

# Digital Twins in Flexible Online Work: Crowdworkers on German-Language Platforms



Paul Hensen, Mareike Reimann, and Martin Schneider

**Abstract** External crowdworking (CW) is paid online work mediated by specialised crowdsourcing platforms. This chapter provides an introduction to various aspects of crowdworking with a focus on German-language platforms, based on the literature and our own results from the ‘Digital Future’ research programme. We define CW as an employment relationship and distinguish it from other forms of (non-)regular employment. Findings from a survey among crowdworkers show that crowdworkers are heterogeneous in terms of socio-demographic characteristics, and that the consequences of CW for health and work-life balance are ambivalent. Various platforms that broker complex tasks have developed a new type of rating system that commits workers to the platform. Based on crowdworkers’ past performance record, they achieve a particular status level, such as ‘five stars’, which indicates a worker’s reputation and determines the pay they can expect, as well as the tasks they can take on. Such rating-based compensation systems rely on a digital twin of each crowdworker that is stored by the platform. Today, such systems are platform-specific and proprietary, with a possible lock-in effect for employees. Public rating systems that cover multiple platforms are an alternative that would enable workers to transfer their reputation to other platforms. Overall, this chapter sheds light on an important but still under-researched form of flexible online work and illustrates that a novel form of the human digital twin is at the heart of platform management, with controversial implications for workers.

**Keywords** Crowdworkers · Temporary work · Rating systems

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# 1 Introduction

This chapter focuses on paid online work on public crowdworking platforms, which is called ‘external crowdworking’ (Giard et al., 2019). In this flexible form of work, various specialised online platforms, such as the microtask platform Amazon Mechanical Turk or the graphic design platform 99Designs, post online work tasks on behalf of their clients. Registered users—the crowdworkers—can decide to apply to perform any of these digital tasks and are paid after the satisfactory completion of a task by the intermediary CW platform.

CW has been discussed as a growing phenomenon of the worldwide digital economy (Boudreau et al., 2011; Horton & Chilton, 2010; Kässi & Lehdonvirta, 2018; Kittur et al., 2013; Fabo et al., 2017). In recent years, the opportunities and risks of CW have become an issue in a German context as well (Mrass et al., 2020; Pongratz & Bormann, 2017). Although CW seems to offer great possibilities for flexible work for diverse groups in the labour market (Reimann & Abendroth, 2023; Zyskowski et al., 2015), researchers, as well as union representatives, have also voiced concerns about labour protection (Barth & Fuß, 2021; Berg, 2016; De Stefano, 2016) and negative consequences such as health issues (Schlicher et al., 2021). Therefore, first, this chapter provides an introduction to external CW as a part of the rising gig economy (Kenney & Zysman, 2016). We review the relevant parts of the literature on CW and focus on the key findings of CW concerning German-language platforms. Using insights from a socio-economic perspective that interprets CW as a complex employment relationship, we compare CW with other forms of (non-)standard employment. Moreover, we present new empirical findings based on our own research. As part of the research programme ‘Digital Future’, which was run jointly by Bielefeld University and Paderborn University, interdisciplinary researchers conducted a German CW survey with 803 crowdworkers on four German-language CW platforms. The goal was to shed light on working conditions in digitalised work processes from the perspectives of computer scientists, economists, engineers, psychologists, and sociologists (for detailed information on the survey, see Giard et al. (2019, 2021)).

Next, we argue that a digital twin of each crowdworker is at the heart of a novel and sophisticated rating system used by multiple CW platforms. Once users have registered, platforms store socio-demographic information, along with the users’ work histories. Crowdworkers also receive an overall rating (such as ‘five stars’). The rating is typically based on performance evaluations by clients and on additional data stored by the platform (e.g., work history, processing time). Although the status hierarchies produced by these rating systems have been discussed before (Javadi Khasraghi & Aghaie, 2014; Goes et al., 2016; Goh et al., 2017), we add new insights to this literature. We show that among German-language CW platforms, these rating systems are crucial only for platforms that mediate complex tasks such as designing, testing, programming, or producing text. We also show how the digital twin of a crowdworker functions as the key element in these rating systems, helping platforms to match sophisticated tasks with qualified experts and to motivate and retain their

crowdworkers. Hence, the digital twin determines the tasks that will be available to a crowdworker and the income they may be able to generate.

Overall, the chapter makes several contributions. We offer a socio-economic perspective on CW that considers employment relationships. For this purpose, we also report and discuss partially new empirical evidence on crowdworkers' characteristics, as well as possible opportunities and risks for work-life balance and health, with a particular focus on German-language platforms. Furthermore, we discuss the digital twins of workers in the context of external CW. This is an important issue. In a digitalised world of work, more information on employees will be assembled, and the resulting digital twins will influence employees' careers. CW is an environment in which this future development can be studied today.

In Sects. 2 to 4 of this chapter, we introduce external CW and distinguish it from other forms of flexible work, characterise CW as a new form of work, and report on empirical findings that indicate the strong heterogeneity of crowdworkers. Section 5 introduces the rating systems that platforms operate, examines how these systems are used by the platforms to allocate tasks and to provide incentives, and argues that there is a conflict of interest between platforms and workers concerning the public availability of the digital twins stored in the rating systems. Section 6 concludes by summarising our main points and projecting them onto future forms of flexible work.

## 2 External Crowdfunding as Part of the Gig Economy

Remember outsourcing? Sending jobs to India and China is so 2003. The new pool of cheap labor: everyday people using their spare cycles to create content, solve problems, even do corporate R & D. [...] It's not outsourcing; it's crowdsourcing (Howe, 2006).

