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RESEARCH PAPER

The Automation of Management and the Multiplication of Labor

On the Role of Algorithmic Management in the Recomposition of Labor

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ABSTRACT

Digital technologies are increasingly used to automatically organize, measure, and control labor in many sectors and industries. This article offers an analysis of how digital technologies, particularly algorithmic management, not only reshape the ways in which work is done and controlled but also drive profound transformations in the division and composition of labor. Drawing on qualitative and ethnographic studies of the gig economy, this research article demonstrates how the digital automation of management serves as a prerequisite for efficiently and flexibly incorporating highly heterogeneous workforces into production processes. This is first demonstrated by an analysis of the online gig economy and its capacity to integrate a wide range of geographically dispersed workers into digital production processes. Then, the paper examines the role of migrant labor in the urban gig economy, contending that in this context too, digital technologies and algorithmic management play a crucial role in the flexible and efficient inclusion of highly diverse workforces. This ultimately illustrates how digital technologies for automated management are integral to a multifaceted process of workforce heterogenization, a phenomenon that can be conceptualized within the framework of the multiplication of labor.

1 Introduction

After the short online application, the "onboarding" was supposed to be the first physical meeting with the food delivery platform for which I intended to become a bicycle courier. After booking a date on the platform's homepage, I suspected some sort of interview when I searched for the address emailed to me. "Entry next to an Asia Restaurant. Please enter through a gate and go to the right to the very end" read the email in a peculiar form of German that hinted at automated translation. After some more searching, I ended up in the right place, the second backyard of a nondescript building in Berlin-Schöneberg. Throughout the meeting, I was surprised to find that no displays of motivation or qualification were required to secure the job. Later, while smoking in front of the building after the meeting concluded, other participants shared similar sentiments. Only one person who was visibly drunk and couldn't provide any ID was sent away before the meeting started. Everybody else was invited into a small ground-floor office that looked rather like a storage space, crammed with the platform's characteristic backpacks. Even though the meeting was held in the German language (an English one was scheduled directly afterward), most of the other riders-to-be around me had moved to Berlin from different countries, some of them quite recently.
A considerable amount of on-the-spot translation ensued, and the platform's youthful, casually dressed employee switched between languages during his introduction. The first act of this introduction was a collective downloading of the platforms' rider app to our smartphones, followed by a quick PowerPoint presentation on a small television screen. Very little was said about the content of the job and the way it was to be done. "Just follow the app and you'll be fine" was the casual answer to one participant's question about how to get shifts and another's question about how to perform deliveries. Finally, some gear, for example, scarves imprinted with the platform's logo, was handed out, and we were instructed on how to order a "starter pack," which included the distinctive backpacks for food delivery, through the platform's online shop. The employee mentioned, "Normally, we charge you €50 for this gear, but currently, it is free," before ushering us out of the office to commence the subsequent onboarding session. A little over an hour after our arrival, we found ourselves once again in the courtyard, equipped with only an app and a scarf and still lacking a clear understanding of how to navigate our new job.

"Onboarding"; fieldnote from ethnographic research on a food delivery platform, Berlin, February 2019

This onboarding meeting, as described in a fieldnote from my (auto-)ethnographic research on a food delivery platform, would remain the only "physical" meeting with persons or on the premises of the platform for the six months I was working for them. Apart from two phone calls and a few chats through the app (where the answers were at least partly automated), this also represented the only personal contact with someone working for the platform (other than the fellow riders I met in the streets and restaurants, of course). The app played a pivotal role in overseeing all facets of labor within the platform. Over time, it became clear that this approach to managing labor was the basis for integrating a very heterogeneous workforce into the platform's labor process with almost no training and minimal human involvement.

This app exemplifies the proliferation of algorithmic management technologies. Across the world of work, such digital technologies are increasingly used to plan, organize, measure, and control labor and the labor process. From simple software to sophisticated machine learning applications, these technologies are starting to profoundly transform labor relations in contemporary capitalism (Rosenblat, 2018; Aloisi & de Stefano, 2022). The reach, form, and impact of algorithmic management, however, differ significantly between companies, sectors, and locations. Consequently, providing a succinct and comprehensive overview of the impact of these technologies on labor is challenging (see Noponen et al., 2023). However, it is possible to identify specific trends associated with the proliferation of algorithmic management.

