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THE DYNAMIC RELATIONSHIPS BETWEEN ALGORITHMIC MANAGEMENT AND WORKERS' OCCUPATIONAL WELL-BEING: A JOB DEMANDS-RESOURCES PERSPECTIVE

Research Paper

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Abstract

Algorithmic management (AM) as key enabler for managing workforce in food delivery services has recently raised growing concerns about workers' occupational well-being (OWB). Existing studies mainly emphasize negative impacts of AM on workers' OWB, e.g., stress due to constant tracking. Contrastingly, a few studies show positive aspects of AM, e.g., receiving personalized real-time feedback. Getting to the root of these opposing findings, we use the job demands-resources (JD-R) model as primary theoretical lens to abductively analyze AM-specific job demands (AM-JD) and AM-specific job resources (AM-JR). Based on semi-structured interviews with 16 food delivery riders in Germany, this study paints a nuanced picture of AM, e.g., by identifying AM-JRs, that help to mitigate AM-JDs. We further find that job crafting, i.e., proactively changing work-related boundaries, increases AM-JRs and workers' OWB. Drawing on our results, we present the integrated DYNAMO Model, which shows novel dynamic relationships between AM, OWB, and job crafting.

Keywords: Algorithmic Management, Job Demands, Job Resources, Occupational Well-being.

1 Introduction

Services of food delivery platforms, such as Instacart, Lieferando, or Wolt, and related business models, for instance, ride-hailing platforms like Uber or Lyft are in ever-increasing demand in society (Lee and Lee, 2020). The organizations running these platform-based business models belong to the quick commerce (q-commerce) sector, which is characterized by "a fast form of on-demand delivery which can deliver goods ordered online by customers to customers in less than one hour" (Huang and Yen, 2021, p. 120). In order to facilitate such a highly instantaneous delivery, platform organizations rely on algorithmic management (AM) as the key enabler for managing delivery workers (Kellogg et al., 2020, Zhang et al., 2022). Based on artificial intelligent (AI) technologies, AM is characterized by "the large-scale collection and use of data on a platform to develop and improve learning algorithms that execute coordination and control functions traditionally performed by managers" (Möhlmann et al., 2021, p. 2001). AM often impairs occupational well-being (OWB), as this kind of "faceless management" (Möhlmann and Henfridsson, 2019) causes stress for workers such as the physical strain due to the above-described time pressure to deliver within only a few minutes or due to a lack of support. Recently, OWB, which involves meeting workers' cognitive, physical, and social needs, is being increasingly

discussed in information systems (IS) research with regard to the usage of information and communication technologies (ICT) (e.g., Tarafdar and Saunders, 2022) and also in the context of AM-based work settings (Wijngaards et al., 2022). Extant literature discusses various impacts of AM on the OWB of workers, mostly with a rather negative connotation. For instance, Qin et al. (2021) show that workers at the food delivery service Wolt frequently commit red-light-running due to the high time pressure of delivery, resulting in a significant risk of accidents. Additionally, Kuhn and Maleki (2017) find that workers frequently leave or switch platforms due to the lack of organizational support, especially when being faced with task-related issues (Jabagi et al., 2020).

While AM is frequently subject to negative implications on the OWB for workers, a few studies also discuss positive outcomes on workers' (occupational) well-being (e.g., Cram et al., 2022). For instance, Wiener et al. (2021) point out that AM in ride-hailing platforms can be used to provide "personalised feedback and reports on worker-specific issues", which includes suggestions on how to "increase customer satisfaction (e.g., opening doors, playing jazz music, etc.)" (p. 4) and in turn, positive ratings for drivers, keeping them motivated and engaged. Generally, workers are often perceived as passive recipients of AM-related mechanisms or decisions and even at the mercy of the algorithm (Möhlmann and Zalmanson, 2017). Contrastingly, Verelst et al. (2022) show that workers in food delivery platforms engage in job crafting. Job crafting refers to the proactive behavior to strive for "physical and cognitive changes individuals make in the task or relational boundaries of their work" (Wrzesniewski and Dutton, 2001, p. 179) and helps to improve occupational well-being (Bakker et al., 2014). For instance, by choosing a different route than provided in the courier's app (e.g., with less traffic) during an order delivery, workers regain autonomy and control over their task execution (Verelst et al., 2022), which increases their resources and, consequently, positively increases their OWB (Bakker et al., 2014). In line with this, it is shown, that this type of (intended) proactive behavior has been shown to add more work meaningfulness which is often not a priori inherent in AM-based work environments (Parent-Rocheleau and Parker, 2022, Berg et al., 2013).

Although there are already a few studies that examine the positive or negative implications of AM on workers (including its effects on aspects that could be subsumed under OWB), none of these studies considered the opportunities for workers to improve their OWB by means of job crafting. Against this backdrop, our study focuses on the following research question: *How does job crafting influence the relationship between AM and delivery workers' OWB?*

Using the job demands-resources (JD-R) model of occupational well-being (Bakker et al., 2014, Demerouti et al., 2001) and Tarafdar and Saunder's (2022) model of "ICT-Enabled Job Crafting to Enhance Occupational Well-Being" as theoretical lenses, we aim to understand the implications of AM and its outcomes on the individual level. In order to achieve our research objective, we follow an abductive research approach (Gioia et al., 2013), building on 16 semi-structured interviews (Myers and Newman, 2007) with bike delivery riders from a German-based food delivery firm, hereafter referred to by the pseudonym *"BikeBites"*.

This study is structured as follows: In the next section, we present the theoretical background of this study, followed by the description of our methodological approach. Next, we present our findings, which also include our DYNAMO Model. We conclude by discussing the impact of AM on OWB, the role of job crafting, and the limitations of this study while pointing out promising avenues for future research.

