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Algorithmic Embeddedness and the 'Gig' Characteristics Model: Examining the Interplay between Technology and Work Design in Crowdwork

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ABSTRACT This article systematically reviews the literature on online task crowdwork to investigate the complex relationship between technology and work design on crowdwork platforms. We highlight the diverse interpretations and uses of technology, specifically platform features and algorithms, in relation to work design. Our review reveals that platform features serve as antecedents to work design characteristics, while algorithms are so intertwined with job execution that a new work characteristic is needed to model this interplay. We introduce this new work characteristic as *algorithmic embeddedness* and show that it varies in degree. When high, algorithmic embeddedness can be perceived as either an affordance or a constraint; when low, it has a limited impact on crowdworkers' jobs. Our 'gig characteristics model' expands previous work design theories and offers a framework for understanding the design of contemporary jobs that rely highly on algorithms. To refine our model and better understand crowdwork dynamics, we provide an agenda for future research directions.

Keywords: Algorithms, algorithmic embeddedness, crowdwork, digital platforms, future of work, gig characteristics model, gig work, work design

INTRODUCTION

The world of work is undergoing a swift and transformative change propelled by the rapid evolution of technologies (e.g., Barley et al., 2017; Parker and Grote, 2022; Spreitzer et al., 2017). Robots, artificial intelligence, and online platforms are changing how people

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work, perceive their jobs, and collaborate within and beyond organizational boundaries. As - jobs increasingly depend on technology, understanding how technology contributes to job design and related workers' experiences becomes fundamental for designing the future of work. In this regard, scholars of work design have acknowledged the pressing need for a thorough understanding of how technology shapes work in various contexts (Erez, 2010; Grant and Parker, 2009; Hackman and Oldham, 1975; Oldham and Hackman, 2010; Parker and Grote, 2022). In response to this call, our article directs its attention to the domain of work design within the specific context of online labour platforms, a prominent sphere significantly influenced by technological advancements.

In the gig economy, clients, both individuals and organizations, increasingly outsource small as well as knowledge-intensive tasks such as software development, editing, and design to a category of workers delivering jobs via online labour platforms such as Upwork, Fiverr, Freelancer.com, or Guru. This type of work has been identified as 'online task crowdwork' (Durward et al., 2016; Howcroft and Bergvall-Kåreborn, 2019) – work that individuals or small groups typically perform in 'online labour markets' (Boudreau and Lakhani, 2013) – and such workers have been named crowdworkers (e.g., Idowu and Elbanna, 2022). These platform-based companies provide a set of rules for workers and clients to operate at a distance in a digital environment, and algorithms to find and manage jobs. By posting their task requests, organizations benefit from connecting with a global workforce, accessing specific skills and expertise to deliver on-demand jobs, and paying based on results. Similarly, crowdworkers can potentially obtain multiple benefits. They can promote their talents and find organizations or other clients needing their competence. They can more readily secure job opportunities that align with their interests by working remotely from home, from a co-working space, or while travelling, improving their quality of life. They can supplement their income, improve existing skills, learn new ones, increase their flexibility (Bucher et al., 2024; Gandhi et al., 2018; Ravenelle et al., 2021), and even develop entrepreneurial identities (Bellesia et al., 2019; Idowu and Elbanna, 2021).

Unfortunately, crowdworkers cannot always take advantage of all these opportunities. Despite being categorized as independent contractors (Barley and Kunda, 2006; Kunda et al., 2002), they are bound by platforms' rules that regulate work at a distance and by algorithms that dictate working opportunities and competition logics, ultimately constraining their decision-making, behaviour, and voice (Bergvall-Kåreborn and Howcroft, 2014; Gegenhuber et al., 2020; Lee, 2018). Platform-based companies usually retain proprietary knowledge over algorithms and do not fully disclose how they operate. Consequently, there is a lack of information regarding their specific functioning mechanisms, such as, for example, how matching and hiring procedures work based on demand and supply characteristics and previous interactions, how performance ratings are computed and updated, or how crowdworkers' tasks are supervised. As algorithms exert such an exceptional control, crowdworkers are said to work in an 'invisible cage' (Rahman, 2021).

Given the steady rise of workers on crowdwork platforms (Kässi et al., 2021), it is crucial to explore the positive and negative aspects of platforms and algorithms and to provide insights on how to improve crowdworkers' well-being and work outcomes. Technology is so embedded in work processes that examining its detailed functioning on

core job characteristics is essential to the understanding of crowdwork itself. Such exploration is also particularly important because crowdworkers are independent contractors working autonomously on knowledge-intensive tasks. The control exerted by platforms and algorithms on job design may significantly limit such autonomy and lead to opportunistic practices from both clients and platform organizations. For example, clients may promise to leave good ratings in exchange for reduced payments (e.g., Gandini, 2019; Rahman, 2021; Wood et al., 2019). Moreover, with the renewed scholarly interest in remote work (e.g., Gajendran et al., 2024; Raghuram et al., 2019), our exploration is essential to understand how to design jobs for a fully remote workforce that operates beyond traditional organizational structures. Thus, our research question is this: *How does technology interplay with work design in crowdwork*?

To understand how work design is accomplished in crowdwork, we conduct a systematic literature review. We build on the well-established job characteristics model (JCM) (Hackman and Oldham, 1975) and its recent developments (e.g., Parent-Rocheleau and Parker, 2022; Parker and Grote, 2022; Parker et al., 2001, 2017; Pierce et al., 2009; Reiche, 2023) and combine these theories with macro-approaches to the study of the role of technologies. In the following sections, we first present this framework. Then, we critically review the emergent literature on crowdwork (Torraco, 2005), emphasizing how this evidence speaks to work characteristics and how platforms and their algorithms are shaping work.

Through our systematic literature review, we uncover the distinct effects of platforms and algorithms on job design. On the one hand, we propose that platform features are a contextual antecedent of work characteristics. On the other hand, the imbricated action of algorithms on crowdworkers' work leads us to introduce and theorize a new work characteristic, which we name *algorithmic embeddedness*. By incorporating algorithmic embeddedness, our 'gig characteristics model' extends previous work design theories which mainly acknowledged technology as an antecedent of work characteristics (Parker and Grote, 2022; Parker et al., 2001; Wang et al., 2020). As significant work must be done to unpack the interplay of platforms and algorithms with key work characteristics and deeply understand the influence of technology on (crowd)workers, our article concludes by proposing a research agenda on the complex relationship between platforms, algorithms, and work design.

A FRAMEWORK TO UNDERSTAND HOW TECHNOLOGY SHAPES WORK DESIGN IN CROWDWORK

To answer our research question, we combine two crucial bodies of knowledge: work design theories and theories on technology use within organizations. In this section, we will provide a concise overview of the critical components of these theories that will serve as the foundation for our literature analysis.

Work Design

Work design 'describes how jobs, tasks, and roles are structured, enacted, and modified, as well as the impact of these structures, enactments, and modifications on individual,

group, and organizational outcomes' (Grant and Parker, 2009, p. 319). To understand what drives outcomes such as individual performance or job satisfaction, work design theories are concerned with understanding the main characteristics of jobs, tasks, and roles and their either negative or positive influence on such outcomes.

According to the job characteristics model (JCM), the most influential job characteristics are skill variety, task identity, task significance, feedback, and autonomy (Hackman and Oldham, 1975). The first variables of JCM, i.e., task characteristics, are meant to qualify the activities assigned to workers. Skill variety refers to the extent to which a job requires different activities based on different skills. Task identity is the extent to which a job requires the completion of a 'whole' and identifiable piece of work, producing a visible outcome (Hackman and Oldham, 1975, p. 161). Task significance refers to the impact on the lives or work of other people. Autonomy is interpreted as the degree of freedom and independence in scheduling the work and in how to carry it out, while feedback refers to 'the degree to which carrying out the work activities required by the job results in the employee obtaining direct and clear information about the effectiveness of his or her performance' (Hackman and Oldham, 1975, p. 162). These characteristics drive better individual performance and higher motivation at work via three critical psychological states, i.e., work meaningfulness, responsibility of work outcomes, and knowledge of work results (Hackman and Oldham, 1975).

New or expanded versions of the JCM have been developed to account for social and technological developments (Grant and Parker, 2009; Parent-Rocheleau and Parker, 2022). Scholars agree that the social dimensions of a job have been underestimated, if not overlooked, by the original JCM (e.g., Grant and Parker, 2009; Humphrey et al., 2007; Morgeson and Humphrey, 2006; Oldham and Hackman, 2010) and suggest adding them as relevant job characteristics. For example, social support from peers or supervisors, or task interdependence among co-workers, have been recognized as influencing individual job outcomes (Morgeson and Humphrey, 2006).

As a further expansion of the original JCM, Parker and colleagues claim that it is crucial to consider the specific antecedents to job characteristics – e.g., technology, external organizational factors such as market conditions, or other individual traits such as proactivity (Parent-Rocheleau and Parker, 2022; Parker et al., 2001), as well as group-level job characteristics structuring tasks and roles. Following this claim, scholars have started to analyse how technology influences the way jobs are structured in general, and job characteristics in particular, both positively and negatively (Gibson et al., 2011; Parker and Grote, 2022; Schroeder et al., 2021; Wang et al., 2020). For instance, Wang et al. (2020) focused their attention on IT technologies as an antecedent of job characteristics. Parker and Grote (2022) provided an overview of how different technologies such as blockchain, algorithms, and artificial intelligence can positively or negatively impact five work design elements – i.e., job autonomy, skill variety, social and relational aspects of work, feedback, and job demands. Parent-Rocheleau and Parker (2022) developed a theoretical model that specifically examines algorithms in the workplace, such as those utilized in HR selection and evaluation procedures, as precursors to work characteristics. Furthermore, the authors explored

how the perceived fairness and transparency of these algorithms, along with the perception of human influence over HR processes, influence the connections between algorithms and job design characteristics.