Jeff Howe introduced the term 'crowdsourcing' in 2006. It did not take long for academic and public discourse to focus on paid activities on crowdsourcing platforms and for the slightly modified term 'crowdworking' to gain prominence. CW has since become a growing phenomenon of the worldwide digital economy (Boudreau et al., 2011; Horton & Chilton, 2010; Kässi & Lehdonvirta, 2018; Kittur et al., 2013; Fabo et al., 2017; Taylor & Joshi, 2019), and this is also the case in a German context (Mrass et al., 2020; Pongratz & Bormann, 2017). In 2013, an estimated 48 million crowdworkers took on tasks brokered by CW platforms, and that figure was expected to rise to over 100 million crowdworkers in 2020, with an estimated gross service revenue of up to \$25 billion (Kuek et al., 2015), making CW an important labour market (Schulte et al., 2020). In the European region, an estimated 9.2% of European and 6.9% of German workers are active crowdworkers or have at least practiced some kind of CW in the past (Serfling, 2019). Although there are no official figures on how many crowdworkers there really are, CW certainly provides interesting employment opportunities for people all over the world (Bracha & Burke, 2016). It attracts a

wide range of people, from freelancers to employees in regular jobs, from people on parental leave to physically challenged people, and from students to retirees (Brabham, 2012).

Various terms are used to refer to work mediated by internet platforms, including ‘crowdsourcing’, ‘gig economy’, and ‘platform economy’. Compared to these terms, CW differs in terms of the types of tasks offered, compensation, and contractual obligations (Schulte et al., 2020). First, CW platforms only involve digital tasks with digital outcomes (Schulte et al., 2020), which makes them globally accessible. The gig and platform economies also include locally restricted work, such as delivery, transportation, and craft services, which is mediated online but performed on site (Schulte et al., 2020). Digital tasks in CW vary from very simple and repetitive tasks that require only basic knowledge of how to use technical devices, such as tagging photos, answering surveys, or training artificial intelligence software, to sophisticated tasks such as writing text, producing graphic designs, or programming software (Durward et al., 2016). Generally, each platform deals with only a few related task types, which allows specialised CW platforms to connect specific clients with suitable experts. Second, CW is a subset of crowdsourcing that refers only to exchanges in which crowdworkers receive financial compensation for a contribution that is found to be satisfactory (Schulte et al., 2020).

Another important distinction is between the external and internal forms of CW. When CW is mentioned, it usually refers to what is known as external CW. External CW consists of task-based online work that is mediated through internet platforms. Internal CW, by contrast, refers to CW platforms created by a company with the intention of using the ‘wisdom of the crowd’ by using the participation of its own employees (plus external contributors in some cases) to solve mostly internal company challenges (Zuchowski et al., 2016; Abendroth et al., 2020). External CW is based on a triangular exchange involving the platform, clients, and crowdworkers (see also Sect. 4). The clients, who may be individuals, groups, or organisations, propose a digital task with a well-defined goal on an external CW platform (Estellés-Arolas & González-Ladrón-de Guevara, 2012). The platform displays these tasks online in the form of a call to a specified crowd, usually the platform’s registered online users. The call includes descriptions of tasks and information about the benefits for each party involved. Like freelancers, crowdworkers undertake these tasks voluntarily, primarily on a task-by-task basis (Estellés-Arolas & González-Ladrón-de Guevara, 2012). They contribute their resources, such as time, money, effort, or expertise, and receive a range of benefits in return, such as intrinsic enjoyment of the activity and task-based payment (Estellés-Arolas & González-Ladrón-de Guevara, 2012). The use of such platforms is free for crowdworkers, but it is indirectly priced, as the platform retains a part of the task price paid by the client for providing a work environment, mediating between the crowdworker and client, and acting as a trustee.

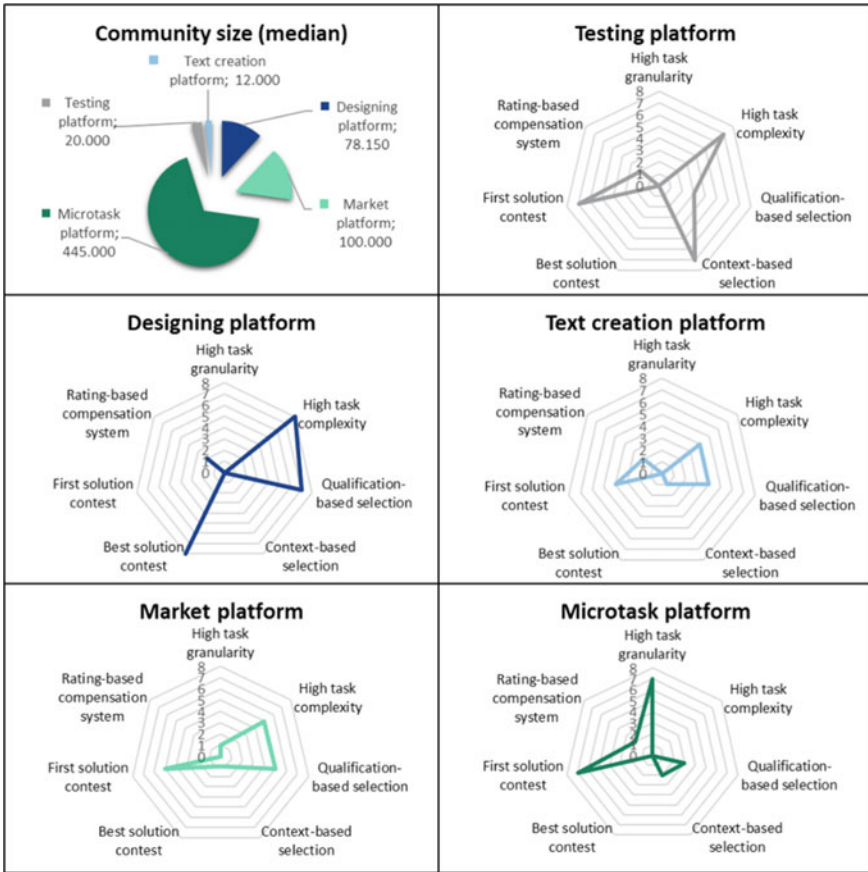
### 3 Platforms in Germany: Expert Tasks Versus Microtasks

