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Producing speed on demand: Reconfiguration of space and time in food delivery platform work

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Abstract

Existing IS research on platform work has narrowly focused on the managerial operations of algorithmic management or its business implications. Limited research has paid attention to the scalar effects and societal implications of platform work. In this study, we address the phenomenon of 'speed' in the on-demand economy through a qualitative study of Chinese food delivery workers. We construct a performative view of spatiotemporality to illustrate the reconfiguration of multiple spatiotemporal orders. The paper thus broadens the theorisation of time and space in IS research and provides a more nuanced and critical understanding of platform work against the backdrop of structural inequality in platform capitalism.

KEYWORDS
algorithmic management, performativity, platform work, spatiotemporality, speed

1 | INTRODUCTION

Research across academic disciplines on platform work and the on-demand economy has flourished in the last few years. As part of the rapidly expanding 'platform capitalism', some platforms operate as a digital labour intermediary where consumer demand is matched with supply from a pool of short-term labour (Graham et al., 2017). Platform work has transformed the nature of employment relations (Duggan et al., 2020) by encouraging the individualisation of work and shifting the responsibilities of worker welfare, job security, and health and safety to individual workers,

leading to a higher level of employment precarity and economic insecurity (Coyle, 2017; Duggan et al., 2020; Malin & Chandler, 2017; Petriglieri et al., 2019).

Information systems (IS) research has mainly focused on the managerial operation of algorithms, for example, the design, implementation and use of algorithmic decision-making in organisations (Marabelli et al., 2021), and the coordination and control of the work process through computer algorithms (de Reuver et al., 2018; Hong et al., 2015; Möhlmann et al., 2020). Limited research has looked into broader social implications of platform work. This paper responds to the call to examine the 'scale effects' of digital work practices (Barrett & Orlikowski, 2021) in the recent MIS Quarterly special issue on future theories, and investigates the 'production of speed' (Wajcman & Dodd, 2016) in the on-demand economy. The scale here does not refer to size or volume, but the 'lived experience of scale' that is enacted in ongoing practice yet with far-reaching effects across time and space (Barrett & Orlikowski, 2021, p. 467). We argue that on-demand labour platforms, as a type of techno-human infrastructure (Iazzolino, 2021; Irani & Silberman, 2014), not only support new business models and serve as an intermediary in the labour market but also produce the scale effect of speed and acceleration (Rosa, 2016) by shaping the spatial and temporal ordering of social life. Such restructuring and reordering may become immersed into the social fabric in the near future, institutionalised, normalised and taken for granted (Hanseth & Monteiro, 1998), and shape our future lives (Hovorka & Peter, 2021). It is therefore important to investigate this social construction process before the 'black box' is closed on the language of actor-network theory (Latour, 2005), that is, when the sociotechnical network becomes stabilised and its effect difficult to reverse.

On-demand platforms contribute to the ongoing trend of acceleration in modern life (Rosa, 2016) by matching, mobilising and coordinating large volumes of human and material resources with algorithms. Drawing upon a wide range of literature on time and space, we adopt a performative perspective (Barad, 2003; Introna, 2013; Suchman, 2007) of spatiotemporality to take on the question - 'how is speed produced' (Wajcman & Dodd, 2016, p. 3) in on-demand platform work? Our aim is to showcase how such a perspective can enrich our understanding of platform-based algorithmic work and shed light on the social and societal effects of digital platforms (Galliers et al., 2017; Newell & Marabelli, 2015). Based on a qualitative study of food delivery platform workers (often referred to as 'riders') in Beijing, the paper seeks to address the research question: *How is the speed of food delivery platform work performed through spatiotemporal practices?*

In the rest of the paper, we first survey the multidisciplinary literature of platform work, the relevance of a spatiotemporal perspective, and the underdeveloped conception of time and space in the IS literature. Section 3 proceeds to construct a 'performative view of spatiotemporality' as our theoretical framework. Following the methodology section detailing the empirical context, the source of the data and the process of analysis, Section 5 presents a rich case study on the work and life of food delivery riders in Beijing, followed by an integrative discussion on the spatiotemporal production of speed in on-demand platform work. We conclude the paper with a short summary of contributions and future research.

