) Influence tactics used by subordinates: a theoretical and empirical analysis and refinement of the Kipnis, Schmidt, and Wilkinson subscales. *Journal of Applied Psychology* 75(3), 246-257.

Shu K, H Liu and C Dong (2023) Transcending "flexible time": platform labor in the Chinese food delivery industry and its temporal politics. *New Media & Society*, 14614448231213624.

Sun P (2019) Your order, their labor: an exploration of algorithms and laboring on food delivery platforms in China. *Chinese Journal of Communication* 12(3), 308-323.

Sun P, J Yujie Chen and U Rani (2021) From flexible labour to 'sticky labour': a tracking study of workers in the food-delivery platform economy of China. *Work, Employment and Society* 37(2),

1320489991.

Trist EL (1981) The evolution of socio-technical systems. *Perspectives on Organization Design & Behavior* 6, 5-67.

Veen A, T Barratt and C Goods (2020) Platform-capital's 'app-etite'for control: a labour process analysis of food-delivery work in Australia. *Work, Employment and Society* 34(3), 388-406.

Vignoles VL, C Regalia, C Manzi, J Golledge and E Scabini (2006) Beyond self-esteem: influence of multiple motives on identity construction. *Journal of personality and social psychology* 90(2), 308.

Wang X, R Zhang, Z Wang and T Li (2021) How does digital competence preserve university students' psychological well-being during the pandemic? An investigation from self-determined theory. *Frontiers in Psychology* 12, 652594.

Wei W and I Thomas MacDonald (2022) Modeling the job quality of 'work relationships' in China's gig economy. *Asia Pacific Journal of Human Resources* 60(4), 855-879.

Wrzesniewski A and JE Dutton (2001) Crafting a job: revisioning employees as active crafters of their work. *Academy of management review* 26(2), 179-201.

Wu Q, H Zhang, Z Li and K Liu (2019) Labor control in the gig economy: evidence from Uber in China. *Journal of Industrial Relations* 61(4), 574-596.

Wu X, Q Liu, H Qu and J Wang (2023) The effect of algorithmic management and workers' coping behavior: an exploratory qualitative research of Chinese food-delivery platform. *Tourism Management* (1982) 96, 104716.

Yam KC, T Tan, JC Jackson, A Shariff and K Gray (2023) Cultural differences in people's reactions and applications of robots, algorithms, and artificial intelligence. *Management and Organization Review* 19(5), 859-875.

Zhang J and C Gill (2019) Leader–follower guanxi: an invisible hand of cronyism in Chinese management. *Asia Pacific Journal of Human Resources* 57(3), 322-344.

Zhang Y, DA Waldman, Y Han and X Li (2015) Paradoxical leader behaviors in people management: antecedents and consequences. *Academy of Management Journal* 58(2), 538-566.

Zhou I (2020) Digital labour platforms and labour protection in China (No. 11). ILO Working Paper.

TABLE 1. Overview of the four algorithmic competency dimensions (labels, descriptions and examples from interviews and literatures)

Label	Description	Examples from interviews	Examples from literatures
Understanding AM	Having a sophisticated understanding of how AM work and can make sense of the dynamic nature of AM	N10: I develop theories about task-allocating and score-calculating algorithms based on my own experience; N21: I know one task-allocating rule: after completing long-distance orders which are more profitable, even if the drivers go to the hot spot, it is difficult to receive more orders; N60: I know that data from the heat map changes constantly and the actual data can be delayed for five minutes.	Workers attempt to get a better understanding of algorithms by approaching them from the client side of the platform (Jarrahi & Sutherland, 2019); "Drivers use the information they bracketed during enactment to deeply reflect and take 'some time to understand' the input they have at hand" (Möhlmannn et al., 2023, p.48).
Embracing AM	Willingness to trust the efficiency and accuracy of AM in matching platform workers and customers and other aspects	N6: The platform improves both the GPS system and the appealing system; N44: The GPS is accurate and the platform provides me with clear route options with low chance of traffic jams; N98: Algorithms are better than humans. Sometimes I think I should send the order in this way, but when the algorithms plan the route for me, I still have the feeling of "Wow, this is more convenient".	Some drivers praise algorithms for effectively matching independent drivers with customers and providing detailed, useful navigational instructions (Cameron, 2022); "Freelancers engage with algorithmic scores as if they were an authentic virtual embodiment of their work identity…...because what they do on the platform is corroborated by algorithmic scores" (Bellesia et al., 2023, pp.20-21).