The objective of this article is to analyze and conceptualize one such tendency: I want to argue that forms of algorithmic management often yield specific effects that impact not only *how* work is performed, organized, and supervised but also the composition of workforces. In other words, without disregarding that these technologies change the way work is done, my interest here is in understanding how this also changes *who* is doing it (and, relatedly, *where* and *when*). While much of the literature on algorithmic management concentrates on the newfound efficiencies of control afforded by these technologies of algorithmic management and the possibilities of workers' resistance (see, e.g., Moore, 2017; Wood et al., 2019; Woodcock, 2021; Heiland, 2022), this dimension has received considerably less attention in academic and public debate. This paper aims to contribute to closing this research gap.

As the opening vignette alludes to, the apps and architectures of algorithmic management employed by digital platforms allow for the quick and efficient inclusion of diverse workers, and their increasingly automated (and multilingual) management. By analyzing this, the paper will show how the effects and affordances of technologies of algorithmic management play important roles in the (re-)composition of workforces and conceptualize this in the context of a "multiplication of labor" in digital capitalism (Mezzadra & Neilson, 2013). In this paper's case studies, this multiplication of labor encompasses socio-demographic dimensions such as migration, mobility, and gender in their relation to

a much broader spatial and temporal re-ordering of labor geographies (a dimension that will become especially explicit in the analysis of the online gig economy, which serves as a counterpoint to the location-bound platforms exemplified by the delivery platform depicted in that opening vignette). This analysis of the ways that digital management technologies intervene in the composition and multiplication of workforces endeavors to contribute to broader debates around the re-composition of labor and class under digital capitalism.

This article will proceed as follows. The next section introduces the methods and empirical data upon which the paper's argument is built. In the following section, the concepts of algorithmic management and the multiplication of labor are established. The following two sections move on to empirically analyze the interplay of these dynamics in the context of the platform economy, with the third section focusing on the online gig economy and its global geographies of distributed digital production and the fourth section picking up the vignette and investigating the urban, location-bound gig economy, including the special role of migrant labor. The article's conclusion summarizes and contextualizes the findings, demonstrating that this analysis also provides a critical perspective on digital technology and automation.[1]

2 Methods and Data

Empirically, the paper draws upon multi-year ethnographic and qualitative research in different parts of the platform economy: digital labor in the global online gig economy, defined as crowdwork, as well as the (already-introduced) location-bound urban gig economy.[2] By considering comprehensive qualitative research into different platforms, I will demonstrate how, in both cases, algorithmic management enables the tightly controlled and standardized cooperation of a huge number of platform workers from different backgrounds, experiences, and situations, workers who are distributed throughout space.

[1] I want to thank Mira Wallis, the editors, and the two anonymous reviewers for their helpful comments on this article. Furthermore, I want to especially thank Manuela Bojadžijev, Mira Wallis, Valentin Niebler, Stefania Animento, and all other colleagues in the PLUS and DAM projects for the collaborative research, discussion and analysis.

[2] This paper is interested in a certain model of platform labor. When it speaks of digital platforms or the platform economy, it is therefore focused on labor platforms such as Uber (and not, for example, Facebook or Google). This labor model is often referred to as the "gig economy" because self-employed workers are often paid for individual tasks ("gigs"). In recent years, this labor model has been increasingly challenged politically and legally, and platforms have started to use alternative models of employment (e.g., sub-contracting or regular contracts). In most of the empirical examples for this paper, the gig model is prevalent. Hence, the paper uses the term gig economy as well as the term platform economy to account for newer developments.

The empirical data stems from three different research projects. First, *Digitalisation of Labour and Migration* (2018–2022) researched digital platforms, especially in relation to migration and mobility.[3] This project encompassed research into both the urban gig economy in Germany (with a focus on delivery and logistics platforms) and crowdwork in Germany and Eastern Europe, exploring the online gig economy by performing in-depth ethnographies of both forms of platform labor and conducting 70 interviews with both types of platform workers. Second, a large European research project on platform labor, *Platform Labour in Urban Spaces* (2019–2022),[4] comparatively analyzed four different platforms in seven European cities, with a focus on labor, the labor process, and digital technologies. That project's empirical work consisted of qualitative interviews with 229 platform workers in the seven European countries combined with focus groups and more than 60 interviews with different experts and stakeholders (including researchers, NGOs, unions, city councils, and administrations), as well as legal and document analysis. Third, this paper draws upon research undertaken by the author in the framework of a different project (2012–2017) including (auto-)ethnographic work on global crowdwork platforms combined with forum analysis and interviews.[5]