There is a surprisingly large number of CW platforms with German-language web interfaces and task offerings. Based on the findings by Hensen (2021b), Table 1 lists 32 such platforms that fall into five commonly applied categories, and Fig. 1 compares the categories in detail, using characteristics that are often discussed in the literature.

The average German-language CW platform has about 100,000 (median) registered crowdworkers, with a strong variation depending on the task types that the platform offers. Among the 32 platforms, there are 8 design platforms (graphic design tasks), 6 market platforms (broader freelance tasks), 7 microtask platforms (simple and short tasks), 7 testing platforms (testing cases for software), and 4 text creation platforms (text writing tasks). On 24 of the 32 CW platforms, clients outsource tasks with a high complexity and a low granularity. In other words, on these platforms, crowdworkers generate holistic solutions for the platforms’ clients. Therefore, it is not surprising that 22 of the 32 CW platforms conduct the qualification-based selection of crowdworkers and hold first-solution contests in which one or only a few crowdworkers work exclusively on a task to generate solutions. In this type of contest, the task price is paid for each acceptable solution. In contrast, in best-solution contests, crowdworkers work on a task simultaneously, and only the workers who create the best solutions are compensated. In addition, the context-specific selection of crowdworkers according to age, gender, or technical devices seems to be primarily relevant on test platforms. Surprisingly, given the large number of platforms for more complex tasks and the obvious need for experts with specific skills, only 8 of the platforms studied offer a rating-based compensation system (RBCS) in which pay and other intangible benefits are contingent on the crowdworker’s rating or reputation, as certified by the platform. The logic of this rating system is examined more fully in Sect. 5 of this chapter. Overall, most German-language CW platforms require a high level of expertise and have created an appropriate working environment for this expertise. Microtask platforms are an exception.

**Table 1** Overview of 32 German-language CW platforms

Platform type	German-language CW platforms
Designing platform	99designs; Brandsupply; Crowdsite; DesignCrowd; Designenlassen; jovoto; Logoarena; Talenthouse
Market platform	Bluepatent; Expertcloud; Fiverr; Freelancer; Twago; VoiceBunny
Microtask platform	Appjobber; Clickworker; Crowdguru; Gprofit; Streetspotr; Veuro; WorkGenius
Testing platform	Applause; Rapidusertest; test.io; testbee; Testbirds; Testemit.de; Uinspect; Testemit.de; Uinspect
Text creation platform	Content.de; Textbroker; Textmaster; Tripsbytips



**Fig. 1** Five platform types distinguished according to 9 platform characteristics, based on the 32 German-language CW platforms. *Note* Figure based on results from Hensen (2021a). The highest value in the net diagram shows how many platforms belong to the platform type, and the thick black lines show how many of these platforms have a particular characteristic

Microtask platforms mainly offer tasks with a high granularity and low complexity. In other words, they are often repetitive, and it is difficult for crowdworkers to identify the underlying purpose of the task. Examples of these tasks are tagging photos or videos, answering surveys, maintaining product data, and performing simple research activities such as clarifying store hours. These tasks are usually taken on for the purpose of making money. However, given the simplicity of the tasks, they often offer low pay, and even with a 40-hour work week, crowdworkers on microtask platforms are unlikely to earn a four-figure monthly income (Giard et al., 2019). Since reputation systems such as RBCSs are rarely used on microtask platforms to improve working terms and conditions, including income, these remain unchanged regardless of the platform affiliation, performance, and behaviour of crowdworkers.

It is unclear why some CW platforms for demanding tasks have not implemented an RBCS, given the strong incentive and commitment effects (for a detailed discussion, see Sect. 5).

Based on what we know about German-language CW platforms, the widespread view, which considers crowdworkers to be merely digital day labourers for the simplest tasks, appears to be unfounded for most platforms, except perhaps for those that mediate microtasks. For German-speaking people, therefore, CW can be more than a type of productive pastime or a poor substitute for access to the ‘regular’ labour market. Instead, compared to regular employment, it is a labour market segment that is much more accessible to multiple groups of differently qualified people from virtually anywhere that only requires internet access.

## 4 The Crowdworkers

### 4.1 *No Employment Contracts But Employment Relationships*

CW can be understood as a new phenomenon of digital platform work, which in turn is part of the rising gig economy that became more prominent at the beginning of the 21st century (Kenney & Zysman, 2016). Nonetheless, it is comparable to other, more established forms of employment when it comes to important dimensions of the employment relationship. In this section, we will a) further explain why CW can be referred to as an employment relationship, and b) describe similarities to other forms of employment, namely regular employment, temporary work, (solo) self-employment, and fixed-term employment. Despite an increase in non-standard employment, the core of the German labour market is still characterised by regular employment relationships (Eichhorst & Tobsch, 2015). Thus, we will use regular employment, which refers to open-ended full-time employment contracts with a fixed employer, as a reference for comparisons, although CW is more similar to other forms of non-standard employment.