2 Related Research and Theoretical Background

In addition to IS research, our paper draws on research in related disciplines, such as (organizational) psychology and occupational health. The constructs relevant to this study, consisting of algorithmic management, the job-demands-resources model with its assumptions, and job crafting, are elaborated in more detail below. We assume that their interplay has a significant positive or negative impact on the occupational well-being of delivery workers.

2.1 Algorithmic Management

Initially defined by Lee et al. in 2015 in the context of ride-hailing platforms, AM is a relatively new and understudied management approach. Generally, AM, as part of AI solutions, comprises algorithmic control and algorithmic matching (Möhlmann et al., 2021). Algorithmic control is defined as the use of intelligent algorithms to "align worker behaviors with organizational goals" (Wiener et al., 2021, p. 1, cf. Möhlmann et al., 2021), and algorithmic matching refers to the "algorithmically mediated coordination of interactions between demand and supply" (Möhlmann et al., 2021, p. 2005) of the workforce. Various self-learning algorithmic mechanisms, often in a complex confluence of algorithmic control and algorithmic matching, are used to achieve organizational goals efficiently. From a technical point of view, the ICT used in algorithmic systems have four essential characteristics: First, algorithmic comprehensiveness refers to a wide range of devices to collect a variety of data. Second, algorithmic instantaneity indicates that real-time information is constantly computed, saved, and communicated. Third, interactivity refers to multiple stakeholders using interactive interfaces. Fourth, opacity means that algorithms are non-transparent and therefore not understandable for workers (Kellogg et al., 2020).

Among others, algorithmic control mechanisms are used to monitor and record workers' activities or locations via Global Positioning System (GPS) and related app-based sensors in their smartphones, cameras, or audio devices (Kellogg et al., 2020). Further, algorithmic control mechanisms are used to rate or reward workers for their performance, which leads to monetary benefits, such as performance-based bonuses or non-monetary advantages by granting high-performing workers early access to shift picker systems where they can select their shift first (Galiere, 2020, Ivanova et al., 2018). Based on these algorithmic control outcomes, workers are assigned to tasks or customers to satisfy a demand for a requested service (Möhlmann et al., 2021).

2.2 Job Demands and Job Resources

A theoretical foundation that helps to understand and predict the implications of AM on the occupational well-being of workers is the job demands–resources (JD–R) model (Demerouti et al., 2001), which proposes to divide job characteristics into job demands and job resources.

Following Bakker et al. (2014), job demands refer to "aspects of the job that require sustained physical, emotional, or cognitive effort" (p. 392). According to Demerouti et al. (2001), examples of job demands in the JD–R model are shift work and heavy physical workload. Job demands, even if sometimes not mentioned explicitly (e.g., job hindrance), have also been discussed in the literature of AM-based work settings (e.g., Kellogg et al., 2020, Watson et al., 2021). For example, a job demand that can be considered to result from AM, i.e., as AM-specific job demand, is the loss of privacy related to feeling permanently observed due to algorithmic recording (Park et al., 2021). Further, as algorithms take over managerial tasks making face-to-face interaction obsolete, working alone is another job demand resulting from AM, as it requires a high emotional and cognitive effort. Workers must solve tasks or even challenges by themselves, since support, especially from supervisors and colleagues, is no longer available (Kellogg et al., 2020, Watson et al., 2021). According to Zheng and Wu (2022), workers in AM-based work environments have to work particularly fast, making it almost impossible to scrutinize the task, as they have to react to task assignments within a "blink-of-an-eye" (p.9), often requiring physical effort.

In contrast, job resources refer to "physical, psychological, social, or organizational aspects of the job that help to either achieve work goals, reduce job demands and the associated physiological and psychological costs, or stimulate personal growth, learning, and development" (Bakker et al., 2014, p. 392). Examples of job resources include job security, feedback, supervisor support (Demerouti et al., 2001), participation (Bakker et al., 2003), and autonomy (Bakker et al., 2004). Workers who have job resources (i.e., supervisor support) are better able to cope with job demands (i.e., heavy physical workload). AM-specific job resources have not been discussed in the literature as frequently as AM-specific job demands, which is why we present only a small selection of examples from the literature

here. Previously discussed resources that can be considered as specific to AM-based work settings are algorithmic monetary (Cameron, 2020) and non-monetary rewards (e.g., assigning more orders to efficient food delivery riders) (Goods et al., 2019), which lead to a higher income and thus being better able to cope with job demands, such as precarious work. As there is a "high degree of flexibility to decide how much and when to work" (Möhlmann et al., 2021, p. 2009) in AM-based work settings, we consider autonomy as a further job resource stemming from AM.

2.3 Job Crafting

A way to strengthen job resources and reduce job demands is job crafting. According to Wrzesniewski and Dutton (2001), job crafting, driven by basic human needs, refers to a proactive behavior that entails "physical and cognitive changes individuals make in the task or relational boundaries of their work" (p. 179). Workers engaging in job crafting want to gain control over the job and work meaning, to be perceived and confirmed positively by others, or to increase interaction and connections with others (e.g., customers or colleagues) (Tims and Bakker, 2010, Wrzesniewski and Dutton, 2001). Tarafdar and Saunders (2022) found that workers can use job crafting to tackle job demands (e.g., responsiveness, coordination) and to increase job resources (e.g., job latitude, time control, individual cognitive resources, etc.).