These in-depth studies cover different forms of platform labor in different countries and locations. This paper does not strive for a quantitative or comparative analysis of the material as a whole. Instead, in the following, I concentrate on the qualitative and conceptual analysis of excerpts from the material. The section on the urban gig economy focuses predominantly on the research into gig economy platforms in Berlin (where extended ethnographic field research was undertaken in addition to the interviews). Because the section concerning the online gig economy naturally lacks this spatial grounding, there the presentation of the analysis proceeds along different constellations of engagement with online platform labor. The workers quoted were chosen according to different labor and employment situations that represent important groups of crowdworkers. Due to the very diverse demographics of crowdworkers, these examples are important groups in our sample but by no means exhaustive. The urban gig workers quoted represent a tendency in our Berlin sample: Most gig workers in the city have a migration background (although with very different visa statuses, employment options, etc.) and are under 40. In the respective empirical sections, the qualitative analyses will be situated within the broader results of our research projects and their demographics in Germany and Europe, as well as incorporating findings from the research literature. Nonetheless, the conceptual argument rests on an analysis that remains qualitative and ethnographic in nature.

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3 https://www.platform-mobilities.net/en, funded by the Deutsche Forschungsgemeinschaft (DFG).

4 Funded by the European Commission in the Horizon2020 framework, https://cordis.europa.eu/project/id/822638.

5 See Altenried 2022.

By using cases from these different sectors and locations of the platform economy, the article demonstrates how algorithmic management enables the quick inclusion and remote organization as well as substitutability and fluctuation of workers, contributing to the flexibilization and heterogenization of labor in very different contexts. Although these cases represent particular examples, because digital platforms only constitute a (rather small) part of today's world of work, I will argue towards the end of this paper that these developments and effects of algorithmic management can also be observed in workplaces and sectors beyond the gig economy.

3 Algorithmic Management and the Multiplication of Labor

The term algorithmic management commonly describes a range of digital technologies designed to partly or completely automate the organization, coordination, and control of the labor process. Instead of receiving instructions and supervision directly from (middle) management, workers are given their orders and specifications via digital applications that control, for example, workflows for office workers or, in the case of the app from the opening vignette, navigation routes and logistics for delivery drivers. The measuring logic of such forms of automated management is often described along the lines of "tracking, tracing, and rating." In some cases, gamification and "nudging techniques" play a bigger role, demonstrating how these systems attempt to incorporate more subtle forms of control (Lee et al., 2015; Moore, 2017; Beverungen, 2017; Wood et al., 2019; Kellog et al., 2020).

The extent of the usage of algorithmic management varies across sectors and locations, as does the extent to which management processes are completely automated or human management works alongside and with the help of digital management tools. Hence, algorithmic management is a broad and somewhat imprecise term that brings together several different techniques and technologies (Krzywdzinski & Gerber, 2021). For the sake of this article, this broad term is sufficient because I am particularly interested in the effects of automated management (i.e., a form of management that is replicable and cheap/efficient at large scales), which can indeed reach from direct control to gamified incentives.

Not least in the context of COVID-19, the development and implementation of such technologies have been dynamic, in places substituting for stagnating attempts to automate labor (Schaupp, 2022a). While these automated management technologies allow for new forms (and often a new granularity) of control over the labor process, control gaps do exist and new forms and strategies of resistance by workers have arisen. This makes it important to understand not only the new forms of control but also the manifold forms of resistance that

workers have developed in the face of algorithmic management (Gerber, 2020; Woodcock, 2021; Heiland, 2022; Altenried & Niebler, 2024). For this paper's purposes, I want to mostly ignore this debate about the intensification of control by means of digital technology and the possibilities of resistance by workers.

Analytically, it is equally important to understand digital forms of management not simply as tools for the more efficient usage and control of labor power (which they certainly are in many cases), but also to focus on the composition and restructuring of workforces based on and enabled by such technologies. In many cases, it is not only (or not even primarily) the level or efficiency of direct control (which can be patchy or limited in other cases), but the speed and cost-efficiency associated with the flexible incorporation of diverse workers into production processes that make algorithmic management a factor in the transformation of work. Before demonstrating this empirically, I want to introduce the concept of the multiplication of labor to conceptualize the tendency.

In their book *Border as method, or, the multiplication of labor*, Sandro Mezzadra and Brett Neilson describe the multiplication of labor as "the parallel operation of the three tendencies – intensification, diversification, and heterogenization of labor – that are increasingly reshaping labor experiences and conditions" (Mezzadra & Neilson, 2013, pp. 91–92). With this concept, they strive to supplement the familiar term of the division of labor and describe the "reorganization of the borders within and between labor markets, as much as the multiplicity and diversity that now makes up labor forces" as key features of this global multiplication of labor (ibid., p. 113).