2 | LITERATURE REVIEW

2.1 | Algorithmic management of platform work

Computer algorithms have been found to reconfigure production and human resource practices in organisations (Meijerink & Bondarouk, 2021; Pachidi et al., 2021; Willems & Hafermalz, 2021). In the specific area of platform work, one of the core research themes lies in how the labour process has been transformed through algorithmic management (Duggan et al., 2020; Gandini, 2019; Kellogg et al., 2020; Purcell & Brook, 2020). Spatial and temporal flexibility and the sense of autonomy in platform work are often considered key attractions to platform workers (Mäntymäki et al., 2019; Prassl, 2018; Wood et al., 2019). For example, Deliveroo attracts workers by accentuating flexibility, independence and attractive income, framing gig workers as entrepreneurs (Galière, 2020).

Critical scholarship on the effect of algorithmic management tends to treat the algorithm or the platform as a 'black box', an invisible hand that coordinates, controls, measures, and even manipulates workers' behaviour. While some emphasise workers' agency and even resistance to algorithmic management (Bucher et al., 2020; Chen, 2018; Jarrahi & Sutherland, 2019; Purcell & Brook, 2020), platforms and algorithms are often treated as objective, independent and technical entities that exert sovereign power over workers. Furthermore, algorithmic management renders managerial control less visible, hidden behind devices, which exert a combination of technical and normative control (Cram et al., 2020; Duggan et al., 2020; Kellogg et al., 2020; Möhlmann et al., 2020; Newlands, 2020) over workers by enacting 'information asymmetries' between the system and workers (Jarrahi & Sutherland, 2019; Rosenblat, 2016; Shapiro, 2018).

In contrast, IS researchers tend to focus on transactional mechanisms or managerial processes on these platforms, in particular, the algorithmic matching, coordination and control (de Reuver et al., 2018; Hong et al., 2015; Möhlmann et al., 2020). Only a small number of IS papers interrogated the wider implications of algorithmic management beyond business benefits (Cram et al., 2020; Deng et al., 2016). For example, Deng et al. (2016) explore how workers at Amazon Mechanical Turk experience a duality of empowerment and marginalisation. As a whole, limited IS research has situated algorithmic work in broader social contexts while scholars have called for research that examines the societal effects of digital algorithms (Galliers et al., 2017; Newell & Marabelli, 2015).

2.2 | Time and space in the on-demand economy

As this paper is interested in answering the question 'how speed is produced' in the on-demand economy, we examine algorithmic management not only in terms of regulating on-the-job work practices but also in a broader societal context where the demand and supply of labour, mediated through digital platforms, interact with existing social orders in the organising of time and space. Graham (2020) points out that digital technologies, such as the Internet, are deeply integrated into urban life, giving rise to 'hybrid spaces that are co-created, transduced, and augmented by the digital' (p.453). For example, Google Maps constructs digital-spatial representations with which users interact, which define their conception and experience with places. Likewise, the notion of the workplace has long evolved from that of a bounded physical space to distributed, fragmented and fluid spaces that are digitally mediated, carried out by a loosely organised set of workers with a highly flexible timescale (Sewell & Taskin, 2015; Wood et al., 2019). Accelerating techno-social changes also leads to a generalised perception of time-scarcity and a pressure to do more in less time (Wajcman, 2008).

On-demand platform work has further exacerbated the fluidity and distributiveness of work across time and space (Graham & Anwar, 2019; Jones, 2008). Compared to just-in-time management in the mass production era, the digital age celebrates the 'pay-as-you-go' on-demand model of gig work, mobilised and made available at any time, any place. On-demand labour platforms operate through the spatial and temporal coordination and control of labour and resources, and the interrelations among various stakeholders. This requires a large and geographically distributed workforce who are constantly recalibrating their own temporal and spatial relations when fulfilling the demand of the platform (Sharma, 2008, 2011, 2014). For example, ride-sharing services (e.g., Uber) are built on sophisticated algorithms that instantly match supply and demand based on the geolocations of drivers and customers at any given time (Scheiber, 2017). Even on platforms where the deliverables are digital goods, workers have to synchronise their time to that of clients all over the world, which leads to irregular and unpredictable work schedules (Wood et al., 2019). In these cases, the spatiotemporal flexibility of workers – often hailed as the hallmark of the gig economy – is actually tethered to and continuously reconfigured by the demands through algorithm management.