Job crafting behavior is divided into three forms: task crafting, cognitive crafting, and relational crafting. First, changing "task boundaries means altering the form or number of activities one engages in while doing the job" (Wrzesniewski and Dutton, 2001, p. 179) refers to task crafting. In AM-based work settings, such as food delivery, task crafting behavior can be performed by "bringing an order to a customer's door instead of waiting on the pavement for someone to pick it up" (Verelst et al., 2022, p. 4498), thus having changed task variety. Second, "changing cognitive task boundaries refers to altering how one sees the job" (Wrzesniewski and Dutton, 2001, p. 179-180), i.e., cognitive crafting. A food delivery rider may, for instance, perform cognitive crafting by perceiving "the fulfillment of daily tasks as a process to positively impact the lives of customers, rather than a simple task assignment" (Verelst et al., 2022, p. 4498). Third, "changing relational boundaries means exercising discretion over with whom one interacts while doing the job" (Wrzesniewski and Dutton, 2001, p. 180), i.e., relational crafting. An example of relational crafting of food delivery riders is to have "a quick chat with satisfied customers" (Verelst et al., 2022, p. 4498), thus increasing social interaction.

2.4 Occupational Well-being

In this paper, we focus on occupational well-being (OWB), as it is one of many outcomes of the interplay between algorithmic management and the associated individually perceived job demands and job resources, as well as workers' job crafting behavior (Bakker et al., 2014).We define occupational well-being as an affective state in which, in the context of work and related tasks, an individual's subjectively evaluated physical, intellectual, and social needs are met (Warr, 1992, Robertson et al., 2011). Drawing on this definition, job demands help to explain a negative impact on OWB at work, such as health complaints (Bakker and Demerouti, 2017), whereas job resources help to explain positive impacts on OWB at work, such as work engagement and job satisfaction.

Using the JD-R model, Tarafdar and Saunders (2022) find workers engaging in job crafting to change task-related, relational and cognitive boundaries of their jobs can improve their OWB. For example, when workers decided to initiate a job crafting practice to self-select their tasks, they changed their job tasks and cognitive aspects; Consequently, they were more satisfied and engaged with their jobs and displayed more positive attitudes toward them. Additionally, the authors show that role ambiguity and role conflict occur when their knowledge to perform a task is inadequate. Though they did not study OWB per se, Cram and Wiener (2020) report that workers feel engaged when receiving constant feedback about their performance from algorithmic control mechanisms, which can be attributed as a positive impact on OWB. Workers in AM-based settings or platform work may be faced with factors that impair their OWB, such as social isolation (Watson et al., 2021), frustration, or low organizational

commitment when they have difficulties in understanding the typically opaque algorithmic decisions (Möhlmann and Zalmanson, 2017). Further, physical exhaustion and psychological problems (e.g., devaluation and mental stress) (Zhang et al., 2022) and being faced with job insecurity due to algorithmic replacing mechanisms that penalize or dismiss workers (e.g., due to repeated low algorithmic rating) are further factors that negatively impact the OWB of workers (Kellogg et al., 2020, Galiere, 2020).

3 Methodology

To reach our research objective, we used an abductive approach as outlined by Gioia et al. (2013) in conjunction with three basic steps as defined by Galletta (2013): Stage-setting, data collection, and data analysis. Conducting an "abductive approach is fruitful if the researcher's objective is to discover new things […] and other relationships" (Dubois and Gadde, 2002, p. 559). For the data collection, we relied on an interview-based approach (Schultze and Avital, 2011), which is appropriate since our research objective addresses the individual level, namely the OWB of delivery riders. During the data analysis, we triangulated the interview data with additional secondary data, such as literature, social media postings, and news, as well as observed public meetings of Workers Collective groups, to be informed about ongoing and current discourses.

Consistent with the abductive approach according to Gioia et al. (2013), we use theory to initially guide our stage-setting and to iteratively execute our data analysis process, drawing on two models that distinguish work characteristics into job demands and job resources and consider job crafting as a crucial behavior for improving occupational well-being. More precisely, we used Bakker et al.'s (2014) "job demands-resources model of occupational well-being" (p. 400) and Tarafdar and Saunders' (2022) model of "ICT-Enabled Job Crafting to Enhance Occupational Well-Being" (p. 726) as forming theoretical sensitizing lenses. By using these models, our research draws on a highly cited model (JD-R model) and on a model derived from research studying the impact of JD-R and job crafting on OWB for a comparable (i.e., to our study) working group, i.e., permanent blue-collar remote and mobile workers (Tarafdar and Saunders, 2022). To complement deductive coding, we applied inductive coding to not to merely confirm existing theories but also to generate new insights and knowledge that expands the current understanding of our studied phenomena.

3.1 Stage Setting and Data Collection

Within the stage setting, i.e., preparing the data collection (Galletta, 2013), we created an interview guide, which was structured as follows: After asking for contextual information, such as how long they had worked for their firm, we asked about the delivery riders' typical workday and how and for what they use their smartphones. Alongside their job demands ("How does your work challenge you?") and job resources ("Which resources do you generally have? How do you solve challenges?"), we asked delivery riders about their occupational well-being (i.e., How do you feel with your tasks? Are you satisfied and why (not)?"). Next, we asked them if they are proactively able to improve their well-being, i.e., if they perform job crafting (e.g., "Do you sometimes try to work less or more?").

To collect data (i.e., to conduct interviews), we used Twitter to find interviewees. In doing so, we focused especially on people commenting and sharing the activities of the so-called 'Workers Collective Groups'-accounts. These Workers Collective groups are characterized by high levels of activity in sharing experiences about their daily work from their perspective as delivery riders to raise awareness about working conditions and find like-minded individuals to support them in improving working conditions. We also contacted delivery riders on the street (between orders or in breaks) and asked them if they were willing and available for an interview via Zoom or on the phone. The interviews lasted between 12:28 minutes and 76:23 minutes and averaged 52:40 minutes in length. Most of the interviews were held and transcribed in German and subsequently translated into English before coding with MAXQDA. We stopped collecting data when we felt we heard nothing new during the interviews, and therefore assumed to have reached saturation.