They point to heterogenization as a crucial development in the composition of labor and workforces. Their argument and approach center on not only the dynamics of migration in the production of labor markets but also the "productive" role of borders in the constantly ongoing segmentation, fragmentation, and temporalization of these labor markets and their overlapping and unstable borders under contemporary capitalism. This notion also considers the flexibilization of labor, the proliferation of short-term, subcontracted, freelance, and other forms of irregular employment, as well as the general trend toward unstable and multiple labor arrangements instead of the Fordist ideal of one stable and lifelong job.

However, the concept is also extremely effective for understanding major dynamics in the transformation of labor driven by digital technology (Altenried, 2022). Digital technology, especially forms of algorithmic management, is a specific driver of heterogenization of workforces. The automation of management and the possibility of algorithmically organizing the labor process enables more efficient, temporal, and flexible incorporation of very heterogeneous workforces into production processes.

From the perspective of the mobility of labor, it becomes crucial to research the interaction between algorithmic workplace regimes and migration regimes and how these are co-productive in the creation and transformation of segmented labor markets (Schaupp, 2022b; Birke, 2022). This means that migration is only one aspect of such a process, albeit an important one. The gendered division of labor is another crucial factor at play and, more generally, these processes of multiplication describe a deep restructuring of labor along various spatial and temporal lines.

Platform labor illustrates this in a concentrated form. Digital platforms express many of the described tendencies of multiplication as they strive to flexibly and efficiently include workers from very heterogenous backgrounds, often for short amounts of time, in their production process precisely by automating large parts of the organization and control of the labor process. Furthermore, we can observe this multiplication quite literally in the sense that many workers are logged into various apps at the same time, simultaneously combining two or more jobs or combining wage labor and reproductive tasks.

In the following sections, I demonstrate these dynamics through an empirical analysis that considers two different sectors of the platform economy. First, I concentrate on crowdwork, which is mostly home-based, online labor. Second, I return to the case of urban food delivery introduced in the opening vignette.

4 Crowdwork: Remote Organization and Spatiotemporal Flexibility

In conversation with Daniel, a student earning parts of his income as a crowdworker, we came to talk about the ways he incorporates online platform work into his daily life.[6] Daniel's specialty at this time was product descriptions for online shops, for example, a hardware store selling curtains. Sitting next to his desk, fitted with two computer screens and a large hourglass, he said, "Food in the oven – half an hour of work; if there is a break between two lectures, I'll quickly write another text on curtains on my laptop." To rank high on search engines, products from online shops need original product descriptions, as was the case for the online shop of the hardware store for which Daniel was writing the small texts on curtains (via a platform). Although he received financial support from his parents and worked as a student assistant, he still needed €100–200 per month to make ends meet.

6 The names of all interview partners have been changed.

In that conversation in his flat in Berlin-Wedding, Daniel explained that he tries to earn this amount on platforms whenever he has some free time to spare. That pause between lectures that Daniel utilizes as labor time expresses a spatiotemporal re-configuration and flexibility that is a crucial quality of digital labor platforms and the ways that they are intervening in the division of labor. This demonstrates the ways that online labor platforms can access new periods and fragments of time for digital wage labor. This break between lectures is a slice of time (and space) that was previously unreachable for wage labor but can now be almost seamlessly integrated into a globally distributed but tightly and automatically organized production line via the digital infrastructure of the platform.

Today, the online gig economy, often also referred to as cloud work or crowdwork, encompasses hundreds of platforms, including Freelancer, Appen, and Clickworker. These online labor platforms enact new forms of control and flexibility and serve as decentralized sites of digital production that are important to many nodes of the global economy, most notably the production and training of artificial intelligence (AI) (Altenried, 2022; Gray & Suri, 2019; Schmidt, 2022). The advancement of AI applications relies significantly on extensive, well-categorized training datasets, the creation of which demands substantial human labor. Presently, crowdwork platforms play a pivotal role in providing the millions of hours of hidden labor essential for the development of the algorithms used to train self-driving cars or the comprehension of human language. Because some crowdwork platforms have exclusively directed their operations towards the burgeoning sector of generating training data for AI applications, the substantial human labor required for the training and optimization of AI has emerged as a primary driving force shaping the dynamics of the online gig economy in recent years. Nonetheless, training data for AI is only crowdwork sector, even if it is currently the most dynamic. Generally, these platforms outsource all kinds of digital work globally, and we can witness not only huge variation between platforms, tasks, and worker profiles but also different forms of labor organization and control (Krzywdzinski & Gerber, 2020; Berg et al., 2018).