Furthermore, the time–space compression and acceleration of speed, as a result of digitisation, are experienced differentially among various social groups, manifesting social disparities and power geometry in digital societies (Jackson, 2016; Sharma, 2014). As Massey (1994) acutely points out:

> different social groups have different relationships to this anyway-differentiated mobility: some are more in charge of it than others; some initiate flows and movement, others don't; some are more on the receiving end of it than others; some are effectively imprisoned by it (p.61).

It is from this perspective that we seek to address the question of 'how speed is produced' in the on-demand economy. That is, as digital platforms reconfigure labour relations and practices, they also exert the effect of stabilising and contesting power relations. To establish a spatiotemporal framework for analysing such power relations, we start with taking stock of the conceptions of time and space in the IS literature below.

2.3 | Time and space in IS research

Spatiotemporal structuring is at the heart of social organisation. The role of digital technology in the temporal transformation of work has long been acknowledged, although only a small number of papers can be found in the 'basket of eight' IS journals. IS researchers have shown how digital technologies affect the temporal organising of work (Barley, 1988; Lee, 1999; Orlikowski & Yates, 2002), the coordination of distributed teamwork (Cummings et al., 2009; Sarker & Sahay, 2004) and distributed IS development projects (Colazo & Fang, 2010; Stacey & Nandhakumar, 2009). Lee (1999) challenges the monochromic view of time in business processes and highlights the digital medication of polychronic, that is, multiple lines of simultaneous activities in achieving a 'temporal symmetry' across employees and departments in an organisation. Similarly, Ancona et al. (2001) recognise the multiplicity of timelines in the 'meshing of activity maps' but focus on 'temporal personality' (individual disposition toward time) to capture and explain 'temporal fit' in organisational activities rather than social processes of organising and structuring. As a whole, it has been noted that IS literature takes a predominantly linear clock view of time, and analyses data with a simplistic time-activity mapping (Shen et al., 2015). The theorisation of space or spatiality is even more scarce in IS research. Space is often used in a physical sense, that is, referring to geographical areas, as in studies of globally distributed teams and online communities (e.g., Cummings et al., 2009; Recker & Lekse, 2016; Sarker & Sahay, 2004), or in the differentiation of virtual space versus physical place (Goel et al., 2011; Saunders et al., 2011).

In short, while the literature has recognised the critical role of digital technologies in the spatial and temporal structuring of work, space and time are largely seen as objective and exogenous of human activities, for example, as containers or measurement of work. Only a handful of IS studies consider temporality and spatiality as emergent effects of social practices, entangled in materiality and embedded in broader power structures. For example, Kavanagh and Araujo (1995) use the oriental origami as a metaphor to show the construction and deconstruction of time and showcase 'a multi-layered view of time' (p.28) where different temporal frames interact. Barrett and Scott (2004), in their study of electronic trading, draw upon Structuration Theory (Giddens, 1984) and Adam's (1995) social analysis of time to examine the 'connections and mutual implications between temporal features of globalisation and (industrial) work time' (p.67). Prasopoulou et al. (2006) examined how a mobile phone sets a temporal boundary between the public and private spheres. Baygi et al. (2021) use a 'flow-oriented' theoretical vocabulary and argue that IS researchers should view temporal becoming as the default condition of being in the world, accentuating the perpetual and relational constitution of sociotechnical phenomena. Recent works in Organisational Studies also shed some light on 'material temporality' (Hernes et al., 2021) and power dynamics in technology-mediated organisational space (Newlands, 2020). Rather than viewing time as an exogenous measure that defines materials' flow, Hernes et al. (2021) show how the movement of materials in the supply chain embodies, transforms, and creates temporality.

The present study is situated in and builds upon the IS and Organisational Studies literature that treats spatiotemporality as multiple, relational, contingent, constitutive, and entangled with everyday practice. Below we construct a performative view of spatiotemporality, expanding from the narrow focus on spatiotemporal structuring in organisational activity and the objective-subjective dichotomy of time and space. Through this view, we seek to

demonstrate that platform-workers' spatial and temporal negotiation with algorithmic management is embedded in societal dynamics of spatiotemporal structuring and power relations, which are inscribed in the technological design and the governance of platform work.