In sum, we conducted 16 semi-structured interviews with 15 male and 1 non-binary delivery rider from *"BikeBites"*, a restaurant-based food delivery service. The delivery workers range in age from 21-50 years, with all but two in their 20s and 30s and their job experience ranges from a few months to six years, with an average experience of 4.3 years. All interviewed workers have a permanent contract with their employer, *"BikeBites"*, and receive a minimum hourly wage. That is, that workers are paid for the hours they work even when they do not receive any orders. In terms of the work equipment, we found that 2/3 of the riders primarily use their own bicycles for the deliveries and that all of them must use their own mobile phones for their daily delivery tasks.

3.2 Data Analysis

An abductive research approach allows using "data and existing theory […] in tandem" (Gioia et al., 2013, p. 21, cf. Alvesson and Kärreman, 2007). Thus, the interview questions were based on our theoretical lenses of the job demands-resources (JD-R) model of occupational well-being according to Bakker et al. (2014) and Tarafdar and Saunders' (2022) model of "ICT-Enabled Job Crafting to Enhance Occupational Well-Being", followed by a subsequent top-down (deductive) and bottom-up (inductive) coding approach of the interview data (Kuckartz, 2019), starting shortly after completing the first few interviews and involving constant comparison across individuals. Our approach allows us to conduct a nuanced and in-depth analysis of the negative implications (job demands) and the positive implications (job resources) of AM on workers' OWB, and the impact of their job crafting behavior.

The codes for the deductive coding were derived from the theoretical foundations, which are described in Sections 2.1 and 2.2. For instance, building on the conceptual foundations of AM and the JD-R model, we coded quotes like *"they compare algorithmically if I start my shift outside a hotspot"* **(David[1])** with 'AM-specific job demands' as superior code and with 'forced compliance' as sub-code. Regarding AM-specific resources, we applied the same procedure: Statements such as *"As soon as you have exceeded the €200 threshold, then the rewards become noticeable…a large portion of my salary is really the bonus."* **(Thomas)** were coded with 'AM-specific job resources' as superior code and 'real-time rewards' as sub-code. For examining workers' OWB and their job crafting behaviors, the bottom-up coding approach (i.e., allowing the emergence of new codes) played an essential role (Kuckartz, 2019). Applying the abductive approach led us to fruitful insights since using various theoretical foundations as a basis for top-down coding is sufficient to guide some, but not all aspects of the coding (Dubois and Gadde, 2002). For instance, we coded the quote "*I think it's a fun job … [You are supposed to] work outside, always discovering new restaurants. You never know where you're driving around—north, south, east, west—there are always surprises."* **(Elias)** with 'positive impacts on OWB' in the first coding pass and with 'job satisfaction' in the second coding pass. The following quote supports an example of the initial code 'negative impacts on OWB': *"In the meantime, although I work for [BikeBites], I don't even see myself as a [BikeBites]-courier anymore, I see myself as a bike courier."* **(Jacob)**, which was eventually coded with 'lack of organizational commitment' and 'alienation'. Particularly the insights regarding job crafting emerged from the inductive coding, as we asked the delivery riders what they actively do to improve their OWB (= job crafting). However, having the definition for task, relational and cognitive crafting, as described by Wrzesniewski and Dutton (2001) in mind, we were again guided by the conceptual foundations in the first coding pass. Accordingly, quotes like *"I sometimes do not confirm immediately but smoke a cigarette first and then confirm the order."* **(David)** were coded with 'task crafting'. The results of our data analysis, showing the dynamic relationships between AM and OWB, are described in the following sections.

[1] The names of the interviewees have been changed.

4 Results

Our data analysis surfaced two AM-specific job demands (AM-JD) (i.e., accelerated work pace and forced compliance), and three AM-specific job resources (AM-JR) (i.e., real-time rewards, real-time performance information, and GPS-facilitated location flexibility). In addition, we identified how AM-JD and AM-JR affect OWB and what job crafting behaviors delivery riders engage in to increase their OWB. Our results are structured as follows: In the first subsection, we introduce the identified AM-JD and AM-JR with corresponding definitions, and in the second, we show how these AM-JD and AM-JR affect OWB and the role of job crafting in this regard. In the third subsection, we introduce our integrated DYNAMO Model.

4.1 AM-specific Job Demands and AM-specific Job Resources

AM systems require workers to ***work at an accelerated pace***, which involves high responsiveness to order assignments and a fast order completion time: When delivery riders receive an order, they must answer immediately to avoid negative entries into their personal records. Moreover, *BikeBites* expects workers to deliver at least two orders per hour. To reach that goal, the underlying algorithms are implemented to assign orders instantaneously and continuously. Some interviewees also reported sometimes being matched to stacked orders (i.e., two or three orders from different customers that must be picked up from the same restaurant), which significantly increases delivery riders' work pace.

AM systems ***force workers into compliance*** in two ways: First, when a customer places a new order in the *BikeBite's* customer app, the AM system sends push notifications to (the restaurant and) the delivery rider closest to this restaurant, which is determined via GPS. The order notifications only include the restaurant's address where the order must be picked up and an "Accept" button, which implies that riders have no choice but to accept the order. After accepting and picking up the order at the restaurant, they press "Picked up" in the app and then see the customer's address. If a customer has tipped online, riders only see this after delivery, i.e., once a rider has *confirmed* the delivery in the app. Second, delivery riders are required to stay in a particular area (usually a hotspot area, i.e., an area with a high density of restaurants), which is also verified through algorithmic recording mechanisms of AM systems. Please refer to Table 1 for an overview of illustrative quotes and emerging definitions regarding AM-specific job demands.