Among many other things, crowdworkers categorize pictures, test software, transcribe audio recordings, and optimize search engine results, accessing the platforms from their homes, cafés, and mobile phones. The platform's digital organization and distribution of tasks, automated management, and quality control allow for this inclusion of deeply heterogeneous workers without the need to spatially, temporally, and subjectively homogenize them in the way that, for example, a factory or office needs to do. For this reason, each platform assembles a very heterogeneous and ever-changing workforce. One U.S. worker, Greg, described his way into platform labor on an online forum for crowdworkers:

> I am one of the many, many underemployed that are out there. I had a great job with a small non-profit, felt good about the work I was doing and made enough to live happily, and then everything just crashed. I was out of work for a bit and then worked part-time jobs just to pay the mortgage. I have a full-time job now but turking [working for the platform Amazon Mechanical Turk] pays for groceries and utilities, wouldn't make it without it. (Forum entry, 2013)

A random task he is working on at a given moment in time might be solved in digitally organized cooperation with a Spanish pensioner looking to increase her pension, a full-time crowdworker from India, a single mother from Australia working while her kid sleeps, an African youth piecing together an income online, a chronically ill and unemployed person from the rural United States, Venezuelans trying to earn money in a stable currency in the middle of their country's economic crisis, or a refugee to Germany unable to find work locally due to legal restrictions (these, and many more, are people we encountered while doing research into crowdwork platforms).

General and universal claims regarding the demographics of crowdworkers are difficult because the results will vary substantially depending on the platforms included, the point in time, the definitions and methodology used, and the payment mechanism, among many other factors (Berg et al., 2020; ILO, 2021; Stephany et al., 2021). Part of this problem is the highly dynamic nature of online crowdwork, with digital platforms able to efficiently and opportunistically match an ever-changing amount and quality of work with a global and equally dynamically changing workforce. This dynamic is part of the logic of multiplication of labor that this paper has set out to interrogate. In our studies, patterns do emerge. For example, students like Daniel and un- or underemployed (for multiple reasons) people like Greg represent important groups. However, another important group of crowd workers that is interesting with respect to the question of how platforms intervene in the (this time: gendered) division of labor are crowd workers with care responsibilities.

These workers, still predominantly women, combine tasks such as caring for children or other relatives with digital wage labor via a platform, performing crowdwork when they have a few hours or minutes to spare. Alexandra, a Romanian crowdworker interviewed by my colleague Mira Wallis in the context of our project, described how she started to work after her baby went to sleep: "After 8 pm or sometimes around 9 pm, when I'm not too, too, too tired, then I start and I try to work until 12 at night." She explains that her baby's naps in the daytime are too short for this "because he's sleeping half an hour. So that's something I want to enjoy for myself, not like work." At the time of the interview, Alexandra's husband was working full-time, and she wanted to complement their income without spending money on a babysitter. Many female crowdworkers revealed similar situations, often also related to caring for older or sick relatives and partners (Altenried, 2022; Berg et al., 2018; Wallis, 2021; Wallis, forthcoming; James, 2022).

However, it is not only digital workers with care responsibilities who have very fragmented labor days – many workers fit in a few minutes or hours whenever they can. Daniel's utilization of the break between lectures or when his food is in the oven hint at this process and the increasing fluidity of labor time. Other crowdworkers interviewed in the context of the focal projects worked in between (or even during, if they had downtime) other jobs. Some reported working uninterrupted hours, some through the nights, while others reported striving for regular working hours. Digital platforms can automatically assemble the fragmented temporalities of their workers into a digital production process that functions effectively. This allows online labor platforms to integrate a very heterogeneous set of people in very different situations, locations, and temporalities. The dissolution of unity of time and space found in the traditional workplace (Huws, 2016) is countered by automated work organization and the digital orchestration of cooperation by platforms.

Besides this ability to accommodate and utilize temporal fragmentation, the spatial dimension of the online gig economy clearly represents an important dimension. Provided there is a working connection to the internet, crowdwork can theoretically be done from anywhere. Although in practice there remain important borders and fragmentations, even in the world of online work, this spatiality, which enables the cooperation of globally dispersed digital workers, articulates a new quality, with the online gig economy as the first truly "planetary labor market" (Graham & Anwar, 2019) implicated in the deep transformation of existing labor geographies. The spatial flexibility is, of course, also an important factor in the described indexing of new workers or time periods for wage labor. Although the possibility of working from home is paramount, adopting a wider lens, we also start to see a broader spatial dynamic. Crowdwork has become, for example, important in locations with few labor market alternatives: from rural North America to urbanizing Africa to refugee camps in Lebanon, to name a few examples (Flores-Saviaga et al., 2020; Amir Anwar & Graham, 2022; Hackl, 2022).