3 | A PERFORMATIVE VIEW OF SPATIOTEMPORALITY

The notion of performativity refers to 'the outcomes produced by the doing' (Orlikowski & Scott, 2015, p. 9), emphasising that reality is enacted and accomplished in discourse and practice. It has a long intellectual history (Barad, 2007; Butler, 2011; de Certeau, 1984; Deleuze & Guattari, 1987; Mackenzie, 2006; Pickering, 1995; Thrift, 2008) and within the IS discipline has been notably incorporated in the conceptualisation of sociomateriality (Orlikowski, 2007; Orlikowski & Scott, 2008; Scott & Orlikowski, 2014). Scott and Orlikowski (2014) conceive performativity as building on 'the idea that the world is enacted in practice… In this view, realities such as identities, spaces, and markets are performed - made real - in ongoing practices' (p. 879).

Beyond the IS discipline, the performative perspective often entails a critical interest, whether it is the performativity of gender (Butler, 2011) or the production of space as 'performative articulation of power' (Gregson & Rose, 2000). Situated in this critical discourse, we propose a performative view of spatiotemporality and conceptualise the performativity of spatiotemporality as *practiced*, *material*, *political*, and *multiple*. Table 1 shows an overview of the framework with each dimension elaborated in the sections below. These theoretical threads are, of course, interwoven and only analytically separated for discussion. Likewise, we use spatiotemporality to indicate that time and space are mutually constitutive and inseparable but sometimes focus on specific temporal and spatial aspects for analytical purposes.

3.1 | Spatiotemporality as practiced

A performative view of spatiotemporality is firstly built upon the idea that time and space are not objective and independent from human activities, but enacted and produced in everyday practice, which in turn are 'consequential in

TABLE 1 Four dimensions of the performative view of spatiotemporality

Dimensions of spatiotemporality	Conceptual connotation
Practiced	• Space and time are co-constitutive, e.g., a place is an 'event' of 'here and now.' • Spatiotemporality is a product of interrelation, and enacted through situated, everyday practices. • Spatiotemporality is contingent and fluid, rather than fixed and stable.
Material	• Spatiotemporality as material-discursive processes. • Spatiotemporality is constituted by flows of people and material (objects and bodies). • Spatiotemporality entails embodied practices, affect and events.
Multiple	• Social actors produce and reproduce their own spatiotemporalities. • Multiple spatiotemporal trajectories and different scales co-exist and intersect to actualise time and space. • The ordering and maintenance of dominant spatiotemporal orders are performative and inherently political.
Political	• Spatiotemporality is produced by, and reproduces power relations. • Spatiotemporal orders differentiate life possibilities, allocation of resources, and social inclusion and exclusion. • Spatiotemporality embodies inequitable spatiotemporal worth among social groups.

the production of social life' (Feldman & Orlikowski, 2011, p. 1241). In human geography, the concept of space has moved away from the empirical and objective notion of physical place, mappable and with clear boundaries (Hubbard & Kitchin, 2010), to a socio-spatial perspective that conceives space as situated and socially produced in everyday practice (de Certeau, 1984; Massey, 2005). Physical space is not a kind of container that permits or constrains human activities; rather, it is part of generative resources that render human activities possible. Similarly, Lefebvre's (1991) sees space as situated, produced and reproduced through social relations and everyday practices. Space is thus fluid rather than fixed and stable (Liu & Grey, 2018) and can be reconfigured through organisational practices (De Vaujany & Vaast, 2014) and micro-spatial tactics of those inhabiting the space (Munro & Jordan, 2013).

Likewise, time is socially constructed and mediated through human experience (Bluedorn, 2002). For example, our notion of time in terms of length and speed depends on the temporal activities and our experience associated with it. The meaning of time, including seasons, dates, day and night, and tempo of life, vary significantly across cultures, societies, cities, organisations, and even individuals. A practice-based view of time departs from the notion of linear, chunkable, clockwork to being porous, fluid, multiple (Baygi et al., 2021; Wajcman & Dodd, 2016).

Space and time are also co-constitutive. Space is 'the effect produced by the operations that orient it, situate it, temporalise it, and make it function' (de Certeau, 1984, p.117). A place is thus not just a location but an 'event', defined by the activities and relations 'here and now', which may be subject to change over time (Massey, 1993, 2005). For example, a university acquires the symbolic and substantive meaning as a space of education not because of the physical buildings and facilities, but the activities taking place in the university over time: the lectures, classes, and schedules; the interaction among the tutors, students and administrators; and the organisational routines and ceremonial rituals.