However, if employment relationships are understood to be more than a written employment contract, it becomes obvious that CW shares important features with other forms of employment, and systematisation can make it easier to understand the possible risks and benefits of CW. We consider the idea that employment relationships are more than just a legal employment contract and also more than the exchange of labour and money. Referring to the basic assumption of social exchange (Blau, 1964), they can be understood as multidimensional social exchange relationships (Brose et al., 2004; Coyle-Shapiro & Conway, 2004; Coyle-Shapiro & Kessler, 2000).

In regular employment and in most forms of non-standard employment, the partners involved in the exchange are an employee and an employer (Cappelli & Keller, 2013), and the exchange is embedded in an organisation that provides structural conditions and formal rules in a relatively stable context. Crowdfunding is different. At



its core is a relationship between the crowdworker and some client that is short-term and limited to the fulfilment of a very specific task, and thus the exchange is a clearly defined contribution for a (mostly) pre-determined payment. The crowdworker agrees to previously defined conditions for payment and task fulfilment by accepting the task. In focusing on single tasks, CW is very similar to (solo) self-employment; self-employed workers have exchange relationships with varying customers, although these exchanges can also be long-term, whereas CW tasks are typically short-term. The client mostly controls the definition of the content, time frame, and payment of a task, and finally decides to accept or not to accept the output of the crowdworker. The crowdworker, in contrast, has limited control because they can only choose from tasks that are available on the platform. Communication with the client is mostly formalised and standardised, and direct interaction is often not possible.

However, CW differs from regular employment in another important way. It is a triangular relationship involving the crowdworker, the client, and the platform, which acts as an intermediary (Langley & Leyshon, 2017). Basically, the platforms mediate the demands of the client and the crowdworkers, who offer their time, competencies, and knowledge. The platform provides the environment, as well as the rules and conditions of the exchange, for both crowdworkers and clients. Crowdworkers accept the terms and conditions when they register on the platform (De Stefano, 2016). The platform's conditions stay the same for different tasks and different clients. Therefore, a series of exchanges is embedded into a relationship with the platform, which is more long-term. In its intermediary position, the platform is the most visible contact for crowdworkers, while the clients are often anonymous and invisible (De Stefano, 2016). Therefore, it can be assumed that the core of the exchange relationship is shifted from the employer-employee relationship to the crowdworker-platform relationship. Crowdworkers cannot negotiate contractual terms with the platform or with the clients, so the triangular relationship is defined by a power imbalance that puts the crowdworker at a disadvantage (Greef et al., 2020). Regarding this triangular relationship, CW is comparable to temporary work for which the hiring firm initiates and maintains a relationship between the lending firm and the employee.

It may be noted that crowdworkers might have some power because the platforms and the clients are reliant on the crowdworkers to work on the platforms, and thus, crowdworkers might advance their interests by threatening to leave the platforms. However, this is far from the daily reality of CW. Especially for crowdworkers on platforms for simple and repetitive tasks, i.e., microtasks, this possibility is excluded by the sheer mass of (globally) available potential crowdworkers with similar skills and knowledge. Crowdworkers on platforms for microtasks are therefore easily replaceable (Howcroft & Bergvall-Kåreborn, 2019). However, it is true that platforms for more demanding tasks rely on a smaller number of qualified and willing crowdworkers than platforms for microtasks (Schulten & Schaefer, 2015; Boons et al., 2015). A valuable tool for retaining qualified crowdworkers can be rating-based compensation systems (see Sect. 5). Again, however, crowdworkers are not in a position to negotiate. There are still two options: Take it or leave it.

It is useful to take a closer look at how the content of the employment relationship in CW differs from, or is sometimes similar to, the content of this relationship



in other forms of employment. We will focus on some important dimensions of this relationship, namely job security, earnings, social security contributions, and flexibility.

*Job security:* In CW, similar to (solo) self-employment, there is no job security, as there is no employment contract that defines the duration of the employment relationship. The duration of the exchange is limited to the fulfilment of a specified task, with no promise of further work opportunities. In comparison, job security is highest in regular employment because of the permanent, open-ended contract and corresponding legal protection against dismissal. The duration is also determined in fixed-term employment, as there is a fixed ending point to the exchange that is set in advance, although in Germany fixed-term contracts are often transferred to permanent contracts, at least in specific industries or occupations (Eichhorst & Tobsch, 2015). Moreover, fixed-term contracts involve a longer time frame compared to the short-term nature of CW. In temporary work, the contract with the hiring firm is limited and insecure, but temporary workers often have permanent contracts with the lending firms and thus a comparably stable employment situation.

*Earnings* Ideal-typical regular employment provides a living wage. This is also true for temporary work or fixed-term employment, although earnings are on average lower compared to regular employment (Giesecke & Verwiebe, 2009). Crowdworkers' earnings are highly task-dependent. However, studies have shown that possible as well as average earnings differ significantly between different platforms and specific task categories, and they depend on the necessary qualifications, experiences, or competencies, and on whether crowdworkers search for available tasks throughout the day on multiple platforms (Lehdonvirta, 2018). Therefore, earnings are highly dependent on individual engagement and also on the availability of (well-paid) tasks (Wood et al., 2019). Crowdworkers often have small hourly and unstable earnings, although there is a high variability in these earnings (Berg, 2016). As there is a low threshold for accessing CW, there is strong competition, and crowdworkers can be replaced easily compared to employees, limiting the amount of payment for tasks. As a result, higher earnings are rare (Hornuf & Vrankar, 2022), and CW is often used for additional income (Berg, 2016). In this regard, CW is again comparable to (solo) self-employment, where workers are dependent on demand. Some self-employed workers earn very little income, but others can compensate for this insecurity by generating very high incomes for their very specific qualifications or competencies (Hamilton, 2000).