Overall, these attempts stemmed from the conviction that work design and technology can work together to fit human competencies and needs. However, insufficient attention has been given to technology-enabled changes in new technology-mediated work contexts (Parker and Grote, 2022). In addition, we need to gain a greater understanding of how technology influences employees' well-being and effectiveness (Wang et al., 2020). We respond to these calls by developing a comprehensive model of how job design occurs in crowdwork settings, emphasizing the paramount role of technology (platforms and algorithms) in shaping work characteristics.

Perspectives on Technology

To analyse the interplay between technology and work design, we draw on the extensive body of literature that categorizes how technology impacts work processes in organizations (e.g., Cascio and Montealegre, 2016; Larson and DeChurch, 2020; Leonardi, 2011; Liker et al., 1999; Orlikowski and Baroudi, 1991; Orlikowski and Scott, 2008). In this literature, we can broadly distinguish between two approaches to viewing technology: technology as a context and technology as a socio-material affordance. When interpreted as a context, technology creates the soil that potentially affects social practices (e.g., Cascio and Shurygailo, 2003; Zaccaro and Bader, 2003). Following this perspective, 'humans and technology are assumed to be discrete, independent entities with inherent characteristics' (Orlikowski and Scott, 2008, p. 438) or features that univocally affect individual and organizational processes. Technology is typically viewed and conceptualized as an independent variable in these studies. Conversely, technology can be seen as a socio-material affordance, that is, as 'action possibilities and opportunities that emerge from actors engaging with a focal technology' (Faraj and Azad, 2012, p. 241; Fayard and Weeks, 2014; Leonardi and Vaast, 2017). In this perspective, technology is perceived as 'part of the complex process through which organizing is accomplished' (Orlikowski and Scott, 2008, p. 446). In other words, humans and technology interact and mutually influence each other.

The following section discusses how we analyse the extant literature on crowdwork (Elsbach and van Knippenberg, 2020; Post et al., 2020; Torraco, 2005), building on these two bodies of knowledge (work design and technology). We systematically and critically synthesize the literature to build a more robust theoretical understanding of how technology and work design interplay in crowdwork. This approach allows us to refine and adapt the JCM to make it applicable to the specific setting of crowdwork.

METHODS

We collected scientific contributions using the SciVerse Scopus online database as our primary source. Due to the novelty of our focal phenomenon and the emerging nature of the literature, the broader scope of Scopus compared with other databases like WOS enabled us to search for a more comprehensive array of outlets, avoiding the less

scrutinized realm of fully open access alternatives. Given our goal to collect novel and relevant findings with high potential for publication, we considered papers published in academic journals, conference proceedings, books, and book chapters, even though not all may have undergone a traditional peer review process. We limited our search to the subject area of 'Social Sciences & Humanities' to retrieve documents with managerial implications (Ghezzi et al., 2018).

To select articles, we adopted the multi-step approach (Di Stefano et al., 2010; Ghezzi et al., 2018) that is described in the PRISMA Flow Chart in Figure 1 (Leicht-Deobald et al., 2023; Rahman et al., 2024; Siddaway et al., 2019).

Our primary focus was on studies that describe the dynamics of crowdwork – i.e., work that single individuals typically perform in 'online labour markets' (Boudreau and Lakhani, 2013; Durward et al., 2016; Howcroft and Bergvall-Kåreborn, 2019). Though 'crowdwork' is currently used to identify this type of work, this term is relatively recent. The very first studies on crowdwork appeared under the label of 'microwork' – an instance of crowdsourcing – or under the mainstream word 'gig economy'. Later on, the terms 'digital labour' and, more often, 'gig work' have been used to refer to crowdwork and crowdworkers' experiences. Moreover, due to the extensive use of algorithms on online labour platforms, the term 'algorithmic management' is also usually coupled with either 'gig work' or 'crowdwork' to refer to the experiences of crowdworkers. Hence, the label used to identify crowdwork has evolved in the scholarly literature.

Therefore, to ensure the inclusion of most studies on crowdwork, we used the following keywords in our search: *gig work*, *crowdwork*, *microwork*, *digital labor, algorithmic management*, and *gig economy*. Our query was set to find articles with at least one of these keywords

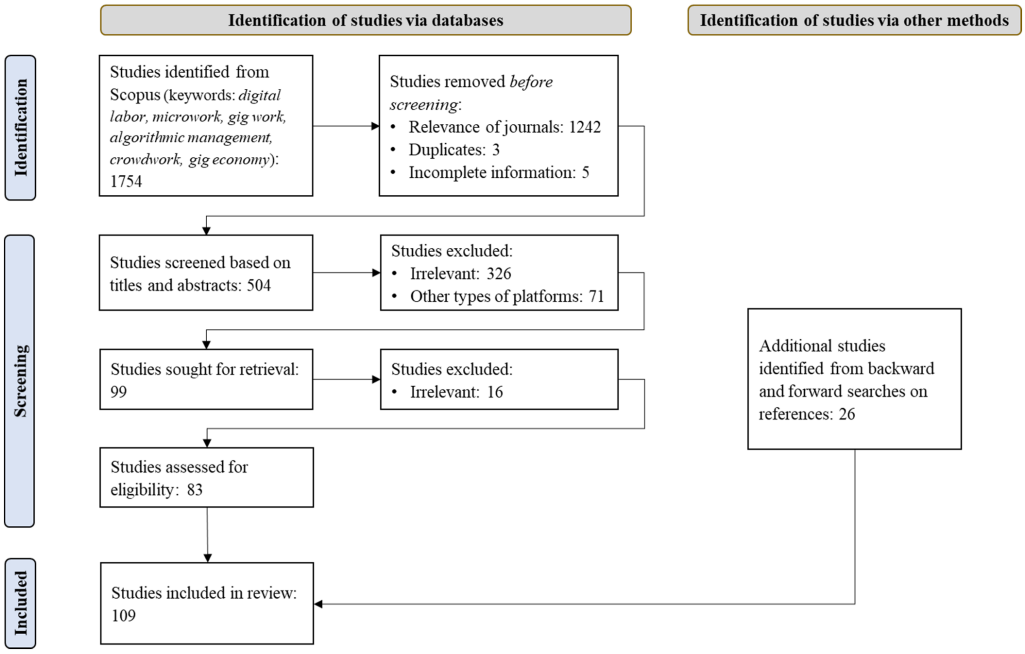

Figure 1. PRISMA flow chart of the article selection process.

in their title, keywords, or abstract. Since we wanted to focus on articles with managerial implications, the search was limited to the sub-subject areas of 'Business, Management and Accounting', 'Social Sciences', and 'Decision Science' (including information systems management). We selected articles that were published between January 2006 and December 2023. We chose January 2006 as the starting date because the general definition of *crowdsourcing* appeared in *Wired* magazine later that year (Howe, 2006). This was instrumental to capture the initial studies under the label 'microwork'. Following this initial search, our database included a total of 1754 documents.

We then pre-screened our studies according to journal quality. As for conferences and book chapters, we checked for conference relevance and for books' titles. We also detected studies with incomplete information – i.e., the full text was non-accessible – and duplicates. This identification phase (see Figure 1) allowed us to restrict the number of studies to be screened to 504.

Following the PRISMA standards (Page et al., 2021; Siddaway et al., 2019), we read the abstracts to refine our search further and retained documents that described individual workers' behaviours and experiences. Since we were interested in the work delivered through 'online labour markets', we included only articles that expressly referred to a type of work performed entirely remotely on global platforms such as Upwork, Freelancer.com, Guru – i.e., 'crowdwork' (see for instance, Fieseler et al., 2019; Jäger et al., 2019; Ma et al., 2018; Margaryan, 2019). This type of work is different from that performed through platforms such as Uber, Lyft, or Airbnb, which match clients and providers of tasks delivered in person (see Howcroft and Bergvall-Kåreborn, 2019; Vallas and Schor, 2020, for typologies of platforms). This platform type also differs from online marketplaces such as eBay or Amazon, where sellers are mainly companies selling their products (see Curchod et al., 2020, for an example). After retaining only studies discussing and analysing online task crowdwork and relevant to answer our research question, our databases included 99 documents for retrieval.

After reading these 99 articles, we added 26 relevant studies obtained by backward and forward searches on references. For instance, we added some studies in the Information Systems domain exploring different types of algorithms that enable team formation and coordination. Though relevant, these studies appeared only on conference proceedings that our Scopus search could not detect. We read and analysed the insights from this additional set, and retained ten that were useful to inform our research question, discarding the other 16. At the end of our process, the final database included 109 articles.

We read all these papers and deductively coded their content (e.g., Cropanzano et al., 2023; Fereday and Muir-Cochrane, 2006; Schleicher et al., 2019) according to the work characteristics derived by the JCM and its recent developments. Specifically, we had *task characteristics* (i.e., skill variety, task identity, task significance), *feedback*, and *autonomy* from the original JCM. We then had a label for the social aspects of crowdwork, such as relations with clients or peers – i.e., *relationships*.