3.2 | Spatiotemporality as material

Spatiotemporality entails materiality. Space is a nexus of interconnected flows of people and material (Urry, 2000). In spatial practices, the two aspects of the materiality of everyday life are co-constitutive: the physicality of materiality, its 'thingness', and the social meanings that are embedded in objects and places, as exemplified by cathedrals and temples, historical buildings, parks and public squares. While materiality in IS often refers to artefacts and technology in relation to human agency (Leonardi et al., 2012; Orlikowski & Scott, 2008), in the broader literature, materiality also refers to embodied practices (Jones, 2014). For example, Dale (2005) advances a conceptualisation of 'social materiality' that incorporates phenomenological approaches to embodiment and explores spatial and embodied politics in organisational control.

Materiality also has a distinctive role in the temporal stitching of social practices, giving rise to the very temporal structures in which materials are being used. For example, Orlikowski and Yates (2002) argue that temporal structures manifested as calendars, schedules, and deadlines, which give rhythm and form to work and life; by following these rhythms, human practices reinforce and legitimise the temporal structures, which can then become taken for granted. Hernes et al. (2021) use the concept of 'material temporality' to capture the interplay between materiality and time in the food industry's organising and innovation. They stress that materials in producing food (e.g., a Carlsberg six-pack beer) embody and express time through material transformation, rather than vice versa; that is, 'materiality "does" time' (p. 353).

3.3 | Spatiotemporality as multiple

If spatiotemporality is practiced and material, it follows that heterogeneous assemblages of multiple relationships constitute the performativity of space and time. Massey (2005) argues that space is made at the intersection of economic, social and material relations operating on a range of scales 'from the immensity of the global to the intimately

tiny' (p. 9). Extending her conception of space as interrelations and becoming, Massey (1994) talks about spatiality as heterogeneous and constructed in inter-relations of multiple scales:

> The 'spatial' then … can be seen as constructed out of the multiplicity of social relations across *all spatial scales*, from the global reach of finance and telecommunications, through the geography of the tentacles of national political power, to the social relations within the town, the settlement, the household and the workplace (p. 4, emphasis added).

Multiplicity here means that multiple spatial and temporal orders coexist and intersect, not just in terms of scale, but also in terms of stakeholders' perspectives, experiences and practices. In his seminal work 'Social Production of Space', Lefebvre's (1991) differentiates *conceived space*, designed and produced by planners and architects; *perceived space* that is the presentation of space and the meaning attached to it and *lived space* enacted in our daily experience interacting with the space. The three aspects of the same space are entangled yet different.

As noted earlier, some IS researchers have highlighted how digital technology mediates multiple timelines at work (Lee, 1999; Ancona et al., 2001) and sensitise use to a 'multi-layered view of time' (Kavanagh & Araujo, 1995). Less visible and explored are what Jackson (2016) call the 'temporalities of breakdowns', that is, how stability and (temporal) orders are achieved through the maintenance and repair of the physical world, and that '…"speed", where it is to be found, is a hard-won and by no means automatic accomplishment (p183).'

Furthermore, multiplicity of spatiotemporality arises from social stratification. As depicted in the Hugo award-winning Chinese sci-fi novelette *Folding Beijing* (Hao, 2015), various social groups co-habiting in the same metropolitan city experience very different aspects of the city, as reflected in differentiated temporal enactment of the urban spaces and patterns of movement. For example, cleaners sweeping the streets before daybreak and the homeless spending their night in 24-hour McDonalds, occupy a dramatically different city from the middle-class residents having breakfast at McDonald's over their smartphones and laptops. These distinct spatiotemporal relations represent and produce different meanings, identities, sense of belonging, and life opportunities. Multiple spatiotemporal orders of different classes thus co-exist in the same locale, constituted by the intersection of multiple trajectories, power geometries and heterogeneous embodied experience.

3.4 | Spatiotemporality as political

To the extent that time and space are multiple and materially produced, they are inevitably intertwined with power relations that structure human activities, knowledge, and the distribution of resources (Simonsen, 2007). As Foucault puts it, space is 'fundamental in any exercise of power' (cited in Harvey, 2000, p. 538). Foucault's (1977) panopticon is perhaps the most prominent example of how the design of space embodies power and discipline. In Organisational Studies, it has long been recognised that space is imbued with meaning and symbolism of power and structure (Dale & Burrell, 2007; De Vaujany & Vaast, 2014). The enactment of space is political in the ways that boundaries, inclusion and exclusion occur, and different connections, identification and spatial possibilities are afforded to different social groups (Massey, 1993, 2005).