(Table 1 Continued)

Label	Description	Examples from interviews	Examples from literatures
Leveraging AM	Capacity to utilize AM strategically or advantageously for workers' benefit	N24 Drivers can ask the platform to screen out customers who complain randomly to avoid bad ratings; N31: When I was tired, I would go to a remote place (almost no orders here) to log in AM and take a rest at the same time. Then I drove to the hot spot and I can receive high-quality orders for a long time; N38: To get high ratings, I am polite to customers, introduce scenic spots to customers, and help customers with their luggage.	Keep one's emotions in check to avoid conflict with clients and prompt positive ratings (Bucher et al., 2021); "Considering the dynamic pricing algorithm, some drivers turned off the app when finishing a ride in a less desirable location and then turned it on again at a more desirable one (e.g., near the airport) to maximize their earnings" (Cameron, 2024, p.481).
Remediating AM	Capacity to solve/supplement the deficiencies of platform's AM system	N22: When receiving unfair ratings from customers, I can use evidence like recordings to appeal to the AM; N38: Proactively addressed the missing information in AM based on my own experience; N96: When I have trouble with the customers' GPS, I can seek help from the WeChat group where peers would reply to my question soon.	"Experienced riders often know what happens at specific times and which restaurants are highly frequented, recognizing that they are not always located in the [hot zone center] suggested by AM" (Heiland, 2023, p.11). "To chase a demand-based incentive, drivers checked heat maps, text messages, or in-app notifications……Drivers on ride-hailing forums offered complex suggestions to monitor demand pricing, such as installing software to take automated screenshots over multiple days to be better able to predict trends" (Cameron,

2024, p.479).

TABLE 2. Factor loadings from EFA, CFA for final algorithmic competency items

Item	Loading			
	Understanding AM	Embracing AM	Leveraging AM	Remediating AM
1. I am willing to take time to develop a good understanding of AM.	**.74(.59)**	-.08	.27	.11
2. I am familiar with the platform's AM.	**.83(.94)**	.18	.09	.15
3. I understand the dynamic changes in algorithms and big data patterns.	**.74(.78)**	.22	.15	.25
4. I can address deficiencies in AM by integrating personal experience.	.16	-.08	.26	**.76(.92)**
5. I can supplement AM's shortcomings (i.e., imprecise navigation) through the help of WeChat groups or other tools.	.10	.02	.16	**.84(.83)**
6. I can use platform APP functions (i.e., reporting exceptions and appealing) to resolve vulnerabilities in AM.	.16	.28	-.01	**.62(.54)**
7. I proactively explore AM rules to obtain more high-quality orders.	.18	.06	**.84(.90)**	.08
8. I proactively explore AM rules to minimize negative customer feedback.	.13	.03	**.77(.67)**	.21
9. I utilize AM rules to minimize labor input and increase earnings.	.03	.25	**.76(.63)**	.07
10. I think the platform AM is accurate in aspects like recording online durations.	.06	**.81(.78)**	.17	-.01

11. I think the platform AM is highly efficient, such as in customers-workers matching.	.12	**.79(.81)**	.02	.15
12. I perceive the AM are undergoing refinement, such as in achieving more accurate location tracking.	.08	**.72(.84)**	.10	.09

Note. N = 275 for EFA loadings (outside parentheses) (sample 2), N= 213 for CFA loadings (inside parentheses) (sample 3). AM for algorithmic management.

TABLE 3. CFA results

Measurement model	CFI	RMSEA	SRMR	χ^2(df)	$\Delta\chi^2$(Δ df)
Four-factor model (A; B; C; D)	.98	.04	.04	66.86(48) *	
Two-factor model 1 (A+B; C+D)	.75	.16	.09	348.88(53) ***	$\Delta\chi^2(5) = 282.02^{***}$
Two-factor model 2 (A+C; B+D)	.69	.18	.10	420.13(53) ***	$\Delta\chi2(5) = 353.27^{***}$
Two-factor model 3 (A+D; B+D)	.75	.16	.10	349.03(53) ***	$\Delta\chi^2(5) = 282.17^{***}$
Three-factor model 1 (A; B+C+D)	.72	.17	.10	382.62(53) ***	$\Delta\chi2(5) = 315.76^{***}$
Three-factor model 2 (B; A+C+D)	.80	.15	.08	295.03(53) ***	$\Delta\chi2(5) = 228.17^{***}$
Three-factor model 3 (C; A+B+D)	.75	.16	.09	354.08(53) ***	$\Delta\chi2(5) = 287.22^{***}$
Three-factor model 4 (D; A+B+C)	.76	.16	.09	338.97(53) ***	$\Delta\chi2(5) = 272.11^{***}$
One-factor model (A+B+C+D)	.66	.19	.10	453.37(54) ***	$\Delta\chi^2(6) = 386.51^{***}$
Second-order four-factor model	.98	.05	.04	71.95(50) *	$\Delta\chi^2(2) = 5.09$

Note. N = 213 (sample 3). A for Understanding algorithmic management (AM); B for Embracing AM; C for Leveraging AM; D for Remediating AM. △ = change relative to the four-factor model; RMSEA = root-mean-square error of approximation, SRMR = standardized root-mean-square residual, CFI = comparative fit index.

$^{***}p < .001$.

TABLE 4. Convergent and discriminant validity correlations

Variables	Mean	SD	1	2	3	4	5	6	7	8
1. Algorithmic competency	3.80	.63	(.85)							
2. Understanding AM	3.66	.96	.78**	(.83)						
3. Embracing AM	3.75	.91	.58**	.25**	(.78)					
4. Leveraging AM	3.88	.88	.76**	.48**	.22*	(.81)				
5. Remediating AM	3.84	.84	.76**	.51**	.23**	.49**	(.77)			
6. Digital competence	3.53	.79	.37**	.37**	.04	.36*	.31**	(.86)		
7. Competence need satisfaction	4.10	.75	.54**	.35**	.28**	.44**	.48**	.32**	(.83)	
8. Perceived AM	3.78	.59	.17*	.17	.20*	.13	-.02	-.09	.05	(.90)

Note. N = 230 (sample 4). AM for algorithmic management. The values on the diagonal are the Cronbach's alpha coefficients.