*Social security contributions:* The social security system in Germany is based on a high share of regular employment, where employees are fully integrated into all social security systems through contributions by employers and employees (pension, health, unemployment). In temporary work, fixed-term employment, and part-time work, employees are also fully integrated into all social security systems, although their contributions are lower due to comparably lower income. Self-employed workers are fully responsible for taxes and social security contributions. They can pay into the systems on a voluntary basis, use private provisions, or not pay at all. In this case, CW is again comparable to self-employment, as crowdworkers are also fully responsible for paying social security contributions.

*Flexibility:* An important aspect that is discussed in the context of CW is flexibility, both from the perspective of the client and from the perspective of the crowdworker (Abendroth et al., 2020). In regular employment, both employer and employee flexibility are low due to strong employment security and the employment contract. Although this is a benefit in terms of job security, predictability, and planning capacity for both the employer and the employee, it restricts short-term reactions to changes in demand for the employer and causes inflexibility in the adaptation to individual preferences and changes in the private life of the employee. In contrast, flexibility is high in CW on both the crowdworker side and the client side. Clients can quickly react to (short-term) demands for specific knowledge or competencies by outsourcing tasks to CW platforms and assessing a heterogeneous pool of crowdworkers (Leimeister et al., 2016). Crowdworkers are highly flexible because they can easily change platforms and tasks and because they can schedule their work around other responsibilities such as childcare, other employment, or individual preferences (Reimann & Abendroth, 2023; Warren, 2021). Additionally, working hours are not fixed, so CW makes it possible to earn more if this is necessary or preferred, and to change the amount of effort put into CW very flexibly, even on a day-to-day basis. However, this flexibility is highly dependent on the available tasks and changes in the demand for specific knowledge or competencies, and therefore again CW is very similar to (solo) self-employment and also to temporary work.

In summary, the platform-based mediation of tasks is a core element of CW. Even though crowdworkers do not have a written employment contract, they still enter employment relationships with characteristics that are comparable to the characteristics of other forms of employment. CW is especially similar to (solo) self-employment when it comes to task-based work assignment, the dependence on demand, uncertainties in earnings, the long-term perspective of work, social security contributions, and also the advantage of flexibility. CW is also similar to temporary work, especially in terms of the triangular relationship between crowdworkers, platforms, and clients.

#### ***4.2 The Diverse Crowd: Demographics, Health, and Work-Life Balance***

Crowdworkers are as diverse as the platforms that they use. Research on CW in Germany suggests that overall crowdworkers are rather young, male, and well-educated individuals, but it has become increasingly obvious that CW is used by heterogeneous workers with various motivations, which we will discuss in this section.

There have been many studies on the (socio-demographic) characteristics of crowdworkers in Germany (e.g., Leimeister et al. (2016); Pesole et al. (2018); Serfling (2019); and our own interdisciplinary German CW survey (Giard et al., 2019, 2021)). Before going into detail on specific aspects, it should be noted that existing studies are only partly comparable because the study designs differ markedly. As there is

no obligatory registration of crowdworkers in Germany, it is not possible to draw representative samples of the crowdworker population. As a result, researchers have used various strategies to collect data about CW; they mostly use self-information online questionnaires, but they also use telephone interviews or algorithm-based data collection on crowdworker behaviour. Consequently, there are similarities between studies and results, but also differences due to the survey methods used, the included platforms, and even the underlying definition of CW (Abendroth et al., 2020; Giard et al., 2019).

Existing surveys performed in Germany, including our own, are somewhat consistent in terms of the mean age of crowdworkers: Crowdworkers are on average about 36 years old (mean values ranging between 36.8 years old in Giard et al. (2021) and 35.6 years old in Leimeister et al. (2016)). However, the average age varies between platform types: On the testing platforms, crowdworkers are on average 32.8 years old; on microtask platforms, they are 36.6 years old; and on marketplace platforms, they are 43.8 years old. Overall, crowdworkers seem to be younger than the average working population in Germany (mean age of 44.1 years old in 2019; BiB, 2019). There are more male than female crowdworkers across all studies (Berg, 2016; Leimeister et al., 2016; Serfling, 2019), with a ratio of roughly 60/40. However, analyses based on our interdisciplinary German CW survey show that the gender distribution differs significantly between platform types: There is a higher share of males on testing (69%) and mobile CW platforms (68%), but there is a higher share of female crowdworkers on marketplace platforms (61%) (Giard et al., 2021). On average, crowdworkers are highly educated, with most of them having 'Abitur' (the highest level of general school education, which is necessary for university entrance) or a tertiary degree (Giard et al., 2021; Leimeister et al., 2016). The motives for performing CW are also diverse. They can be intrinsic motives such as self-fulfilment, fun, content-related interest in the tasks, or the advancement of individual competencies and experiences, but they can also be extrinsic motives such as earning money and acquiring new customers as a self-employed worker (Al-Ani & Stumpp, 2015; Feldmann et al., 2018).

In addition to studying the characteristics and motivations of crowdworkers, scholars have increasingly investigated the consequences of CW for different aspects of life, such as work-life balance and health.

### *Work-life balance*

The flexibility involved in CW makes it possible for individuals to facilitate work-life balance. In research on the work-life interface, flexible working is referred to as a job resource that allows for the more individual scheduling of work obligations and thus facilitates the integration of work and a person's private life (Hill et al., 2010; Schieman & Glavin, 2008). In line with this, work-family border theory (Clark, 2000) and boundary management theory (Kossek, 2016) specify that having control over one's schedule allows for flexible adaptation and the coordination of the timing of work demands with private obligations.