As mentioned, we were particularly interested in the role of technology. While reading the papers, we realized that technology was mostly described in terms of 'platforms' in general or in terms of the way algorithms work. We therefore decided to recode our articles to better keep track of how technology operates and is interpreted in the context of crowdwork, building on the two perspectives on technology described above

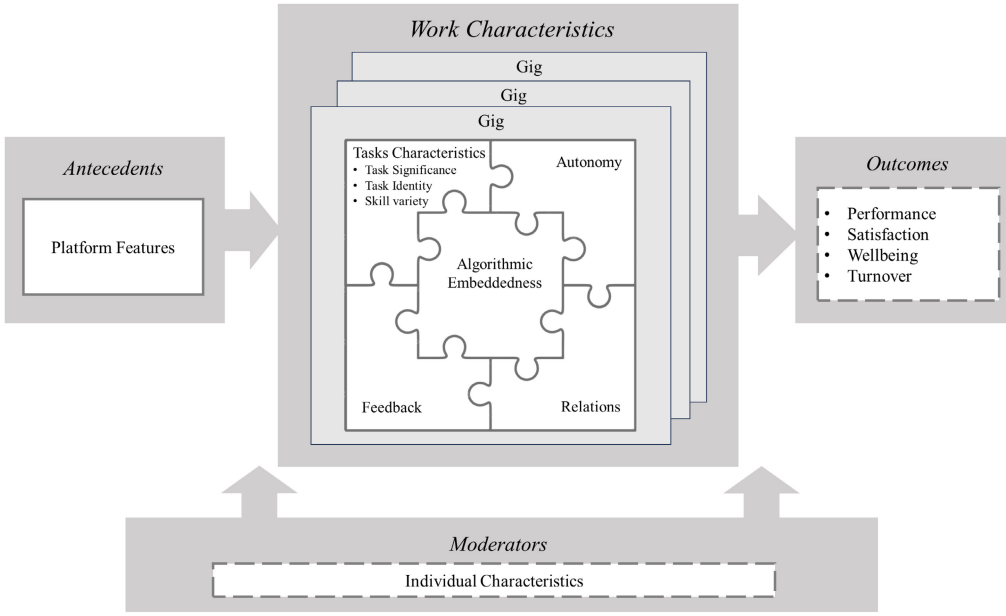

Figure 2. The Gig Characteristic model. Variables inside dotted boxes are not discussed in the paper or represent issues to be investigated by future research.
Source: Binik 1 (2024), jigsaw puzzle blank simple vector of five pieces, retreived 19 March, royalty-free illustration.

(Leonardi, 2011; Orlikowski and Scott, 2008): technology as a *context* and technology as a *socio-material affordance*. Figure 2 reports our critical synthesis (Post et al., 2020; Torraco, 2005).

THE 'GIG' CHARACTERISTICS MODEL

This section discusses the insights we gained from our analysis of existing studies introducing crowdwork platforms as a technology *context* influencing work design. Specifically, the features of platforms act as antecedents to work design, and we describe how such features affect the traditional job characteristics as illustrated in our pool of studies. In reviewing the literature, however, we realized that interpreting platforms as a context was not enough for comprehensively describing crowdworkers' job design. Using a socio-material perspective, we identify and define a new work characteristic, that we label *algorithmic embeddedness*. We present evidence of algorithmic embeddedness from previous studies, and we further illustrate how this characteristic is deeply intertwined with the others.

Crowdwork Platforms as Context

Online digital platforms such as Upwork, Fiverr, Freelancer.com, and Guru are examples of online environments that organizations and other clients can use to externalize a wide variety of tasks – from short and easy ones ('gigs'), to more complex jobs such as large language models' development, illustrations, or translations (Boudreau and Lakhani, 2013). Clients can search for workers by posting their job requests, and they usually interact

with crowdworkers at a distance. Along with a general description of the job, requests typically provide information on payment, project duration, and skills. Clients should also enclose some keywords on required skills and the broader area of expertise – e.g., graphic design or web development.

To join these platforms and navigate job requests, crowdworkers are asked to follow specific rules and fill out online profiles with, among other information, a brief personal description, previous working experiences, and educational background, selecting keywords highlighting their competences. Profiles are usually publicly available for clients and workers who have subscribed to the platform. These profiles typically track completed online jobs and other performance details. For instance, the Job Success Score on Upwork shows the percentage of completed jobs (Blyth et al., 2024) – i.e., algorithmic scores. Freelancer.com displays variables such as 'On budget' and 'On time' to inform clients about the percentage of projects successfully delivered on time and according to negotiated budget conditions. Other platforms also create badges to showcase crowdworkers' accomplishments (Jabagi et al., 2019), like 'Top Performer' or 'Rising Status' labels (Bellesia et al., 2023). Through this process, online profiles help crowdworkers gain visibility, attract clients' attention, and secure new job opportunities (Blyth et al., 2024). When applying for new jobs, crowdworkers might also be asked to write cover letters, which serve as an additional opportunity to showcase skills and quality, thereby capturing the attention of potential clients (Bellesia et al., 2019; Blyth et al., 2024).

As complementary services, some platforms host proprietary communities to support crowdworkers and provide the opportunity to get in touch with peers (Jabagi et al., 2019). Platforms can also secure transactions through escrow payment systems protecting workers from unfair clients' behaviours (Jarrahi et al., 2020). Recently, platforms have started offering enterprise sections where crowdworkers can present themselves as members of a team. On Upwork, for instance, crowdworkers can build 'agencies' and apply for complex jobs with their teams of collaborators (Bellesia et al., 2019; Idowu and Elbanna, 2022).

Online platforms further shape work through algorithms (Kellogg et al., 2020; Möhlmann et al., 2021). For instance, most online labour markets use a variety of algorithms whose technical features vary from platform to platform. Platforms rely on *rating algorithms* to compute crowdworkers' scores (Gandini, 2016; Rahman, 2021); on *control algorithms* to make sure their policies are followed (Jarrahi et al., 2020); and on *matching algorithms* to propose new jobs to workers or refer workers to clients. These algorithms, as part of the technological context of a platform, vary in their objective features, but the logics behind their functioning are exclusive property of the platform organization and are not known to workers or clients (Rahman, 2021). The ways in which such algorithms are intertwined with work design and crowdworkers' experiences are described in a following section through the concept of algorithmic embeddedness. In the next section, we describe how the objective features of a platform affect work characteristics.

The Influence of Platforms on the Traditional Elements of Work Design

Task characteristics: Skill variety, task significance, and task identity. The debate on online platforms has evolved around the implicit assumption that the tasks to be completed

entail low levels of task identity and significance and require limited expertise – i.e., they are fast, short, and easy gigs (Ashford et al., 2018; Cropanzano et al., 2023; Ens et al., 2018; Kuhn and Galloway, 2019). This idea comes from the first studies on crowdworkers and the so-called gig economy, which focused primarily on platforms such as Amazon Mechanical Turk (e.g., Bergvall-Kåreborn and Howcroft, 2014; Deng et al., 2016; Irani, 2015; Lehdonvirta, 2016). Accordingly, online labour platforms have been mainly described as collectors of disempowering and deskilling jobs (Bergvall-Kåreborn and Howcroft, 2014; Irani, 2015). These 'adverse' working conditions led scholars to argue that workers need flexibility (Lehdonvirta, 2018), self-efficacy (Barnes et al., 2015), agility, resilience, proactivity, and emotion regulation as essential capabilities (Ashford et al., 2018).

More recent studies, though, have started to acknowledge that also complex, knowledge-intensive, and long-term oriented jobs can be searched and delivered through platforms such as Upwork or Freelancer.com (Howcroft and Bergvall-Kåreborn, 2019; Kuhn and Maleki, 2017; Pulignano et al., 2023; Schmidt et al., 2023) and that workers look for task significance and meaning of work while delivering jobs online (Boons et al., 2015; Bucher et al., 2019; Deng and Joshi, 2016; Deng et al., 2016; Gandhi et al., 2018; Gol et al., 2018; Kost et al., 2018). For instance, field experiments on workers' reactions to wage cuts (Chen and Horton, 2016), or studies of workers' collaborative initiatives (Panteli et al., 2020), highlight that online workers show attachment to the platform and feel part of an employment relationship. As such, they expect to be treated fairly by platforms and prospective clients (Pfeiffer and Kawalec, 2020). Similarly, when workers perceive the tasks they perform as significant and identify with their jobs, they are more likely to experience their work as meaningful (Wong et al., 2020) and are more engaged with digital labour (Bellesia et al., 2023; Rahman, 2021), suggesting a positive effect of task significance on crowdworkers' motivation (Hackman and Oldham, 1975).

As far as skills are concerned, it has been recognized that the platform workforce is composed mainly of professionals (Alacovska et al., 2024; Herrmann et al., 2023) who need an initial set of skills to access the platform market – e.g., they need to own a verifiable set of skills to work on, for instance, design or software development tasks (Barnes et al., 2015). On platforms such as 99design or Turing, which mainly attract designers or IT developers, crowdworkers can refine and improve existing capabilities. However, they have limited choices in terms of skill diversification. On platforms such as Upwork or Freelancer.com, on the other hand, crowdworkers can subscribe to and apply for a wider variety of jobs, from logo design and database administration to translations or software development. Therefore, crowdworkers on these platforms can find knowledge intensive tasks requiring a broad set of skills.