This is only a glimpse into the multifaceted geographies of online platform labor. Millions of remote digital workers across the globe log into these platforms daily from their kitchens or living rooms to earn money. Digital standardization and algorithmic management, as enacted by digital platforms, make "work identifiable, searchable, and tradable at a truly planetary scale" (Ferrari & Graham, 2022, p. 12). Even though platform workers come from very different backgrounds and situations and are located in vastly different geographical, cultural, and temporal contexts, the algorithmic infrastructure of digital platforms synchronizes their labor into a tightly organized production process.

In this way, online platform labor also challenges our understanding of an international division of labor as described by Mezzadra and Neilson in terms of the multiplication of labor. We do not only observe a transformation of local economies when digital platforms become a factor in these economies; instead, these digital platforms transform the very spatiality of these labor geographies as they open up possibilities of remote work that create new proximities and, thereby, enable new production processes. This means that online platform labor embodies a quality of digital technology that "forces seemingly discrete territories and actors into unexpected connections that facilitate processes of production, dispossession, and exploitation" and thereby contribute to the "heterogenization" of global space (Mezzadra & Neilson, 2013, p. 23).

5 Urban Gig Work: Migration and Mobility

From the online gig economy and its global geographies, we return to location-bound gig economy platforms. Here, the provision of services such as cleaning, cab rides, and food delivery is fixed to the location of the customer. Accordingly, this variant of the gig economy develops a predominantly urban geography. The food delivery platform introduced in this paper's opening vignette, like similar platforms in other sectors and cities, provides a related yet particular impression of the dynamic interaction between automated management and the heterogenization of labor in comparison to the crowdwork platforms.

In August 2019, I interviewed Bastián, a Chilean food delivery rider for the platform Deliveroo, in a park in Berlin's Neukölln neighborhood. We were speaking about his decision to move to Berlin and how he started as a rider. "I always thought that it was an option working in Deliveroo, even when I was in Chile," he told me. For migrants from Chile, most of whom, like Bastián, had come to Berlin on a one-year visa, these platforms provide a starting point: "It's quite known that both Helpling and Deliveroo are the easy jobs to apply to when you come with a visa because you only have one year (…). You don't need [too many] papers, and you don't need to speak German."

In a few words, he has already described many of the reasons that migrants often end up working for gig economy platforms, not only in Berlin but in many cities in Europe and across the globe. As exemplified by this paper's opening vignette, most platforms have a quick and simple application process with very few formal requirements in terms of qualifications, documents, or skills. Many platforms demand minimal registration papers, work permits, or similar documents before new workers can start. Thus, for many migrants whose documentation, visa, or proof of permanent address would not suffice at other jobs, digital platforms represent a quick way into the labor market, as Bastián and his many fellow platform workers demonstrate.

For example, Cristina, a recent newcomer to Berlin from Buenos Aires, works for the cleaning platform Helpling, which provides her with cleaning gigs, predominantly in private homes. To start working, all she had to do was complete an online application. Then, she could start work in a matter of days, after uploading her passport and her visa and entering her bank details. Another crucial factor for migrants such as Bastián and Cristina was their lack of command of the German language. Asked why these platforms attract so many migrants, Cristina identified the issue of language as a main reason: "It is an easier way to get a job without having to do an interview in German or English." Without basic German skills, access to even precarious or low-skilled jobs is limited. However, because gig economy apps often work in several languages and are quite simple to operate, they are an option even for those who speak little or no German or English.

Hence, the accessibility of platforms like Helpling or Deliveroo and the ability to earn money without knowledge of the language make those platforms important especially for many recent migrants. In the case of Bastián, Cristina, and many of their colleagues, digital platforms have become essential parts of "migration infrastructures" (Xiang & Lindquist, 2014; for more detail, see Altenried, 2021; Altenried et al., 2018). Oftentimes, these workers also switch between platforms or work for different platforms at the same time to support their migration projects. This is the case for Gabriela, a young woman from Barcelona who left Spain and its precarious labor market for young people, moving first to France and then Berlin. In Berlin, she started to work for Deliveroo (and later moved on to Lieferando, another food delivery platform). In addition to the income earned on her bike delivering food, she also worked for Helpling and would intermittently sublet her (rented) apartment via Airbnb. This is another example showing how Berlin's platform urbanism is interwoven with mobility and migration (Altenried et al., 2021).