* $p < .05$; ** $p < .01$.

TABLE 5. Means, standard deviations and bivariate correlations among studied variables in Sample 5

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.Gender	.89	.31																
2.Age	29.05	9.74	-.05															
3.Education	3.36	1.02	-.00	-.41**														
4.Platform tenure	1.79	2.15	-.02	.56**	-.37**													
5.Full time	.61	.48	.06	.34**	-.29**	.31**												
6.Daily working hours	9.15	2.76	.13	.16*	-.23**	.14*	.37**											
7.Household registration	.30	.46	-.05	.01	-.07	.02	.07	.05										
8.Marital status	.37	.48	-.04	.67**	-.26**	.34**	.21**	.07	.04									
9.Platform type	.82	.38	-.05	-.50**	.22**	-.37**	-.07	.11	.07	-.36**								
10.Algorithmic competency	3.80	.64	.03	-.08	.06	.01	.07	-.01	-.06	-.06	.16*	(.85)						
11.Social support from peers	3.42	1.04	-.04	-.04	-.09	.04	.08	-.00	.16*	-.03	.14*	.39**	(.94)					
12.Cognitive job crafting	4.09	.79	.01	.09	.00	.08	.06	-.11	.00	.06	-.13	.47**	.36**	(.90)				
13.Digital competence	3.52	.78	.03	-.08	.02	.02	-.01	.02	-.05	-.04	-.03	.37**	.30**	.30**	(.86)			
14.Competence need satisfaction	4.12	.71	.08	-.03	.01	.11	.04	.18**	-.10	-.06	-.01	.56**	.21**	.44**	.31**	(.83)		
15.Customer-oriented service behavior	3.91	.72	.08	.01	-.06	.01	-.00	.18**	-.08	-.06	-.00	.54**	.26**	.31**	.35**	.40**	(.82)	
16.Identification with gig work	3.35	.98	-.02	-.14*	.02	-.07	-.10	-.15*	-.00	.00	.06	.34**	.25**	.24**	.30**	.24**	.37**	(.92)

Note. N=225 (sample 5). Cronbach's alphas are on the diagonal. Gender was coded as 1 for male and 0 for female. Platform type was coded as 1 for food-delivery platform, and 0 for ride-hailing platform. Household registration was coded as 1 for local, and 0 for non-local. Marital status was coded as 1 for married, and 0 for other types.
$^{*}p < .05$; $^{**}p < .01$.

TABLE 6. Results of hierarchical regression analysis for antecedents of algorithmic competency

Predictor variable	Algorithmic competency	
	Step1	Step2
Gender	.04	.03
Age	-.05	-.07
Education	.04	.05
Platform tenure	.10	.07
Full time	.11	.05
Daily working hours	-.06	.02
Household registration	-.07	-.11
Marital status	.01	.01
Platform type	.18*	.18*
Social support from peers		.23***
Cognitive job crafting		.41***
Model R^2	.05	.33

Note. N = 225 (sample 5). Gender was coded as 1 for male and 0 for female. Platform type was coded as 1 for food-delivery platform, and 0 for ride-hailing platform. Household registration was coded as 1 for local, and 0 for non-local. Marital status was coded as 1 for married, and 0 for other types. Standardized regression coefficients are reported.

**p < .05; **p < .01; ***p<.001.*

TABLE 7. Results of hierarchical regression analysis for outcomes of algorithmic competency

Predictor variable	Customer-oriented service behavior			Identification with gig work		
	Step1	Step2	Step3	Step1	Step2	Step3
Gender	.05	.03	.03	-.003	-.01	-.02
Age	.05	.14	.11	-.25*	-.17	-.19
Education	-.05	-.07	-.07	-.08	-.09	-.09
Platform tenure	-.02	-.10	-.09	.02	-.04	-.04
Full time	-.08	-.07	-.13*	-.03	-.03	-.05
Daily working hours	.20**	.13*	.22***	-.14*	-.19**	-.15*
Household registration	-.08	-.03	-.03	-.01	.03	.03
Marital status	-.10	-.09	-.11	.17	.18*	.17*
Platform type	-.03	.01	-.11	.03	.06	.01
Digital competence		.27***	.15**		.24***	.19**
Competence need satisfaction		.30***	.04		.22**	.11
Algorithmic competency			.50***			.22**
Model R^2	.06	.25	.40	.06	.18	.21

Note. N = 225 (sample 5). Gender was coded as 1 for male and 0 for female. Platform type was coded as 1 for food-delivery platform, and 0 for ride-hailing platform. Household registration was coded as 1 for local, and 0 for non-local. Marital status was coded as 1 for married, and 0 for other types. Standardized regression coefficients are reported.

**p < .05; **p < .01; ***p<.001*