CW can be accessible for almost everyone because it offers low barriers for flexible working. It involves a high potential flexibility (Reimann & Abendroth, 2023): Crowdworkers have easy access to job tasks via platforms, and they can perform the job tasks at the location of their choice because tasks can be done completely digitally using internet-ready devices such as computers and smartphones (Berg, 2016). For example, CW can be conducted at home but also at a café or while commuting to another job and thus has a high degree of flexibility in terms of location. CW can be carried out on any day of the week and at any time of day (De Stefano, 2016). Work schedules and the lengths of individual tasks can vary depending on the crowdworker's selection of work tasks (Pesole et al., 2018). Consequently, CW is characterised by a high degree of flexibility in time as well: The timing of the beginning and end of work, the scheduling of breaks and days off, and the distribution of work over the day or week can easily be adjusted so that they do not conflict with obligations from other jobs or from private life. Finally, CW is characterised by a high degree of task autonomy, because crowdworkers control which tasks they choose from the available tasks. They may decide to do more or less complex or time-consuming tasks, tasks that seem more interesting than others, tasks that are more appropriate for their individual skills and knowledge, or tasks that have a better anticipated cost-benefit ratio than others (Howcroft & Bergvall-Kåreborn, 2019).

However, permanent switching between roles requires complex individual self-management abilities and may also result in an increased blurring of boundaries (Kossek et al., 2006). Thus, despite the high potential flexibility of CW, the actual daily life of a crowdworker may look somewhat different (Lehdonvirta, 2018), and exposure to employment insecurity and market pressures might counteract flexibility (De Stefano, 2016). Formal autonomy may come at the price of long, unsocial, and irregular working hours (Berg et al., 2018), and the need to constantly check for available tasks if a decent income needs to be earned (Wood et al., 2019); this may have negative effects on work-life integration.

Our own research based on the interdisciplinary German CW survey shows that flex-time and flex-place in CW are not as widespread among crowdworkers as this type of digital labour would seem to suggest. However, if crowdworkers do work flexibly in time and if they have high task autonomy, they are indeed able to benefit from flexible working hours, as they experience fewer work-life conflicts. This does not apply to working flexibly in place. In contrast, if crowdworkers are not able to choose their tasks autonomously or if they are restricted in terms of when they perform their tasks, CW increases the likelihood that work strain will seep into non-work life (Reimann & Abendroth, 2023).

### *Health*

Although CW has been discussed as an opportunity for workers with health issues (Zyskowski et al., 2015), little is known about the possible health consequences of CW. A long tradition of research on non-standard work arrangements, however, has already shown their possibly negative impact on an individual's perceived stress, mental health, musculoskeletal problems, and other physical health problems

(e.g., Quinlan et al. (2001); Sverke et al. (2002)). As CW can be compared to those forms of employment (see Sect. 4.1), its health risks may be similar. Research on technology-enabled work indicates possible mental and physical health risks as well. Examples of these risks are isolation and a lack of support when working from home (Collins et al., 2016; Cooper & Kurland, 2002; Tavares, 2017), as well as technology-driven work intensification (Meyer et al., 2019). As CW is completely internet-based and carried out on computers or smartphones, the risks of digitalised work and working from home are relevant for CW as well. Moreover, irregular and unsocial working hours, which seem to be very common in CW (Berg et al., 2018), are associated with impaired health as well (Costa et al., 2006).

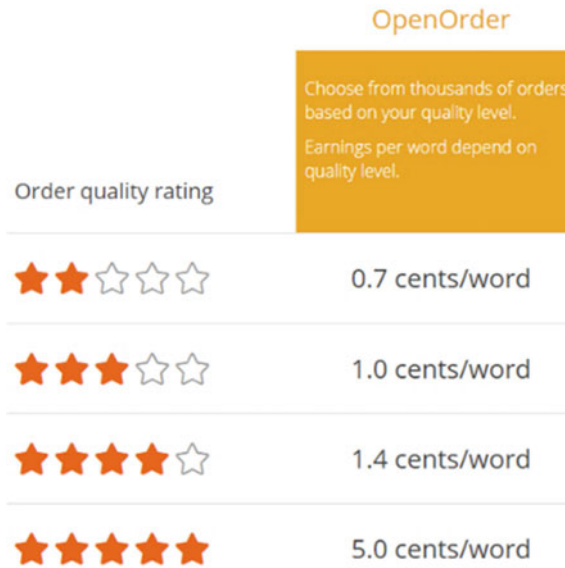
In research based on the interdisciplinary German CW survey, we analysed whether participation in CW is linked to increased somatic symptoms compared to regularly employed personnel. We found that crowdworkers show significantly increased somatic symptoms compared to a German norm sample. The higher symptoms are stable across different kinds of tasks and platforms, gender, and age groups, and they are statistically related to the extent of participation in CW. Specifically, we found that the total work hours per week were not associated with an increase in somatic symptoms, but we did find associations with strain-based work-family conflict and with earning money being the primary motivation to participate in CW (Schlicher et al., 2021).

## 5 Rating Systems on Platforms

### 5.1 *An Instrument to Allocate Tasks, as Well as to Attract, Motivate, and Retain Crowdworkers*

Rating systems are already common in online shopping, on social media platforms, and on a variety of other internet platforms; they are used, for example, to rate products or content from social media profiles (Jøsang et al., 2007). Not surprisingly, CW platforms have also developed rating systems to quantify crowdworkers' overall performance (Gandini, 2019). Figure 2 provides an example of an RBCS used by the German text creation platform Textbroker. In this example, crowdworkers receive one to five stars. Importantly, individual compensation and the attractiveness of the available tasks depend on this rating. The number of stars in an RBCS is typically influenced by the crowdworker's performance record in terms of the length of membership, number of tasks completed, and quality of task fulfilment (Hemsen, 2021b).