Unlike Gabriela, an EU migrant who can work without a visa, Bastián and Cristina only have temporary work permits. They are from South America, which represents a substantial contingent of Berlin's platform workers, partly due to a certain type of visa and network effects of migrant communities. Overall, however, migration histories and biographies, visa and employment status, and other vectors vary greatly across the heterogeneous platform workforces of Berlin. Students and other migrants from South Asia work alongside European migrants, especially those from the south and east of the continent, refugees from Syria and Afghanistan, and North American tech workers who are between jobs, to give just a few examples from our research in Berlin in recent years. For all these migrant workers, platforms mean different things, and their duration on the platforms, their alternatives, and their future plans can vary significantly, as can their dependency on gigs and, accordingly, their level of precarity.

Similar tendencies could be observed in our research across different European cities. Sometimes bigger contingents of certain migrant communities or visa types were more strongly represented in a particular platform or city. Overall, workforce composition varies greatly from city to city and country to country, dependent on national migration regimes, local labor markets, and other factors. Although platform-based food delivery is done almost predominantly by undocumented migrants in some cities, in other cities, the same platforms might be populated predominantly by legal migrants, native workers, international students, or any combination of these (Pirone, 2023; Mezzadra et al., 2024).

Because the labor model of gig economy platforms is somewhat indifferent to these differences, it can opportunistically profit from the ways migration regimes structurally produce precarious situations predominantly for migrant workers who, in most of the bigger European cities, constitute the majority of those working for digital platforms. For platforms like Deliveroo, Helpling, and Uber, these migrant workers constitute a crucial labor pool because they are forced to accept unstable and precarious conditions that are less attractive to workers with more options in the labor market. Although similar patterns can be observed globally, in some cases, they are more connected to internal rather than transnational migration patterns (see, e.g., Altenried, 2021; Van Doorn & Vijay, 2021; Van Doorn & Ferrari, 2023; Gebrial, 2022; Greef, 2019; Liu, 2019; Das & Srravya, 2021; Orth, 2023).

To a certain extent, this is to be expected: Many global cities develop "new migrant divisions of labor" characterized by a segmented labor market, where precarious jobs, especially in the service sector, are largely filled by migrant workers (Wills et al., 2010). However, digital platforms, their labor model, and their systems of algorithmic management still express a new and special quality that I want to underline. In many ways, the platform's systems of automated management of contingent workforces are suited perfectly to the employment and exploitation of mobile workforces. App-based systems of algorithmic management allow for the largely automated organization of workers and their daily work. Food delivery riders, Uber drivers, and Helpling cleaners need little training, language skills, or supervision because the app navigates urban space and daily work tasks on their behalf. These possibilities of digital organization, instruction, and control make it possible and efficient for platforms to hire workers who are new to a city and do not speak the native language (and possibly no lingua franca, such as English), let them start working immediately, and, possibly, let them go again after only a few weeks. Here, algorithmic management substitutes for the large amounts of training, various forms of supervision, control by human management, and building of trust that would make it hugely inefficient (and possibly risky) for corporations to hire workers for only a few weeks or months.

Considering the business model of digital platforms, algorithmic management develops its effect and efficiency in combination with the contingent labor arrangements represented by the forms of self-employment, short-term or zero-hour contracts, and sub-contracting models often found in the platform economy. Furthermore, this very combination allows platforms to accept a high number of workers because the few fixed costs and risks are outsourced to the workers. Under these conditions, a high fluctuation in the workforce is not a problem but, instead, part of the calculus for platforms that can count on a latent reserve army of (migrant) workers who can be flexibly and temporarily included in production processes.

Digital platforms enable new strategies, routes, and pathways for migrant workers who base their mobility projects on platform labor, and these platforms condition their differential, partial, and temporal inclusion in national labor markets (Mezzadra & Neilson, 2013). A large part of today's gig economy is based on predominantly migrant and often highly mobile workforces whose quick, flexible, and temporal inclusion in the platform's labor process is predicated upon automated management technologies. In Germany and many other countries, the migration regime produces many different migrant situations, groups, and categories. Vectors of migration regimes – such as citizenship, visa, work permits, language skills, and racism – lead to fragmented labor markets characterized by a range of statuses and positions. The workforces of digital platforms often represent many of these, sometimes very different, migrant situations (while others are absent; see Orth, 2023).

That so many of these migrants end up working for digital platforms is, in many cases, not the intended effect of these migration policies and laws but often a function of the strategic and creative utilization of grey zones by workers (and platforms) and sometimes even the direct circumvention of laws, as in the case of the informal renting of accounts to undocumented migrants (see Altenried, 2021; Animento, 2024). In any case, these migration regimes are producing the workforces that carry many gig platforms today. The flexible, temporal, and efficient inclusion of these workers in the production processes of these platforms is largely based on algorithmic management. Here, we can see digital technologies – and automated management more specifically – interact with migration regimes and the mobility of labor and help to co-produce the specific labor model upon which the contemporary gig economy is built.