Even if they hold an initial set of skills, many crowdworkers enlarge their skills over time and develop an entrepreneurial mindset to fully exploit platform opportunities (Bellesia et al., 2019; Sutherland et al., 2019). For instance, workers learn skills to promote their work on the platform and to negotiate favourable working conditions with clients (Barnes et al., 2015; Blyth et al., 2022). The study by Margaryan (2019) explores how crowdworkers can learn these skills. It shows that they embrace a wide range of learning strategies, both autonomously and in collaboration with others

– e.g., they learn by undertaking free online courses or receiving feedback from others (Margaryan, 2019).

Taken together, these findings suggest that, under certain conditions, crowdworkers can experience meaningfulness in their jobs and that online platforms can serve as an *online context* providing significant job opportunities, empowering crowdworkers' skills, and enabling new skills development.

Autonomy. Autonomy – freedom and independence in scheduling work and in how to carry it out (Hackman and Oldham, 1975) – is found as a critical motivator for newcomers and longtime crowdworkers (Gol et al., 2018; Ozimek, 2021), and it is a central job characteristic of freelancers in general. Scholars from various disciplines are questioning the concept of autonomy on digital platforms, given the inherent uncertainty of gig-based work models and the prominent role of algorithms in driving workers' behaviours (Kuhn and Maleki, 2017; Lehdonvirta, 2018; Rosenblat and Stark, 2016; Shapiro, 2018; Veen et al., 2020). For these reasons, crowdworkers are often considered platform-dependent rather than independent contractors (Cutolo and Kenney, 2021; Kuhn and Maleki, 2017).

However, there is emerging evidence that crowdworkers do not surrender their decision-making power and work following their needs and preferences (Lehdonvirta, 2018; Muldoon and Apostolidis, 2023), especially when they can get access to a broader client base. Platforms can be uncertainty reducers and provide details not only about a job's content and requests but also about potential clients. For instance, some platforms equip crowdworkers with information on clients' location or payment reliability, influencing workers' willingness to apply for specific jobs. Crowdworkers can also access information on clients' job histories and analyse the reviews left by other freelancers. As most online profiles and job histories are public, crowdworkers can also gain insights into the competition on specific skills and jobs. This understanding enables them to tailor their offerings to match opportunities (Bellesia et al., 2019), increasing their sense of self-efficacy and control over their work. Thanks to easier access to precious information about clients and potential job opportunities, platforms may increase crowdworkers' levels of autonomy in decision-making and negotiating power. Moreover, as a traditional employment relationship is missing, crowdworkers are not bound to a single platform and can adopt the practice of 'multi-homing', i.e., working simultaneously from multiple platforms, to increase the number of potential job opportunities (Cutolo and Kenney, 2021). Finally, platforms such as Upwork offer crowdworkers features to automate transaction management and reduce the time spent negotiating employment conditions with clients. For instance, they employ escrow systems (Jarrahi et al., 2020). These contextual features of the platform allow for more temporal flexibility. In addition, the opportunity to perform the job at a distance guarantees spatial flexibility (Wood et al., 2019).

Relationships. *Relationships with Peers*. Crowdworkers are often described as working in isolation. They rarely engage with other online freelancers, who are mostly seen as competitors rather than co-workers (Lehdonvirta, 2016; Wood et al., 2018). They are alone in dealing with clients, who can be reached only via technology-mediated communication. They face difficulties in building a sense of community (Cini, 2023; Gerber, 2021; Lehdonvirta, 2016; Schou and Bucher, 2023), and attempts to create

unions are often single-individuals efforts (Newlands et al., 2018). Moreover, 'interaction costs unpaid extra time' (Gerber, 2021, p. 208). Recent reports of crowdworkers interacting on online interest communities such as Reddit provide further evidence of conflicts (Schou and Bucher, 2023). Specifically, crowdworkers disagree on the role of platforms, especially Upwork, as exploitative or enabling entities. Their different status on the platform triggers different perceptions: successful workers tend to have a favourable view of Upwork, while crowdworkers under pressure consider it exploitative. Gerber and Krzywdzinski (2019) even consider the online communities where these conversations happen as another technology that controls crowdworkers' behaviour.

However, there is evidence that some forms of collaboration happen between crowdworkers (Bellesia et al., 2023; Hondros et al., 2023; Kinder et al., 2019; Ma et al., 2018, 2020). Some studies describe social media groups as central in supporting and structuring communications among workers (Hertwig et al., 2024; Hondros et al., 2023; Lehdonvirta, 2016), especially during turbulent times (Bellesia, 2023; Granger et al., 2022). Here, participation increases workers' perception of security, protection (Wood et al., 2018), and a sense of belonging (Mousa and Chaouali, 2023). Overall, workers seem to have specific benefits from participation in online communities, and platforms that host proprietary communities have been said to positively impact crowdworkers' motivation (Jabagi et al., 2019). For instance, participation in these communities reduces turnover intention in online markets (Ma et al., 2018) and enhances group identification among platform workers (Hondros et al., 2023; Ihl et al., 2020). Discussing crowdwork skills in online communities also increases workers' earnings (Di Gangi et al., 2023; Ma et al., 2020). However, actively providing knowledge to these communities seems, surprisingly, negatively associated with crowdworkers' intention to continue their jobs on platforms (Ma et al., 2020).

While some research has focused on the informal and unstructured support that online communities provide to crowdworkers, others underscore that crowdworkers are also likely to establish long-term working collaborations with peers (Bellesia et al., 2019; Elbanna and Idowu, 2021, 2022; Idowu and Elbanna, 2019, 2021, 2022). Platforms such as Upwork allow groups of workers to form 'agencies' that offer clients more skills and support larger projects (also called macro-tasks; Elbanna and Idowu, 2022). Recently, Upwork has created an 'Enterprise' section where clients or crowdworkers can seek support to assemble on-demand teams. Through the implementation of these features, platforms enable the creation of 'flash teams' or 'flash organizations' (Retelny et al., 2014; Valentine et al., 2017). These are quickly assembled teams of expert crowdworkers who deliver complex jobs and are dismantled once the task is completed. These systems draw from labour modularization so that the job is seen as a sequence of linked tasks that can be delivered by different experts (Retelny et al., 2014). Due to modularization, these teams are scalable and can automatically adjust their size via ad hoc algorithms that are responsible for filtering and matching. By building ad hoc solutions and sections on their websites, platforms can assist crowdworkers in connecting with peers and competing for complex jobs that require groups of workers to be performed.

Relationships with Clients. If research on relationships between crowdworkers in teams and communities is gaining scholarly attention, an underexamined topic is represented by crowdworkers' social relations with clients. While crowdwork platforms provide the

algorithmic infrastructure to match demand and supply, it is the client's responsibility to define tasks' content. Clients play an active role in negotiating activities, task execution, and feedback release. As such, clients represent social touchpoints for crowdworkers and impact how work is designed.

When discussing relationships mediated by technology, the issue of trust is of primary consideration. As work is performed at a distance, clients must trust crowdworkers' reliability and competence in delivering the job. At the same time, crowdworkers need to trust clients' capability to pay for the work and hold fair expectations (Alacovska et al., 2024). By being responsible for matching clients with crowdworkers, platforms are also in charge of building systems that engender trust, as it happens with escrow systems (Jarrahi et al., 2020) and the feedback that clients receive (Bellesia et al., 2023; Gandini et al., 2016). As such, platforms' features, including the availability of matching algorithms, can enhance trust between parties at the beginning of working relationships and enable social relations between clients and workers.

Feedback. Feedback and reputation systems are likely the most extensively studied topics in the crowdwork literature (Bellesia, 2023; Bucher et al., 2021; Gandini et al., 2016; Herrmann et al., 2023; Lehdonvirta et al., 2019; Lin et al., 2018; Pongratz, 2018; Rahman, 2021). Online labour platforms connect clients with a global pool of workers (Howe, 2006; Lehdonvirta, 2018). Geographical distance, communication through technology, or cultural differences make it difficult for workers to signal their quality and for employers to properly sort out the desired skills. To attenuate these difficulties, online labour platforms usually 'organize' or 'categorize' their workforce through algorithmic scores based on past performance. Scores help workers signal reliability and capabilities, enabling clients to trust prospective collaborators. Some platforms even use badging systems to reward workers for their achievements and good performance (Jabagi et al., 2019).

Accordingly, crowdworkers owning higher ratings enjoy a better reputation and win more jobs (Lukac and Grow, 2021). Similarly, other evidence shows that workers without scores are less likely to win contracts than those with higher ratings (Bellesia et al., 2023; Bucher et al., 2021; Gandini et al., 2016; Lin et al., 2018). It has also been shown that good feedback matters more than educational background in obtaining new jobs (Herrmann et al., 2023) and that higher scores are positively associated with higher income (Gandini et al., 2016; Herrmann et al., 2023; Lehdonvirta et al., 2019).

Although platform feedback systems appear to provide workers with clear and explicit feedback on their performance, research suggests that feedback in this setting is often viewed as a tool for exerting control and does not typically improve individuals' comprehension of their efforts. For instance, workers in online labour markets lack information about the reasons behind rejection or failure, behind other online workers' success, and behind client expectations and algorithmic ranking calculations, making their experience precarious and frustrating (Blaising et al., 2018). Formal client scores and feedback may not fully capture performed work and workers' quality (Irani, 2015; Pongratz, 2018). Additionally, researchers are investigating whether gender and race are significantly correlated with workers' evaluations, potentially hindering employment opportunities, especially for women and people of colour, with mixed results (Foong et al., 2018; Gerber, 2022; Thebault-Spieker et al., 2017).