Illustrative quotes	***AM-JD*** (Definition)
"Sometimes the app says after an order: Take a break! But it's not possible, because the next [order] is arriving immediately." (David)	***Accelerated work pace*** (Need for high responsiveness to order assignments and fast order completion time)
"[You have to reach] at least 17 kilometers per hour average speed. Otherwise, you're just rated as a bad rider and then you probably haven't made it through the probationary period." (Ferdinand)	
"So a push-up message pops up: here's a new job… and I can't refuse the job…"; "There are concrete areas [here in city A]. And you should really stay in these hotspot areas." (Baal)	***Forced compliance*** (Need for compulsory acceptance of orders and strict instructions on whereabouts)
"I just see where I have to go, to which restaurant. Then I pick up the food there, press 'picked up' and [then]see where I have to go with the food." (Elias)	

Table 1. AM-specific job demands.

AM systems also provide valuable AM-JR for workers to help them cope with the mentioned AM-JDs. Accordingly, two forms of ***real-time rewards*** are displayed in the delivery rider's app: First, if customers tipped them via the *BikeBite's* customer app, riders see the tip amount in their rider app immediately after each order. Additionally, *BikeBites* grants riders a staggering bonus which increases depending on the number of orders delivered. Depending on the delivered number of orders, they immediately see the company-granted bonus for these orders (see also Table 2 for an explaining statement).

Another valuable AM-JR for workers is ***real-time performance information*** in the form of personal statistics. Each rider has an individual job history showing the number of jobs and kilometers driven per day and as a total for the current month and three previous months. As with the real-time rewards, this overview updates after each order.

Although there is the AM-JD of forced compliance concerning their location, workers still have leeway within the given radius regarding their specific whereabouts, i.e., ***GPS-facilitated job location flexibility***. In order words, delivery riders take advantage of being algorithmically recorded and matched based on their location, e.g., by starting their shift from home. Starting from home applies to about 2/3 of the delivery riders at *BikeBites*, as many of them live (consciously or by chance) within the hotspot and delivery area, which are preliminary in city centers. Please refer to Table 2 for illustrative quotes and corresponding definitions of AM-specific job resources.

Illustrative quotes	***AM-JR*** (Definition)
"So at BikeBites we receive a staggered bonus [on top of our salary]: from the 25th order [in the current] month we get 25ct, from the 100th order 1€ and from the 200th order, we receive 2€ per order." (Christian)	***Real-time rewards*** (Real-time tips and bonuses displayed via app)
"There is also online tip. But we always see that only after we have confirmed the delivery." (Ferdinand)	
"And the statistics [show] how many kilometers I drove and how many orders I delivered." (Baal)	***Real-time performance information*** (Real-time information via app displaying the number of orders and driven kilometers)
"We need to be tracked so that our kilometer allowance can be calculated. We get, if we use our own bike, 0,15 € per kilometer [...] and we see the driven kilometers after each order." (Ferdinand)	
"My shift started, and I was logged in, still able to eat, shower and then somehow after half an hour the first order came." (Elias)	***GPS-facilitated job location flexibility*** (Having leeway regarding whereabouts within a defined radius during a shift)
"Well, I have my own bike and start from home. I now live here in [the city X], directly at the University Hospital in the Center. So that's also still in the [shift] starting area, which is very relaxed." (Kai)	

Table 2. AM-specific job resources.

4.2 AM-JD-R and Occupational Well-being and the influence of Job Crafting

Having identified AM-JD and AM-JR, we are now equipped to examine the impact of job crafting (as response to AM-JD-R) on the OWB of delivery workers. Of 16 food delivery riders, 15 said they proactively took steps to improve their occupational well-being, while one worker felt no need to do so. However, those who had performed job crafting gave us detailed descriptions of their underlying intentions and effects on their OWB, which are elaborated below.

First, we find that ***accelerated work pace*** as AM-JD negatively affects the OWB of delivery workers on the physical level (physical OWB). Statements like *"I'm afraid to start shifts because of my back"* **(David)** or *"Normally, when it's busy, so, Sunday evening 6:00 p.m. is the busiest. Then it just goes on for the whole shift, restaurant customer, restaurant customer, and you don't have any break times"* **(Elias)** gave us evidence that accelerated work pace causes repetitive strain injuries, such as back pain and even accidents. Moreover, especially the high responsiveness to order assignments lowers the cognitive needs of OWB (cognitive OWB) in the sense of ongoing tension and stress, illustrated by the following statements: *"You are sent around algorithmically, there are core times where many people like to order."* **(Mads)** and *"Yes, [there is] really pressure on you [...] and you really have to step on the gas."* **(Jacob)**. To cope with this job demand, delivery riders perform task crafting: For instance, they confirm orders later to extend the order completion time: *"After having [handed over] an order [to the customer], I sometimes do not confirm [this] immediately [in the app] but smoke a cigarette first and then confirm the order"* **(David)**. Trying to reduce the number of orders by extending the delivery

time had a positive effect on the physical OWB, as back pain and accidents were reduced. Another negative impact of the accelerated work pace on the OWB is of a social nature (social OWB): Due to the accelerated work pace, there is almost no time to interact with co-workers or customers, which leads to the effect of being socially isolated: *"You always have new restaurants and new customers, but you still notice at some point that you are somehow only driving and also have a total tunneling effect. And that's exactly what happens in the job: you get a bit lonely and isolated."* **(Ferdinand)**. Nevertheless, some delivery riders consciously and proactively seek contact to increase their social needs and thus their OWB through relational crafting: On the one hand, they connect with the staff of the restaurants from which they pick up the orders: *"Sometimes I get a coffee at a restaurant while waiting [for the food to be ready] and this is pretty cool. Then you also get into conversation with one or the other, whom you then meet more often."* **(David)**. In other words, although the pace of work is high, food delivery riders use algorithmic recording to their advantage when they stop at the restaurant to pick up food or while waiting for the food to be ready by engaging in interaction, thus proving to the AM system that they are sticking to the rules. On the other hand, workers also try to interact with colleagues in seeking support by using smartphone messenger apps when it comes to executing orders under time pressure: "*If [a rider] can't find a restaurant, for example, as restaurants sometimes don't have a house number or are hidden in shopping malls, then you sometimes write in WhatsApp: 'Hey, where is that…and someone might then know directly where it is…"* **(Gabriel)**. The special thing about using these messenger apps is that the delivery riders organized its usage and distribution among riders by themselves, which emphasizes the lack of organizational support in establishing communication or interaction channels among colleagues. As a result of this relational crafting behavior described above, delivery riders report increased satisfaction with their social needs, which positively impacts their OWB by building up relationships and having support as a new job resource.