6 Conclusion

The worlds of both the online and urban platform-based gig economies show how technologies of algorithmic management drive the flexibilization and heterogenization of workforces. The gig economy shows many dimensions of this multifaceted process that can be understood in the framework of a multiplication of labor. Digital platforms function as distributed "digital factories" (Altenried, 2022) that can, as in the case of crowdwork, coordinate tens of thousands of spatially distributed digital workers into automatically organized production processes. However, with the help of digital technologies, this functions without the need to temporally, spatially, or subjectively homogenize these workers as, say, a Fordist factory needed to. Relatedly, algorithmic management allows the flexible and temporal inclusion of heterogeneous and often predominately migrant workers in the labor processes of the urban platform economy.

The digital organization, standardization, and automation of management drive the heterogenization and flexibilization of workforces described here as the multiplication of labor. This allows for the quick and flexible incorporation of very diverse workers into production processes and the synchronization of varying temporalities and spatialities. Digital technologies and algorithmic management are part and parcel of the flexibilization of labor relations signified by the proliferation of flexible contractual forms – such as short-term, subcontracted, and freelance, among other forms of irregular employment – or, simply, by the example of a platform worker working multiple jobs or for multiple platforms at the same time. In this way, algorithmic management – and digital technology more broadly – are an important aspect of contemporary transformation processes that affect not only the labor process but the division of labor in all its dimensions.

To consider one example, if a woman with care responsibilities can now participate in wage labor because an online platform allows her to work from home for a few hours in between domestic tasks, this enables new combinations of digital wage labor and unpaid reproductive work, thereby intervening in the gendered division of labor and the composition of workforces. It also pertains to a new geography of production connecting private homes and global platforms on the basis of very flexible ways of including workers in production processes. Although none of these dimensions are completely new (we might think of home-based labor done predominantly by women in early industrial capitalism), digital technologies do bring about new and dynamic transformations of all dimensions of the division of labor and, therefore, the composition of class under digital capitalism.

Digital platforms represent a very vivid example of the tendency toward the interplay between digital technologies and the multiplication of labor. However, the gig economy's labor model is quite particular and this paper does

not intend to claim that we can observe a generalization of this labor model. Instead, today's world of work is characterized by the co-existence of very different labor regimes. The importance of algorithmic management varies greatly between regimes, sectors, and locations, and the implementation is often complicated and contested, with different (or limited) effects observed in different settings (Jarrahi et al., 2021; Baiocco et al., 2022; Doellgast et al., 2023). Nonetheless, I would argue that what I have described as the interplay between algorithmic management and the multiplication of labor also becomes visible across sites of work outside the gig economy.

One example is the infamous warehouses of the logistics giant Amazon. Here, the various technologies of standardization and algorithmic management reduce training times and increase control possibilities. Amazon, one of the world's biggest private employers, can utilize flexible and short-term solutions in the recruitment of labor with the help of these technologies. Short-term hiring and firing of workers to satisfy the contingencies of supply chains and business peaks – as in the weeks before Christmas, when the workforce in many warehouses doubles – would be impossible without this form of partly automated organization and control of the labor process (see Barthel & Rottenbach, 2017; Apicella, 2021; Altenried, 2022; Birke, 2022). Seasonal work, short-term contracts, and outsourced labor are important components of the labor regime in Amazon's distribution centers, proliferating across different sectors in today's world of work. This hints at the fact that the tendency I have analyzed here is not limited to the gig economy but can be observed across different sites. Nonetheless, the tendency has far from become universal in a very diverse world of work.

Finally, these findings suggest an important point concerning digital technologies and automation. While the discussion around digital automation is often limited to debates and prognoses concerning the number of jobs set to vanish, the examples discussed in this article turn our attention to the ways digital technologies are implicated in a deep restructuring of the division of labor from a global perspective. Some jobs that are seemingly automated at one point have the curious tendency to reappear in a new location, in a different technological constellation, performed by different workers. Beyond the way that online gig workers as a hidden form of labor behind AI applications clearly demonstrate an important dimension of such technologies, this phenomenon exemplifies the ways that labor is restructured, multiplied, and re-divided. In the examples discussed, the automation of management surely means that digital technologies imply that less human labor is needed to manage workers. However, instead of counting the number of lost jobs, it seems more important to concentrate on the ways that these automated management technologies help to produce new labor regimes such as the gig economy. It is here, in the deep restructuring of the division of labor in all its aspects, that we find the most profound transformations of work brought forth by digital automation technologies.

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