Algorithmic Embeddedness as a Work Design Characteristic

So far, our studies' systematization has offered insights on work characteristics in crowdwork and on how objective platform features influence such work characteristics. In turn, other studies delve deeper into the socio-material interplay between crowdworkers' jobs and algorithms. In this section, we first organize insights from these studies along four main algorithms described below: matching, control, rating, and teaming. We then propose and define a new work characteristic, *algorithmic embeddedness*, which we argue is a novel and distinctive feature of crowdwork. We conclude the section by illustrating how algorithmic embeddedness is intertwined with the other job characteristics.

The socio-material interplay between jobs and algorithms in crowdwork. Matching Algorithms. In a previous section, we explained how, when they subscribe to platforms, crowdworkers are asked to select keywords used by matching algorithms (Bellesia et al., 2019) to suggest new jobs to crowdworkers or crowdworkers' profiles to clients (Alasoini et al., 2023). Interestingly, crowdworkers are often described as playing with and manipulating these keywords until matching algorithms ultimately suggest specific job categories aligned with their interests and aspirations (Cameron and Rahman, 2022; Kellogg et al., 2020). Some research further highlights that clients also play with matching algorithms to refine their search for specific skills while navigating the platform's workforce (Blyth et al., 2024). Hence, we can claim that keywords and matching algorithms can be purposefully manipulated to access specific jobs and craft crowdworkers' unique job experiences on the platform. Other studies further support this positive effect. Manipulating matching algorithms was found to be helpful in diversifying crowdworkers' experience, switching between tasks with different contents and lengths (Lascau et al., 2019), and fostering learning and diversification, ultimately increasing job satisfaction and meaningfulness (Van Zoonen et al., 2024).

However, some scholars have also hinted at the potential drawbacks of relying on matching algorithms. For example, Bucher et al. (2021) report that on platforms such as Upwork, matching algorithms are machine learning and deep algorithms that dynamically adapt to market conditions in real time. Consequently, in the event of market saturation of specific skills, crowdworkers may be encouraged to take jobs requiring different skills and may opt against following suggestions from matching algorithms. Alternatively, they may be forced to 'reinvent themselves' to continue working online. Both these strategies require additional time and effort, likely reducing well-being or job satisfaction. Therefore, rather than an opportunity, working with matching algorithms may also represent a necessity for 'crowdworkers'. On the one hand, matching algorithms can act as resources that make some jobs – that would otherwise remain hidden – accessible to workers. On the other hand, they might also intentionally obscure certain opportunities and thus represent a constraint.

Control Algorithms. A recent study shows that Upwork relies on control algorithms to inspect worker-client communications and prompt warning messages when words like 'Skype', 'phone', 'email', 'Dropbox', or 'Google Drive' are used (Jarrahi et al., 2020). These are examples of restricting algorithms, that is, algorithms driving workers'

behaviours towards platforms' expectations (Kellogg et al., 2020). These algorithms discourage crowdworkers from taking clients off the platform. As an additional example, Upwork algorithms hide crowdworkers' profiles from clients if they are inactive for more than 30 days (Jarrahi et al., 2020), forcing them to execute additional jobs or negotiations with clients. These are examples of jobs undertaken to 'appease' control algorithms, which likely would not have been executed without such subtle algorithmic intervention.

Furthermore, control algorithms make workers accountable for their actions, even when they are not directly responsible for behaviours that are punished by the platform. It has been shown that unfair punishments result in decreased work meaningfulness (Van Zoonen et al., 2024). For instance, algorithms penalize crowdworkers' scores if they hold inactive contracts in their portfolios, even when clients require them to keep these contracts open or are responsible for interrupted communications (Bucher et al., 2021). Some jobs are then carried out to respond to and to mitigate the potential adverse effects of control algorithms.

Rating Algorithms. Along with control algorithms, rating algorithms do not protect crowdworkers from unfair client behaviours (Benson et al., 2020), such as asking them to move contracts off the platform or offering good reviews in exchange for more work (Bellesia et al., 2019; Bucher et al., 2021). Indeed, clients have been described as negotiating good feedback in exchange for unpaid work or constantly adjusting their requests while refusing additional compensation (Bellesia et al., 2019; Bucher et al., 2021; Rahman and Valentine, 2021; Schörpf et al., 2017). For these reasons, it is a widespread belief that algorithmic scores and rating algorithms create unbalanced power structures (Gandini, 2019; Gandini et al., 2016; Veen et al., 2020) and information asymmetries (Blaising et al., 2018). Algorithms' opacity emerges as a primary source of disempowerment (Rani and Furrer, 2021; Schörpf et al., 2017) and frustration (Rahman, 2021; Strunk et al., 2022).

Nonetheless, recent evidence shows that crowdworkers develop anticipatory direct or indirect strategies to control and mitigate the negative effects of rating algorithms (Bucher et al., 2021; Jarrahi and Sutherland, 2019). For instance, they initiate private conversations with clients (Alacovska et al., 2024; Bucher et al., 2021), or they engage in over-delivering and under-billing practices (Bucher et al., 2021). Similarly, Rahman's (2021) study proposes that rating algorithms make workers experience an 'invisible cage', a type of control in which 'the criteria for success and changes to those criteria are unpredictable' (Rahman, 2021, p. 3), and to which individuals react in different ways. Some workers experiment with different tactics to improve or maintain their scores on the platform, as by taking smaller, easier jobs to increase their ratings after an evaluation seatback or to quickly gain a good score at the beginning of their platform career (Bellesia et al., 2023; Blyth et al., 2024; Bucher et al., 2021; Rahman, 2021). Consequently, these jobs become part of the portfolio of a crowdworker to mitigate rating algorithms, and the decision to undertake them is highly dependent on the outcomes of rating algorithms' calculations. Conversely, other workers preserve their high scores by limiting their engagement with the platform and moving the work with some clients offline.

There is also evidence that crowdworkers focus on their work rather than taking actions to buffer the potential adverse effects of algorithms (Bellesia et al., 2023). In this case, jobs appear minimally embedded in algorithmic logics. However, this strategy ultimately

results in frustration and negative emotions when unexpected events such as an evaluation setback occur. The study by Bellesia et al. (2023) further argues that the way crowdworkers respond to algorithmic scores is driven by whether they see algorithms as barriers or as providing the affordances of self-extension or individual visibility. This and other evidence (e.g., Blyth et al., 2024; Bucher et al., 2021) suggests that rating algorithms can nevertheless be circumvented, manipulated, or even used to crowdworkers' personal advantage. In this case, however, additional time and effort are required to eventually negotiate conditions with clients or showcase the quality of delivered work during subsequent jobs' execution.

In sum, although reputation systems are designed to foster trust between clients and crowdworkers, current research suggests that they often lead to unfavourable results for either party. Crowdworkers are forced to employ tactics to resist negative consequences (Bucher et al., 2021; Rahman, 2021) or to ascribe their algorithmic scores with meaning to handle their situation better (Bellesia et al., 2023). Meanwhile, the overall system is prone to inflation (Horton et al., 2015; Rahman and Valentine, 2021).

Teaming Algorithms. Some studies from the information systems literature present various algorithms designed to assemble diverse competencies and form teams to perform complex jobs. We refer here to these algorithms as 'teaming' algorithms. The literature shows that teaming algorithms use either a top-down or bottom-up approach. Top-down approaches usually collect information on crowdworkers from their profiles before the task begins, and then algorithms select workers according to specific criteria, such as optimizing profitability, computational efficiency, pricing, and affinity mechanisms (Liu et al., 2015; Rahman et al., 2019), as well as skills diversification and adaptability (Retelny et al., 2014; Valentine et al., 2017). In this case, team composition for delivering a specific job is entirely driven by algorithmic mechanisms.

More recent studies are adopting a bottom-up approach and are testing how to include crowdworkers' preferences in team formation and in building algorithmic structures that adjust to real-time collaboration and group dynamics during task execution. These algorithms should assist crowdworkers' self-organization (Lykourentzou et al., 2021) and take the role of co-workers, for example project managers, facilitators, and team designers. Other scholars are testing how to integrate peers' evaluations during team formation – i.e., 'team dating' (Lykourentzou et al., 2016). As such, different algorithms might allow crowdworkers (or clients) to assemble the most performative team of collaborators, thus facilitating job execution. Here, algorithms are configured as assistants during task execution and hence the work process highly relies on algorithmic functioning, an approach which can potentially lead to positive productivity and job satisfaction outcomes.

Towards a definition of algorithmic embeddedness. The insights presented in the previous section suggest a close interplay between algorithmic mechanisms, job design, and crowdworkers' behaviours. Specifically, they underscore that crowdworkers' jobs are regulated by algorithms to the extent that such jobs rely on or are dependent on algorithms. To capture the embeddedness of algorithms into the way jobs are designed, we propose adding a new work characteristic to existing job design models.

We define *algorithmic embeddedness* as the extent to which a crowdworker perceives that a job exists thanks to the action of algorithms or requires compliance with algorithmic rules

to be accomplished. According to a socio-material perspective, this definition reflects two aspects of the jobs delivered on crowdwork platforms. The first aspect concerns the dependence on algorithms, so that specific jobs exist and can be pursued because of the way algorithms work. For instance, when a crowdworker applies for a job suggested by matching algorithms, it can be said that the job is available because matching algorithms brought it to their attention. In other words, without matching algorithms, that job would not have been visible. The second aspect refers to crowdworkers' opportunity to work around algorithms, deliberately take advantage of the technology, or actively manipulate opaque algorithms. For instance, when additional jobs are undertaken to increase algorithmic scores in response to evaluation setbacks, i.e., a low score in a previous job, crowdworkers are trying to work around algorithms. Without the score decrease imposed by rating algorithms, those additional jobs might have been avoided.