Second, we find in relation to ***forced compliance***, that delivery riders experience a detrimental impact on both, their cognitive and emotional needs associated with their OWB. More precisely, as workers are obliged to accept orders and are precluded from declining orders, frustration and confusion emerge: "*Sometimes I have stacked [i.e., multiple] orders [...] And then you must comply with the algorithm on which order you should deliver first—for example: Customer A lives 200 meters away from the restaurant. But you should go first to customer B, who lives two kilometers away. You can also ignore the algorithm, of course, but then you'll get a message like "Please follow the order in the app""* **(Christian)**. Accepting an order without having the complete information available and thus without understanding why exactly they were assigned to this order results in role ambiguity: "*There are thousands of screenshots of completely nonsensical orders, where you really have to drive twelve kilometers just to the restaurant and then another five kilometers in the other direction to get to the customer, where you think, isn't another rider closer or something?"* **(Christian)**. Riders then try to overcome forced compliance by task crafting (i.e., consciously trying to avoid these orders) so as to minimize the number of tasks they must complete in the following way: Although the app user interface is designed to only allow order acceptance by providing only one button, delivery riders appropriate the app as follows: *"...and sometimes, I just push an order through"* **(Aaron)**. Pushing an order through means producing a fake order delivery, that is, immediately after accepting an order via the rider app, the order is set to "Picked up" in the app without having picked it up physically and then set to "Delivered". Further, to regain job control and autonomy, as opposed to the job crafting behavior in response to the accelerated work pace, some workers also confirm orders earlier to reduce the uncertainty regarding the time of the next order. As a result, the workers' cognitive OWB improves, that is, feeling less frustrated and confused and decreased role ambiguity. Another factor of forced compliance for delivery riders is having strict instructions on their whereabouts. They subsequently try to increase their autonomy by task crafting (i.e., avoiding task assignments), as illustrated by the following statement: *"I mean you can also set your phone into airplane mode, you can go somewhere...out of town and sit in the park, where you get fewer orders. Those would be such tricks to work less."* **(Elias)**. Another job crafting behavior is of a cognitive nature, in the sense that the order delivery is perceived not only as a job to be completed but also as a way to discover unknown corners of one's city: "*I like to ride my bike,the ideal job if you are new in the city. I like the streets. I get a*

feeling for the city and that's pretty cool! I see how people live and how the city changes." **(David)**. David's statement suggests that riders who engage in this kind of cognitive crafting feel more satisfied and are thus more able to cope with the AM-JD of forced compliance. Table 3 summarizes the elaborated job crafting behaviors as reaction to the identified AM-JDs and the implications on the OWB of delivery riders.

AM-JD	Job Crafting Behavior	Outcomes from Job Crafting
Accelerated work pace	- Task crafting: Confirming orders later to extend order completion time. - Relational crafting: Seeking support from colleagues, e.g., when finding a restaurant.	- Improved physical OWB: Reduced strain, especially musculoskeletal and decreased accidents. - Improved social OWB: Building up relationships. - New Resource: Social support.
Forced compliance	- Task crafting: 'Pushing orders through'; putting phone into flight mode; confirming orders earlier - Cognitive crafting: Discovering new places by bike.	- Improved cognitive OWB: Less frustration and confusion, decreased role ambiguity, better cope with forced compliance. - New resources: Job control (by reduced uncertainty), autonomy (especially decision autonomy)

Table 3. AM-JDs, their effects on OWB, and the role of job crafting.

In terms of AM-JR, we find that ***real-time rewards*** improve the emotional needs of delivery workers, which positively contributes to their OWB in the sense of feeling empowered: *"I like the speed. I don't like driving slowly. The bonus drives me, like a watch."* **(David)**. Further, having real-time rewards as AM-JR, we find that delivery riders can better cope with the AM-JD of forced compliance. By engaging in task crafting, workers increased their real-time rewards, as illustrated by the following statement: *"I sometimes press 'Delivered' a bit faster: then I see whether the customer has tipped online...and then I can thank them for it. Otherwise, it's a bit of a strange feeling, then I'm gone, and I see: Oh, he gave me a particularly large tip."* **(Elias)**. This small change not only increases workers' task variety – by not only handing over the order – but instead also engaging in a short interaction; It also decreases their uncertainty regarding the next order (as described within the task crafting behavior as reaction to forced compliance) and increases their job performance. Further, confirming tasks earlier also helps delivery workers to receive more orders per hour and subsequently more bonuses, which helps them to improve their financial needs, which positively affects their OWB (financial OWB).