Rating systems are platform-specific and their details vary, for example, in terms of the importance of monetary incentives and the granularity of the ratings. Although the previous literature has not systematically explained how the more sophisticated rating systems of Textbroker and similar platforms work (more on this below), some evidence is available that suggests that the rating system is an important element in



**Fig. 2** Example of an RBCS for a German-language CW platform for text creation. *Note* A star rating is the core element of the RBCS of the German text creation platform Textbroker (screenshot: 02.09.2021). In order to achieve a higher rating on a text creation platform, it is usually important that the produced texts are error-free in terms of grammar, spelling, punctuation, and expressions. The platform also checks whether or not the client's specifications have been met. Theoretically, every written text can improve the rating, but the rating is updated only over longer intervals, and the platforms also do not usually justify the amount of pay for each rating level

each platform's business model. Basically, the rating system is supposed to attract and commit crowdworkers to the platform by providing incentives. It is also meant to help platforms to match tasks with crowdworkers, thus increasing the quality of the completed tasks and client satisfaction.

In line with this view, rating systems have been shown to exert a positive influence on the performance and participation of crowdworkers on a platform (Schörpf et al., 2017). Even for rating systems without monetary incentives, users with higher rating levels will perform better, allegedly based on the displayed reputation (Peer et al., 2014; Basili & Rossi, 2020; Goes et al., 2016). The reputation also encourages crowdworkers to adapt their behaviour to the requirements of the platform and its clients (Riedl & Seidel, 2018). In addition, positive effects on crowdworker participation are achieved through virtual reward systems with gamified elements, such as ratings, that amplify intrinsic crowdworker motivation (Feng et al., 2018; Goh et al., 2017). Similarly, direct performance evaluations by clients and peers, even during an ongoing work process, also affect performance (Jian et al., 2019).

The literature does not discuss one important distinction. While some rating systems are based on reputation and fame alone, some are tied to considerable monetary

incentives. We call these more sophisticated examples ‘rating-based compensation systems’ (RBCSs) (Hemsen, 2021a, b). RBCSs differ from simple ‘status hierarchies’ in which recognition evolves spontaneously within a community based on visible contributions and positive feedback (Goes et al., 2016). Instead, platforms carefully craft the ratings in RBCSs. Performance is measured with multiple criteria, including the number of tasks solved and their quality according to the subjective evaluations of the platform provider and the clients. Furthermore, the crowdworker category, which may be the number of stars or some achieved title, has important implications because the RBCSs combine material and immaterial rewards. More stars, badges, or titles imply more recognition or a higher reputation, as individual ratings are visible to peers and clients (Auriol & Renault, 2001; Goes et al., 2016). A higher rating level also leads to material rewards (Auriol & Renault, 2001). Crowdworkers with higher ratings typically receive higher pay rates per task, bonuses, and privileged access to more lucrative and interesting tasks. As Fig. 2 shows, at Textbroker, five-star workers receive considerably higher pay than four-star workers.

As a result, RBCSs are sophisticated instruments that simulate an incentive hierarchy or so-called ‘internal labour market’ within a traditional organisation, but without the contractual obligations of an employer-employee relationship (Hemsen, 2021a, b). Moving to a higher rating is comparable to a promotion (Auriol & Renault, 2001). The hierarchy of status levels describes a predefined career path for registered crowdworkers on the platform. In order to be promoted, they need to invest specifically by being active on a particular platform and by receiving favourable feedback from the platform and its clients. Hence, the effects of this system are also quite similar to those of internal labour markets (Hemsen, 2021a, b). This deters workers who are not interested in a more long-term engagement, and attracts workers who are. These latter crowdworkers become to some extent bound to the platform because leaving it causes a loss of reputation and the associated rewards. This is because the RBCS is platform-specific. On comparable platforms, workers would have to start at the bottom of the incentive hierarchy. This effect restricts crowdworkers’ flexibility and mobility more the longer they have been registered and the higher they are in the incentive hierarchy. Hence, the RBCS not only commits crowdworkers to the platform but also stimulates the accumulation of platform-specific expertise, because crowdworkers often work on similar tasks over time and receive continuous performance feedback.

Empirical work using the interdisciplinary German CW survey provides some evidence on the commitment effects that the RBCSs exert. Platforms with an RBCS have significantly more committed crowdworkers who work more hours per week than crowdworkers on platforms with non-reputational fixed task prices (Hemsen, 2021a). In addition, both emotional and rational economically driven commitment to the platform are found to increase significantly with each rating level. To some extent, the number of hours worked per week also increases for higher ratings, provided that sufficiently high incentives are offered.

Although RBCSs are applicable to many different types of platforms, they are not that widespread in the German-language CW market. Among the 32 CW platforms surveyed (see Fig. 1 above), only 8 have implemented an RBCS—and these platforms



broker more complex tasks. Platforms for complex tasks rely on the commitment and motivation of their expert crowdworkers to keep the business running, and this can be achieved by the RBCS. In contrast, microtask CW platforms can rely on the existing crowdworkers who are willing to take on microtasks from time to time, and each crowdworker can be replaced by others given the low level of expertise involved. Therefore, we interpret the RBCS as a sophisticated solution to the problem of retaining and incentivising expert workers on highly specialised platforms.