Algorithmic embeddedness is a matter of degree. Table I provides examples of high and low algorithmic embeddedness from existing studies. For instance, at high levels of algorithmic embeddedness, the existence and execution of a job is highly dependent on algorithms. High algorithmic embeddedness can be perceived as either an affordance or a constraint. It is an affordance when algorithms represent an opportunity for securing

Table I. Examples of high and low algorithmic embeddedness

Type of algorithmic embeddedness	*Examples of algorithmic affordances and constraints*
High algorithmic embeddedness	Algorithms as affordances • In taking a job, ratings and algorithmic scores are used to showcase the quality of previously delivered jobs (e.g., Blyth et al., 2024; Gandini, 2016) • A job is taken following suggestions from matching algorithms (i.e., in terms of length, content, or required skills) (e.g., Cameron and Rahman, 2022) • A job is delivered adjusting the composition of team members and competences through teaming algorithms (e.g., Lykourentzou et al., 2016, 2021) Algorithms as constraints • A small, easy job is delivered to keep the profile active and respond to control algorithms (e.g., Jarrahi et al., 2020) • A job is taken to respond to a negative evaluation setback (e.g., Bucher et al., 2021; Rahman, 2021) • A job's hourly price is lowered to obtain a good evaluation (e.g., Bucher et al., 2021; Jarrahi and Sutherland, 2019) • The team member composition of a job is immutable and top-down-determined (e.g., Liu et al., 2015; Valentine et al., 2017)
Low algorithmic embeddedness	Algorithms as neither affordances nor constraints • A job is delivered upon direct request from a long-term client (Bellesia et al., 2023; Idowu and Elbanna, 2022) • An offline team is created to land a job on the platform (e.g., Bellesia et al., 2019; Idowu and Elbanna, 2022) • A job is taken offline and the platform is used just to secure the contract (e.g., Cropanzano et al., 2023; Jarrahi et al., 2020; Kuhn and Maleki, 2017) • Rating on a job is not negotiated at the beginning of job execution (e.g., Bellesia et al., 2023; Cameron and Rahman, 2022)

better jobs or are purposefully used or circumvented by crowdworkers to their advantage. Conversely, it is a constraint when working around algorithms to obtain or execute a job becomes a stressful and demeaning experience. In the examples above related to taking a job to react to an evaluation setback, the job exists because of the need to buffer the effect of rating algorithms.

Algorithmic embeddedness can be low, too, making algorithms neither an affordance nor a constraint for a worker. When crowdworkers are able to establish long-term relationships with clients, they can rely on a stable work flow coming from that stable client base (Bellesia et al., 2019; Idowu and Elbanna, 2022). In this case, they do not need, for instance, matching algorithms to find new jobs.

Considering all of the above, algorithmic embeddedness emerges as an essential element of job design on crowdwork platforms, deserving recognition as a new work characteristic. Without acknowledging algorithmic embeddedness as a job characteristic, we would fail to distinguish the unique features of jobs on these platforms, as traditional job characteristics (i.e., task characteristics, autonomy, flexibility, and relations) do not explicitly encompass the idea of the subjective algorithmic influence on work.

Our literature analysis further allows us to provide examples of interplays between algorithmic embeddedness and the other work characteristics (Parker et al., 2001), so that each characteristic is impacted by or can impact the level of algorithmic embeddedness, as described below.

Algorithmic embeddedness and the other work characteristics. *Algorithmic embeddedness and Task Characteristics.* We have already discussed how matching algorithms and keywords are purposefully used to access specific jobs. Accordingly, those jobs are characterized by a high level of algorithmic embeddedness, and matching algorithms are used to access tasks with high task significance or identity. Crowdworkers may oscillate between 'gigs' and knowledge-intensive tasks on a need basis, and they may also perform tasks with a low task identity on purpose. Similarly, matching algorithms could be purposefully manipulated to win jobs requiring different sets of skills (Van Zoonen et al., 2024), thus increasing skill variety. However, if specific skills reach market saturation, crowdworkers may feel compelled to take jobs requiring alternative skill sets (Möhlmann et al., 2021). Consequently, jobs may become highly algorithmically embedded, with skill diversification emerging not as a deliberate choice but as a response to an algorithmic constraint.

In sum, job characteristics such as task identity, significance, and skill variety can drive meaningfulness and motivation on online labour platforms, as in traditional organizational contexts (Hackman and Oldham, 1975). However, in crowdwork, such characteristics are often related to the algorithmic embeddedness of the job.

Algorithmic embeddedness and Autonomy. It is a common belief that algorithms potentially exert a new form of supervision, overcoming spatial and temporal barriers of traditional organizational workplaces (Gandini et al., 2016; Wood et al., 2019). For instance, when proposing hourly contracts on Upwork, clients can opt for monitoring crowdworkers' work through control algorithms, which are responsible for taking screenshots of crowdworkers' activities (Bucher et al., 2021; Kellogg et al., 2020). If this is the case, control algorithms limit crowdworkers' autonomy in scheduling their work, as they force them to adhere to negotiated working hours. Moreover, such jobs show high levels of algorithmic

embeddedness. Without control algorithms, these jobs could not have been delivered, as some clients might have hesitated to engage workers without the ability to monitor their progress. Not surprisingly, crowdworkers have been mainly described as resistant to the imposition of control algorithms (Kellogg et al., 2020; Van Zoonen et al., 2024). Therefore, high levels of algorithmic embeddedness might be perceived as a constraint and associated with low levels of autonomy.

Algorithms also produce real-time metrics to monitor workers and detect compliance with a platform's rules and design. For instance, platforms such as Freelancer.com display the variables 'On budget' and 'On time' to inform clients about crowdworkers' performance and concurrently nudge workers to respect deadlines while discouraging budget renegotiations. Similarly, on Upwork, metrics such as '100% complete worker profile' are computed to encourage workers to adhere to the platform's standards (Kellogg et al., 2020; Rahman, 2021). These metrics may not limit crowdworkers' autonomy in *how* to carry out their jobs (Hackman and Oldham, 1975). However, if some jobs are taken to please or ameliorate those metrics, crowdworkers might feel constrained in *when* to perform such jobs, and thus might still perceive such jobs as highly algorithmically embedded.

Algorithmic embeddedness and Relationships. A job that is perceived to require teaming algorithms to collect a diversified set of skills (i.e., crowdworkers with different competences) is highly algorithmically embedded. Teaming algorithms might be an opportunity for crowdworkers to get in touch with peers and potentially build long-standing working relations. This is especially true when teams are formed through bottom-up approaches, which create flexible and creative team structures that can later adapt to the actual tasks to be performed (Retelny et al., 2017). Conversely, evidence on teams created with a top-down approach indicates that such teams exhibit lower levels of intra-group collaboration and compatibility and adapt poorly to team members' collaboration preferences (Vinella et al., 2022). Creating a supporting network of collaborators and long-standing relations with peers might be more challenging in teams created by algorithms with a top-down approach, suggesting that high algorithmic embeddedness is, in this case, a constraint.

In terms of relations with clients, current research provides mixed evidence on whether relations with clients serve as demands or resources. Some research argues that clients reinforce the exploitative nature of crowdwork, describing crowdworkers' negative experience with clients (e.g., Ashford et al., 2018; Irani, 2015). For instance, clients have been found to negotiate good feedback in exchange for unpaid work, or to constantly adjust their requests while refusing additional compensation (Bellesia et al., 2019; Bucher et al., 2021; Rahman and Valentine, 2021; Schörpf et al., 2017).

However, some studies seem to suggest that freelancers can leverage their relations with clients to mitigate the effects of algorithms over their work (Alacovska et al., 2024; Bucher et al., 2021), e.g., by initiating private conversations with clients before being hired, or by nurturing relationships with clients during work execution (Bellesia et al., 2023). In this regard, Rahman and Valentine differentiate between clients who use the platform features to exert control over crowdworkers (e.g., giving low scores whenever a problem surfaces) and clients who engage in 'collaborative repair', i.e., have repeated interactions with workers intended to build mutual understanding and trust (Rahman and Valentine, 2021). Moreover, clients feed rating algorithms and influence algorithmic scores as they write reviews at the end of contracts. Clients can actively help crowdworkers

deal with platforms' technological rules, for example by changing the length of contracts to help signal that crowdworkers are active players on the platform. In other words, clients might be 'allies' in reducing highly constraining levels of algorithmic embeddedness associated with some jobs, ultimately influencing crowdworkers' well-being.

Algorithmic embeddedness and Feedback. When crowdworkers try to increase the probability of positive feedback, or to avoid negative feedback altogether, for example, by taking advantage of their positive relations with clients (Alacovska et al., 2024; Bucher et al., 2021; Hong et al., 2018), they are often able to negotiate favourable employment conditions and therefore mitigate the potential adverse effects of high levels of algorithmic embeddedness. Cameron and Rahman (2022) suggest that if feedback is negotiated in advance when crowdworkers hold the highest negotiating power, the effect of algorithms on the job is reduced. As such, algorithmic embeddedness will likely shift from high to low. However, when clients use feedback as a threat or to negotiate discounts and lower payments (Bellesia et al., 2023; Rahman and Valentine, 2021), high algorithmic embeddedness is a constraint for crowdworkers.