We further find that ***real-time performance information*** is associated with a high level of satisfaction of cognitive and emotional needs related to workers' OWB. Asking them what they particularly like about their tasks resulted in statements like *"Hey yeah, get on your bike now, just listen to an audiobook or music and just cycle straight away. A warm summer evening like that, it's fun, keeps you fit and clears your head and stuff like that"* **(Jacob)** or *"Well, [the push messages are] actually more like joy: hey, it goes on!"* **(Baal)**. We attribute both statements to cognitive crafting, which also implies feelings of being physically fit. Especially those workers with a 40-hour contract, i.e., working eight hours per day (i.e., having a high number of orders per day), feel proud regarding their physical performance at the end of the day when they check their order history: *"And in the meantime so this daily workload is at the end, if you are so full time, so about 80 kilometers."* **(Mads)**. In terms of job crafting, workers perform the same task crafting behavior as the AM-JR of real-time rewards but with the intention of achieving a higher job performance. By confirming orders earlier, the number of tasks increases, which makes the order history much more 'imposing' for delivery workers. The above-described task crafting and cognitive crafting behavior leads them to being more satisfied emotionally and cognitively. More precisely, we observed feelings of being proud and having a sense of purpose among workers.

We find that having the AM-JR of ***GPS-facilitated job location flexibility*** increasingly satisfies their emotional and social needs, thus improving delivery workers' OWB. For instance, workers use the (by

the *BikeBites*) given radius as their advantage: *"Normally, I would have to drive to a starting point, but because I live in the middle of the delivery area, no one bothers. I simply log in and already wear my equipment"* **(Jacob)**. Starting the shift in the hotspot area is not only a way to better cope with forced compliance but also an attractive option for delivery workers for regaining autonomy and improving their satisfaction in terms of their order completion. Consider the following example of relational crafting and proactively choosing the clientele: *"I always try to stay in the [hip district] at the beginning of my shift and not in the old town, because I have gained the impression [...] that you have much more relaxed people of customers there."* **(Baal)**. Thus, workers using the location restrictions and being tracked to their advantage are more satisfied with their job than those who do not live in the hotspot area. Another example of relational crafting within these defined hotspot areas is given by **Victor**: *"I was in [district x] at a friend's restaurant…a friend [I got to know him through "BikeBites"]. So, I just chilled there for an hour and ate dinner and didn't get any orders, although I was still on duty".* As a result of the described relational crafting behavior, we find that delivery riders could satisfy their social needs, and thus their OWB by maintaining meaningful relationships and gained increased decision autonomy as a new job resource, which helps them to better cope with the strict requirements regarding their whereabouts, i.e., forced compliance. Please refer to Table 4 for an overview of job crafting behavior workers engage in related to each AM-JR and the corresponding outcomes regarding OWB and new resources.

AM-JR	Job Crafting Behavior	Outcomes from Job Crafting
Real-time rewards	- Task crafting: Increasing task variety by thanking the customer for tips or confirming orders sooner to see the next order earlier.	- Improved cognitive and emotional OWB: Increased job engagement, better coping with forced compliance. - Improved financial OWB: Improvement of financial concerns.
Real-time performance information	- Cognitive crafting: Perceiving orders as workout. - Task crafting: Confirming orders sooner to have high performance statistics.	- Improved physical OWB: Feelings of being physically fit. - Improved cognitive and emotional OWB: Increased job engagement, feeling proud, having a sense of purpose.
GPS-facilitated job location flexibility	- Relational crafting: Proactively selecting clientele and meeting friends.	- Improved emotional OWB: Better coping with forced compliance. - New resource: Autonomy - Improved social OWB: Maintaining meaningful relationships

Table 4. AM-JRs and their effects on OWB and the role of job crafting.

4.3 The Integrated DYNAMO Model

Based on our results and emerging from our theoretical approach, we present the integrated model of the "Dynamic Relationships between AM and OWB" (DYNAMO) Model in Figure 1, which proposes myriad *relationships* among AM-specific job demands (AM-JD), AM-specific resources (AM-JR), job crafting and occupational well-being (OWB). It is further derived from the theoretical foundations, especially with regard to the JD-R model according to Bakker et al. (2014) and the model of "ICT-Enabled Job Crafting to Enhance Occupational Well-Being" as introduced by Tarafdar and Saunders (2022).

Although our research is based on previous theories, our findings offer new and fruitful insights. Particularly in the context of AM-based work settings and their associated job demands and resources, they extend what is already known regarding the JD-R model, job crafting and occupational well-being. Specifically, the model proposes that AM-JD impair OWB, as evidenced by frustration and social isolation. The model also considers job crafting as an important behavioral process that not only mitigates AM-JD, but also positively impacts OWB and increases AM-JR in several ways. Further, we

assume the relationship between job crafting and AM-JR is a *reinforcing* cycle—comparable to the power transmission enabled by the bicycle chain when riding a bicycle. Thus, the more job crafting delivery riders engage in, the more AM-JR they have and the higher their OWB.

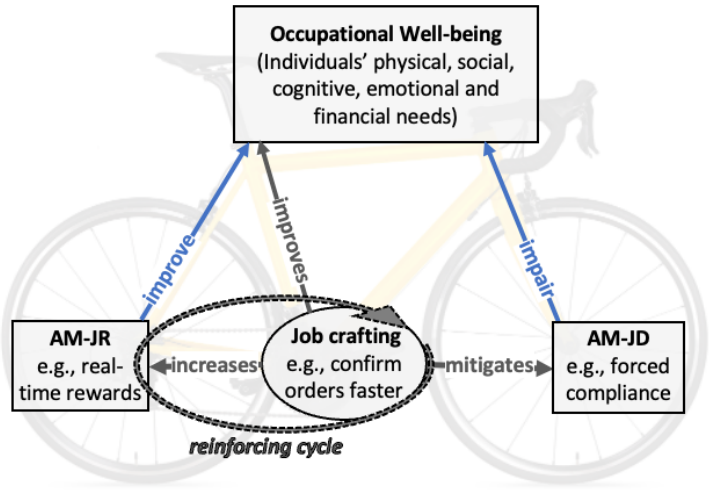

Figure 1. The integrated DYNAMO Model.