## ***5.2 A Crowdworker's Record in the Rating System Is a Digital Twin***

RBCSs or other forms of monetary or non-monetary reputation systems on CW platforms create a digital twin for each crowdworker. In this context, the digital twin consists of all the information collected by the platform on a specific worker, including, for example, their age, sex, time of registration with the platform, qualifications, and skills, the number and level of tasks they have taken on, and the clients' quality ratings. The digital twin forms the basis for assigning the crowdworker to a level in the RBCS and hence for matching workers and tasks. Thus, it is crucial to the business models of many CW platforms. Even on microtask platforms, the digital twin is important. For example, a client on a microtask platform may want to conduct a survey on a particular topic and may only be interested in the opinion of a specific target group (e.g., women who are more than 40 years old), but also needs reliable participants within a short period of time. The digital twins of the crowdworkers make it possible to selectively offer the survey task to the specific target group and to those who have reliably fulfilled similar tasks within a preset time frame in the past. Another example is that a client on a designing platform might need crowdworkers with verifiable experience in designing labels for a specific product group, such as soft drinks, who also speak Italian. In this case, the digital twins are also used to select those crowdworkers who are most likely to fulfil the task.

The digital twins within the RBCS are important because without them platforms would have little information about their diverse crowdworkers; platforms would lack information about a crowdworker's actual performance level, motives, and personal background (Boons et al., 2015; Schulten & Schaefer, 2015). This lack of information is a problem, especially for CW platforms that rely on qualified experts who they match with clients who demand their expertise (Schulten & Schaefer, 2015). To attract, motivate, and retain such experts, platforms must be aware of the economic and social needs of their crowdworkers. This requires information about their crowdworkers. Crowdworkers, in turn, benefit from such systems by being able to satisfy their social need for recognition, status, or reputation, while platforms with an RBCS are also able to offer more desirable compensation that is more in line with the required skill level, as well as opportunities for incremental improvement in performance and behaviour.

One crucial effect of RBCSs is the commitment effect that they have on workers. As part of the ‘Digital Future’ research programme, Schneider and Hensen (2021) demonstrated that crowdworkers developed different types and different degrees of commitment to a text creation platform, depending on their specific personal circumstances. Multiple distinct groups of crowdworkers were found to exhibit similar emotionally or rationally based commitments to the platform, and commitment was reflected in group-specific patterns of participation and the intention to stay. For example, the most important group of crowdworkers on the platform studied are strongly motivated by additional income and not interested in simply passing the time, and they are rationally committed to the platform. This group consists mostly of self-employed persons and persons who report CW as their main occupation. These findings support the commitment effect of RBCS—and they imply that platforms could make their incentive system even more attractive by tailoring their rewards specifically to these groups, thus benefitting all parties involved. The findings were based on survey data, which the platform could also request from workers to complement the digital twins. Hence, our findings illustrate more generally how the digital twins stored in rating systems can be used by platforms to learn about their diverse crowdworkers.

However, rating systems and the digital twin are platform-specific and proprietary. Crowdworkers are neither able nor allowed to transfer their reputation and status to other platforms or companies. As a result, the digital twin may be locked into the particular CW platform that created it, as there is no standardised way to merge information from different platforms. This has drawbacks for all parties involved. For crowdworkers, it leads to so-called vendor lock-in: No information about the qualifications or reputation of the crowdworker is shared between different platforms (Hensen et al., 2020). Therefore, crowdworkers who leave a platform because they want to invest more time in a more lucrative or interesting platform simultaneously lose their reputation on the previous platform (Hensen et al., 2020). Similarly, crowdworkers who work for multiple CW platforms, which is not uncommon, may be undervalued compared to their counterparts who work for only one platform. The consequence of having undervalued crowdworkers is that their skills may be underused. Of course, platforms might benefit in the short run from qualified crowdworkers who are locked in, but in the long term, the underutilisation of the skills of undervalued crowdworkers can negatively impact the quality of the solutions offered to clients (Hensen et al., 2020).

Conceptual work by researchers from the ‘Digital Future’ research programme suggests that an appropriate solution consists of the platform-independent management and storage of crowdworker information (Hensen et al., 2020). Such platform-independent management and storage systems can mitigate the effects of vendor lock-in, as crowdworkers can freely transfer and share their information and thus, their digital twin. By making crowdworker information available to all CW platforms to which a crowdworker has been granted access, platforms can reduce the cost of information collection, which is likely to improve the fit between crowdworkers and tasks, and thus client satisfaction. Whether platforms are willing to standardise and

share information collected from crowdworkers, whether legislators may need to enforce this by law, and what a system for managing and storing crowdworker data should look like are still unclear and call for future research.

## 6 Conclusions

Although CW seems to involve highly flexible short-lived gigs at first glance, it has the potential to give rise to more long-term relationships. As an employment form, it shares important features with a number of other employment forms, namely regular employment, temporary work, and self-employment, but it is still a unique and novel form of work arrangement. The incomes reported by German crowdworkers vary considerably, so CW should not as a whole be considered an exploitative form of day labour. Though CW tends to be compatible with a good work-life balance, some of its potential health effects are problematic. The rating system, which creates digital twins of crowdworkers, is a central element in CW (and, by implication, in other forms of flexible work). Crowdworkers are extremely diverse in terms of their ages, personal situations, and motives. Therefore, a platform can learn about its workers' expertise and commit workers to the platform by using sophisticated rating systems, which are based on creating crowdworker digital twins. Crowdworkers in turn rely on their reputation according to their digital twin to access interesting and lucrative work tasks. Today, rating systems are platform-specific and proprietary. There is already some discussion on public rating systems that cover various platforms. This discussion should continue and potentially include other forms of work, because employer-operated rating systems will become more comprehensive and have more of an influence on workers' careers.

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