DISCUSSION

In this article, we explored the interplay between technology and work design in the context of online task crowdwork. We answered the call of work design scholars to thoroughly understand how technology shapes work in various contexts (Erez, 2010; Grant and Parker, 2009; Hackman and Oldham, 1975; Oldham and Hackman, 2010; Parker and Grote, 2022).

In particular, our systematic review shows that, in crowdwork platforms, the effect of technology on work characteristics is complex and multifaceted. We reveal that platforms play the role of technological *contexts*, i.e., a set of given features and rules that represent a new working environment. In this sense, the role played by platforms such as Upwork, Freelancer.com, or Fiverr is consistent with what has been previously acknowledged by work design theories, that is, technology as an antecedent of work characteristics (Parker and Grote, 2022; Parker et al., 2001; Wang et al., 2020). In addition, we find that platforms' algorithms are more subjectively embedded in the work process than 'objective' platform features. To capture this aspect, we build on a socio-material perspective of technology and argue that jobs in a crowdwork context are so dependent on algorithms that their very existence and execution can become inherently intertwined with both algorithms and the strategies crowdworkers employ to navigate them. Specifically, we identify *algorithmic embeddedness* as a new work characteristic and define it as the degree to which a crowdworker perceives a job as dependent on algorithms for its existence or as requiring responsiveness to algorithmic rules for successful completion. Our gig characteristics model theorizes a closer relationship between technology and work execution and extends previous work design models by introducing a new work characteristic required to interpret and design contemporary jobs relying on algorithms. As such, our model and the concept of algorithmic embeddedness could be applied not only to crowdwork jobs but also to jobs undertaken in traditional workplaces that make an intense use of algorithms to manage people's processes.

In distinguishing the different forms of *algorithmic embeddedness*, we employ the terms 'constraints' and 'affordances' to align our theoretical framework with the sociomaterial perspective on technology, which suggests that individuals perceive technologies beyond their objective features. This enables us to make two additional significant contributions to work design theories. Firstly, we assert that algorithmic embeddedness is a job characteristic contingent upon the perspective of crowdworkers. Even when operating on the same platform and undertaking similar tasks, individuals may interpret the algorithmic embeddedness of a job differently. Secondly, constraints and affordances represent distinct demands and resources for crowdworkers. Recent studies on job design have urged researchers to include job demands and resources alongside the traditionally 'studied' job characteristics (such as task characteristics, autonomy, feedback, and relationships) (Bakker and Demerouti, 2007; Parker and Grote, 2022). By conceptualizing algorithmic embeddedness as constraints and affordances, we delineate a unique set of demands and resources encountered by crowdworkers in their work. We further show how these demands and resources are intertwined with the other job characteristics.

As far as the literature on crowdwork and algorithms is concerned, our review follows recent scholarly recommendations to recognize, reflect on, and discuss the diversity of platforms' workers (e.g., in-person workers on Uber or Instacart versus online workers on Upwork or Fiverr) while considering the rules of the specific platforms these workers use (Ashford et al., 2018; Cropanzano et al., 2023). This article answers these calls by focusing on 'online task crowdwork' (Durward et al., 2016; Howcroft and Bergvall-Kåreborn, 2019; Idowu and Elbanna, 2021), i.e., on freelancers with a variety of skills, who provide their services to clients through an online platform, without any face-to-face contact. However, we argue that our model could be applied to understanding other contemporary jobs highly reliant on algorithms, such as those provided by other platforms like Uber, Deliveroo, or Foodora. For instance, we speculate that, on such gig work platforms, riders, drivers, and workers' jobs are likely to be more algorithmically embedded, as algorithms tend to be here more prescriptive than on crowdwork platforms (Cameron and Rahman, 2022; Möhlmann et al., 2021). As our model in Figure 1 shows, as a work characteristic, algorithmic embeddedness is influenced by platform features. Consequently, different platform features might differently affect the degree of algorithmic embeddedness experienced by workers. We better articulate these considerations through a set of research questions in our future research agenda below.

These reflections further resonate with recent contributions to the emergent platform literature, which are increasingly focused on opening the algorithmic black box and have therefore begun categorizing different types of algorithms according to their functioning (Cameron and Rahman, 2022; Kellogg et al., 2020; Liu et al., 2022; Möhlmann et al., 2021). Our review identifies and describes the constraining and affording dimensions of four algorithms, i.e., matching, control, rating, and teaming. Nevertheless, considering the ongoing updates to existing algorithms and the emergence of new ones, we argue that further research is needed to deepen our understanding of algorithmic embeddedness. Moreover, new dimensions could emerge with technological advancements, especially within the realm of artificial intelligence.

We defined algorithmic embeddedness as the characteristic of a single job. However, especially in microwork, workers take multiple jobs simultaneously, most of which are described as small, short, and easy to be delivered (Ashford et al., 2018; Boudreau and Lakhani, 2013; Kost et al., 2018). Our findings suggest that, beyond interpreting online work as an *emergent pool* of small, short, and easily delivered tasks, we may start to think about it as a *designed collection* of diverse jobs that can be purposefully picked and matched by crowdworkers to enhance their skills, enlarge their portfolios, or game algorithms on a need basis. Accordingly, as a whole, crowdworkers' work should be interpreted as a combination and recombination of single jobs that may differ in terms of work characteristics – e.g., level of autonomy, skill variety, task significance, relationships, and algorithmic embeddedness. We visually represent this idea in Figure 2.

In the next sections we provide additional reflections and avenues for future research in relation to the different parts of the gig characteristics model.

FUTURE RESEARCH AGENDA

Platforms' Features and the Gig Characteristics

Given the short and precarious nature of jobs in the gig economy, it has been debated whether new (portable) skills can be developed on platforms or whether platforms themselves can support new skills development (see Kost et al., 2019; Margaryan, 2019; Sutherland et al., 2019). However, our knowledge of the mechanisms for learning new skills and enlarging crowdworkers' skill sets is still limited. Moreover, most skill debates focus on soft skills rather than hard skills. While workers need negotiating and marketing skills, as well as resilience, how platforms promote (hard) skills development or if workers need to develop new skills in response to negative experiences with clients and algorithms are still open questions. The extent to which crowdworkers seek support from their peers, and whether this support facilitates skills development, is also a critical research question (RQ) to consider.

> *RQ1:* How do platforms support new skills development and learning in the gig economy?

We discussed how some platform features can be antecedents to crowdworkers' autonomy in choosing clients and jobs – e.g., platforms providing information on prospective clients, such as payment reliability and reviews left by other crowdworkers. However, we also discussed how platforms can negatively influence workers' sense of autonomy, particularly when a single platform represents a worker's primary source of income. We propose that new insights are needed to understand which elements can be more easily controlled by workers – e.g., task allocation, working hours, and scheduling. To date, it is still largely unclear whether platforms mainly influence autonomy related to decision-making power or autonomy over when or where to perform the work (Parker and Grote, 2022). Current insights predominately emphasize autonomy in decision-making power, often taking for granted the importance of space flexibility inherent in remote work arrangements (Dunn et al., 2023). However, it has been argued that crowdworkers

are likely to work unsocial hours (Wood et al., 2019), especially if they come from developing countries (Anwar and Graham, 2021). We therefore encourage future studies to unpack the concept of autonomy and delve deeper into understanding how platforms influence the different dimensions of autonomy:

> *RQ2:* How do platforms influence the different dimensions of crowdworkers' autonomy – i.e., autonomy in decision-making, in scheduling their work, and in where to perform their work?

In terms of relationships, we highlighted that crowdworkers can find peer support in online communities (Hondros et al., 2023; Kinder et al., 2019; Ma et al., 2018, 2020) or can build teams of experts to deliver more complex jobs (e.g., Retelny et al., 2014; Valentine et al., 2017). Unfortunately, the available evidence is rather controversial on these points. First, more clarity is needed to understand what happens in online communities and when and how crowdworkers ask for peers' support. More investigation is also needed to uncover what kind of knowledge is exchanged and which work outcomes are influenced by interactions with peers, as theorized by work design theories. We thus propose the following questions:

> *RQ3:* Which types of support do workers ask for in online social groups, and under what circumstances?
>
> *RQ4:* To what extent does knowledge shared in online communities impact work outcomes, and under what circumstances?

Second, regarding team formation, extant research has mainly focused on developing the technological solutions to create and disassemble teams rapidly (e.g., Lykourentzou et al., 2016; Retelny et al., 2014; Valentine et al., 2017; Vinella et al., 2022). How collaboration unfolds between team members, or whether these relations stabilize over time and influence work outcomes, is still largely unknown. For instance, as platforms such as Upwork propose the 'agency' option to help crowdworkers work as a team, how these teams emerge is unclear. Are these single crowdworkers' initiatives where peers are hired to deliver complex jobs? Are these co-located teams who find jobs online? Are there differences in clients' preferences or crowdworkers' outcomes, such as performance or well-being? Exploring team dynamics in crowdwork is a promising avenue for future research. We suggest the following research questions as starting points:

> *RQ5:* How does team collaboration emerge and unfold over time on crowdwork platforms?
>
> *RQ6:* How much are 'flash' teams likely to stabilize over time, and how does this influence work outcomes?