5 Discussion and Conclusion

The integrated DYNAMO Model confirms previous relationships reported among ***job demands***, job resources, and OWB (Bakker et al., 2014). In particular, some of our findings are in line with prior research related to job demands in AM-based work settings, for instance, accelerated work pace (Zheng and Wu, 2022). In this regard, by refining previous findings, we hope to contribute to a better understanding regarding the triggers of a high work pace and the associated coping mechanisms. In line with Watson et al. (2021), we also find in our data that social isolation impairs the delivery workers' OWB. Furthermore, our abductive research approach surfaced a previously unreported relationship: being socially isolated could be improved by relational crafting, such as proactively seeking support from colleagues via self-organized messenger services. As found in previous research conducted in AM-based work settings, our interviewees referred to algorithmic recording as a job demand (e.g., Park et al., 2021, Kellogg et al., 2020). However, it did *not occur in relation to* AM-specific job demands on OWB but in relation to the employers' (i.e., the delivery service firms) contractual arrangements and working conditions on OWB. We further surfaced forced compliance as a novel job demand, thus providing new insights regarding the effects of AM mechanisms, such as algorithmic restricting on the OWB of delivery workers.

We identify, confirm, and refine the pre-found ***job resources*** of AM-based work settings. We *identify* real-time performance information as a novel AM-specific job resource, and our findings demonstrate its positive impact on delivery workers' OWB at the cognitive, emotional, and physical levels. Moreover, we find that task crafting and cognitive crafting increase and strengthen this novel resource and improve workers' OWB, eventually leading to higher job motivation. Further, we *confirm* the job resource of algorithms granting monetary rewards (e.g., Cameron, 2020), i.e., real-time rewards. In applying task or cognitive crafting techniques, delivery riders can enhance their job satisfaction and performance, which are key indicators of OWB. For instance, confirming orders earlier enables them to solve more orders per hour and consequently to receive higher monetary rewards. In a similar vein, perceiving the job as a workout motivates workers to perform better, which also leads to higher monetary rewards. We are also able to refine the previously considered job resource of autonomy within AM-based work settings (e.g., Möhlmann and Zalmanson, 2017) as GPS-facilitated job location autonomy, as several workers reported enjoying their flexibility in terms of starting their shift from home.

5.1 Theoretical and Practical Contributions

Our study of how job crafting influences the relationship between algorithmic management (AM) and delivery workers' occupational well-being (OWB) has two major contributions. First, by introducing the integrated DYNAMO Model as the overarching contribution, we present a novel framework to gain a new understanding regarding workers' OWB in AM-based work settings. Another important aspect of our integrated DYNAMO Model is that it refines, specifies, and restructures prior findings and deciphers the essential constructs and relationships regarding AM and OWB. More precisely, we show dynamic relationships that help to explain how AM-JD can be mitigated and AM-JR can be increased by job crafting. As prior literature predominantly paints a rather 'dark picture' of AM regarding workers' well-being on several levels, our results show that AM also fosters positive impacts, namely job resources, inhibiting or leading to high or improved OWB. In doing so, we hope to show practitioners possible ways to strengthen the positive aspects of AM-based work settings and which negative aspects of AM-based work settings should be mitigated in designing employee-friendly AM-based work settings or systems. Second, an underlying assumption of past research seems to be that workers are passive recipients under AM. In contrast, our results show that workers *can* proactively respond to AM by job crafting. For instance, by consciously completing more orders (i.e., task crafting), by perceiving the order delivery as a workout (i.e., cognitive crafting), or by proactively selecting the customer clientele (i.e., relational crafting), we find that workers can proactively increase their OWB. However, job crafting is not a panacea for improving OWB. Although being rather positive for workers, as they might feel better or create new resources, we point out that excessive job crafting can also have negative impacts, especially when it comes to violations of the employment contract, for instance, when repeatedly putting the phone into flight mode. Further, there might also be job demands in AM-based work settings that can hardly be coped with job resources or job crafting, such as job insecurity. However, this was not part of our findings, as we focused on workers with a permanent employment contract. Generally, the medium- and long-term effects of AM on OWB are still largely unexplored, which makes it worth taking a closer look at how workers can proactively act to improve their OWB. Groups of worker representatives can especially benefit from our results in implementing these insights in practice and increasing workers' participation and organizational support that reflects governmental regulations.

5.2 Limitations and Future Research

As with every study, our study also has limitations, suggesting promising avenues for future research. First, by relying on a relatively small sample of 16 interviewees with a permanent, and mostly part-time (25 hours in average) working contract, our findings might not be generalizable to other groups of workers, such as full-time workers in similar contexts or freelancers being paid per delivery. These other groups could face additional AM-JD or AM-JR or perceive their OWB differently. Thus, future research could employ research designs involving interviews with these other groups. Additionally, quantitative research could be conducted in different work settings, for instance, within knowledge work, to detect more aspects of the dynamic relationships of AM-JR and AM-JD on OWB, and the influence job crafting, being derived from or integrated into our model. Furthermore, as we found that job crafting is a highly effective behavior in improving OWB, we suggest future research designs to assess additional ways of enhancing AM by employing mechanisms and technologies to protect workers (e.g., with sensors to overview the weight of backpacks, health monitoring via smartwatches or related AI solutions). We conclude with the following statement of our interviewee **Christian**, thus encouraging future researchers to generate a nuanced sophisticated regarding AM: *"It's actually a cool job. You get paid for cycling and you don't have a boss breathing down your neck…but that quickly becomes relativized when you consider that the boss who isn't breathing down your neck is sitting in your cell phone and there's nothing you can do about it".* We hope our results and, especially, our DYNAMO Model may help guide such future research on AM.

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