We extensively discussed the necessity for crowdworkers to establish client relationships (Alacovska et al., 2024; Blyth et al., 2022; Rahman and Valentine, 2021). Some

recent research on how client-crowdworker relations unfold during work execution explores if, and how, workers hired on platforms are integrated into clients' traditional organizational activities, or whether they are hired to deliver specific activities in isolation (e.g., Gol, 2021). Other studies have started to include clients' perceptions of the rating and working systems (Blyth et al., 2022; Rahman, 2021). However, current research has not systematically examined the perspective of clients, and we do not know much about how they search for crowdworkers on platforms, how much they rely on ratings to select potential workers, and to what extent tasks are the result of concurrent clients' and workers' design. As such, we build on some human resource management works calling for more research on the clients' side of crowdwork (e.g., Keegan and Meijerink, 2023; Meijerink and Bondarouk, 2023) and propose the following as future research questions:

> *RQ7:* How do clients use platforms for searching and selecting crowdworkers?
>
> *RQ8:* How do clients manage relations with crowdworkers?

Studies on algorithmic ratings have mainly focused on the 'quantitative' aspects of the feedback system, neglecting other more relational, qualitative elements that can help workers to obtain better information on their performance and enhance their knowledge of results. For instance, workers can leverage their relations with clients to avoid clients feeding rating algorithms with negative evaluations (e.g., Bucher et al., 2021). Furthermore, current studies have neglected the qualitative content of the feedback left on crowdworkers' jobs. To advance our knowledge on feedback-related mechanisms in crowdwork design, then, we believe future studies should disentangle the effects of the different components of the feedback system. We thus propose the following question:

> *RQ9:* How does qualitative feedback left by clients enhance crowdworkers' motivation/knowledge of results?

Algorithmic Embeddedness, Collections of Jobs, and the Interplay with Different Algorithms

As crowdworkers' work is a collection of different jobs that change over time, work characteristics are not stable, but rather follow the dynamic recombination of such diverse jobs (see Figure 2). However, how crowdworkers build their job portfolio over time is still an open question. Portfolios can be diversified in response to platform-driven changes (e.g., specific skills requests in a specific timeframe; Bucher et al., 2021) or as a result of a planned career-changing strategy (Bellesia et al., 2019). Diverse jobs can also be taken to experience meaningfulness (Van Zoonen et al., 2024; Wong et al., 2020), to follow suggestions of matching algorithms (Möhlmann et al., 2021), or work around negative evaluations affecting algorithmic scores (e.g., Bellesia et al., 2023; Bucher et al., 2021; Rahman, 2021), with different degrees of algorithmic embeddedness. We thus propose the following questions to guide future research:

RQ10: How are jobs with different characteristics combined?

RQ11: How do such different combinations influence outcomes such as job satisfaction or well-being?

A further issue that future research should clarify is the role of the different categories of algorithms in influencing algorithmic embeddedness (Cameron and Rahman, 2022; Jarrahi et al., 2020; Kellogg et al., 2020; Möhlmann et al., 2021). Most studies have discussed so far the implications of rating algorithms and how crowdworkers resist (or purposefully leverage) algorithmic evaluations (e.g., Bellesia et al., 2023; Bucher et al., 2021; Rahman, 2021). Our findings additionally reveal that crowdworkers play with the keywords feeding matching algorithms (e.g., Bellesia et al., 2019; Bucher et al., 2021); use teaming algorithms to perform complex jobs (Lykourentzou et al., 2021; Retelny et al., 2017; Vinella et al., 2022); and feel constrained by control algorithms .

As different algorithms act differently in the work process, important questions are how these actions compare and combine with each other, and ultimately influence algorithmic embeddedness. For instance, is a job taken following matching algorithms' suggestions more algorithmically embedded than one taken to buffer an evaluation setback? Should control algorithms be viewed only as constraints, or could they potentially serve as tools to effectively showcase crowdworkers' timely and high-quality task delivery, especially when coupled with good ratings? Answering these types of questions is likely to reveal additional dimensions of algorithmic embeddedness and may therefore be useful to further refine the concept. More generally, we propose the following avenues for future research:

RQ12: How do different algorithms (e.g., matching, rating, control, and teaming algorithms) interplay with algorithmic embeddedness?

RQ13: Do different dimensions of algorithmic embeddedness emerge when combining the effects of different algorithms?

As multiple crowdwork platforms exist and each has its own algorithmic rules and metrics (see the examples of Freelancer.com and Upwork in the findings section), more empirical evidence is needed to explore if algorithmic embeddedness differs from platform to platform. Current studies have mainly used Amazon Mechanical Turk or Upwork as empirical settings, but we encourage future work to look at different platforms to better understand if and how different platform features have different implications for crowdworkers and algorithmic embeddedness.

RQ14: How do the different platform features affect algorithmic embeddedness?

As a concluding remark, our review provides some hints at potential interplays between algorithmic embeddedness and the other work characteristics. Given that research on algorithms and their affordances is still in its early stages, we believe that future studies will be able to provide additional insights and details into such interplays. We provide examples of potential questions that might help to address such issues.

RQ15: How do clients use algorithms for searching and selecting crowdworkers, and therefore influence algorithmic embeddedness?

RQ16: What is the role of algorithms in team formation, and how is this related to algorithmic embeddedness?

Moderating Variables: Individual Characteristics

In the JCM, moderating variables, such as individual growth need, play an important role in explaining the relations between work characteristics, psychological states, and outcomes. Unfortunately, the exploration of crowdworkers' personal characteristics has so far received very limited attention. The investigation of individuals' platform dependence is an exception to this tendency (e.g., Kuhn and Maleki, 2017; Rahman, 2021). When work on platforms is the workers' main source of income, crowdworkers have been described as most likely to be dependent on platforms (Kuhn and Maleki, 2017). Platform dependence has also been identified as a key mechanism for understanding crowdworkers' reactions to evaluation setbacks and rating algorithms (Rahman, 2021). When job availability on platforms is low and workers show high levels of dependence, they end up being constantly 'on call' and allocate a considerable portion of their time to job applications and interviews, thereby losing control of their working time (Lehdonvirta, 2018). However, additional evidence is showing that work on platforms might be a way for workers to supplement their income rather than serving as the primary source of income (Huws et al., 2018; Ravenelle et al., 2021), suggesting that platform dependence can also be low.

Additionally, it has been argued that, through identity work, crowdworkers can mitigate the effect of algorithms (Bucher et al., 2024; Van Zoonen et al., 2024), and that whether crowdworkers see working on platforms as a long-lasting career or as a temporary job shapes their experience (Keith et al., 2019). Consistently, recent attempts to build workers' typologies suggest that workers' experience can be diverse, depending on their motivation to join online platforms and their career expectations (see Dunn, 2020; Ens et al., 2018).

We argue that variables such as age, gender (Herrmann et al., 2023; James, 2024), profession, nationality (Idowu and Elbanna, 2021; Kanat et al., 2018), or motivations to engage in digital work (Dunn, 2020) may play a significant role in understanding the way individuals approach online jobs and therefore their outcomes (Idowu and Elbanna, 2019). Furthermore, previous offline experiences (or the absence of this kind of experience) can influence individual behaviours and outcomes. Workers who hold an offline, traditional job need to harmonize what happens in the two realms (Caza et al., 2017), and thus their perceptions of technology and lived experiences may differ from those of full-time online crowdworkers.

We therefore call for studies focusing on individual differences and understanding their effects on how platforms affect job design characteristics, or on the relationships between work characteristics and outcomes.

RQ17: Which individual differences affect how platforms shape work characteristics and with what consequences?

PRACTICAL IMPLICATIONS AND CONCLUDING REMARKS

Our work offers practical implications to workers, platform organizations, and policymakers. First, our exploration of different types of algorithms and their relationship with work design – through the concept of algorithmic embeddedness – holds significant potential in empowering crowdworkers. It raises their awareness about how to craft their working strategies better, considering algorithmic embeddedness of each taken job, thus improving their job motivation, meaningfulness, and satisfaction. Furthermore, our work helps platform providers by underscoring how the features they design for online marketplaces can have a profound impact on the workforce they host. As the different work characteristics represent both demands and resources in influencing a variety of outcomes (Hackman and Oldham, 1975; Parker and Grote, 2022), platform providers should regularly adjust and revise platform features in order to positively impact crowdworkers' work outcomes. Similarly, we invite algorithms designers to engage in participatory design approaches with crowdworkers to preempt possible implications of different uses of platform algorithms. As a third, final practical consideration, our work is essential for policymakers responsible for designing platform market regulations. We highlight how platforms impact crowdworkers' work both at more macro (i.e., through platform features) and micro (i.e., through algorithms) levels. Therefore, in line with current debates and initiatives, such as the EU AI Act, to limit the unethical uses and risky consequences of artificial intelligence (e.g., Lebovitz et al., 2022; Raisch and Krakowski, 2021; von Krogh, 2018), we suggest the need to unveil algorithmic functioning and promote guidelines and limitations on how such algorithms should be designed and implemented, to attenuate the potential adverse effects of algorithmic embeddedness over workers.

To conclude, the scope of this article was investigating the interplay between technology and work design to deepen our understanding of crowdwork dynamics. Our systematic review reveals that, for crowdworkers on platforms, algorithmic embeddedness is a crucial design characteristic of their job. We further argue that the platform, as a technological context, is an antecedent to all the design characteristics. In doing so, we moved 'beyond just capturing the state of the science' (Elsbach and van Knippenberg, 2020, p. 1287) and provided a synthesis that updates the job characteristics model for the crowdwork context. Our review of existing studies also allowed us to speculate about future research directions that we hope will inspire scholars to further detail how technology interplays with job design in the new world of work.

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