Likewise, Jackson (2016) cautions against 'the global story of speed' (p. 185), which assumes a unified pace and orientation of time across actors. Jackson reminds us that speed's distributional character and consequence may render certain actors' work marginal or even invisible. Sharma (2011, 2014) goes a step further to call temporality a 'structuring relation of power' and juxtapose the 'chronopolitics' of social life between two temporal classes: *fast* classes and *slow* classes, the time *rich* and the time *poor*. As individuals and social institutions each produce and reproduce their own temporalities, they lead to differentiated and inequitable temporal worth for different populations.

3.5 | The on-demand reconfiguration of spatiotemporality

To reiterate, the conceptual themes of space and time outlined above are not independent or mutually exclusive. Instead, they serve as an integrative theoretical foundation for understanding the practice of platform work. Building on a performative view of spatiotemporality that encapsulates practice, materiality, multiplicity and politics as outlined above and in Table 1, we seek to examine how the spatiotemporality of on-demand platform work is reconfigured in the production of 'speed' (Wajcman & Dodd, 2016). Understanding the production and maintenance of speed sheds light on inequitable social relations and labour arrangements among various social groups across space and time. We conceive the food delivery work in our empirical case as an entanglement of multiple layers of restructuring and reproducing spatiotemporal realities performed by a plethora of human and non-human actors. These realities are teased out later in the findings section as different scales of spatiotemporal orders.

4 | EMPIRICAL CONTEXT AND RESEARCH METHODOLOGY

Data collection in the case study mainly consists of semi-structured interviews supplemented by secondary material from a non-participant observation of online chat groups. The empirical work focuses on one of the largest O2O (online-to-offline) service platforms in China that mobilises around 2.7 million delivery riders, delivering as many as 160 million food orders on a single day. We chose this specific platform because it is the most dominant food delivery platform in China. Using the platform's customer-facing app, one can search restaurants, browse food menus, order dishes, and have the food delivered to their doorstep.

There are two main types of employment contracts in the Chinese food delivery business: *platform exclusive* (专送) and *externally crowdsourced* (外包). Platform-exclusive delivery workers are the platform company employees and work in regular shifts. They deliver orders assigned by the platform and collect a monthly base salary. They are organised in stations and managed by a station manager, who oversees a particular delivery zone in a city. By contrast, externally crowdsourced riders are real 'gig workers' (henceforth referred to as 'gig riders') who get paid for each completed delivery. In principle, anyone in China could register to become a gig rider on the platform by uploading their identity card and a health certificate. Once registered, a gig rider could then switch on their app and start taking delivery orders right away. Gig riders compete with one another to 'snatch orders' from the platform, that is, the first person tapping on the 'Accept Order' button in the app gets the delivery task. There is no limit to the number of hours per day a gig rider can work, and a rider may hold as many as 12 orders in hand at any given point in time. Station managers rely on the platform's backend system to coordinate the riders in real-time.

The empirical research was conducted in July 2018 in Beijing. We started recruiting participants through our personal contacts and followed with a snowballing method. A total of 30 interviews were conducted: 27 riders (23 gig riders and 4 platform-exclusive riders; 5 were women) and three station managers. The interviews were semi-structured and lasted between 28 to 74 min (average length was approximately 51 min). A list of the interviewee demographic and interview duration is provided in the Appendix A (Table A1), as well as the interview protocol. Interviews with riders were conducted in public places such as a restaurant or a cafe at a location convenient to the worker. Twenty eight interviews were audio-recorded, and two were documented with extensive notes. The rider interviewees were given 100 yuan (about 12 GBP) as compensation for their lost work time. All interviews were conducted in Chinese, which were transcribed by professional transcribers and then imported into NVivo for analysis.

We also joined two WeChat groups of gig riders where workers and station managers discussed work-related issues. The station managers used the channel to make announcements, for example, to adjust pay rates in bad weather conditions, answer queries from riders, and communicate platform policies. Some riders shared their work experience, compared earnings, made complaints, sought help from other workers, and sometimes tried to buy or sell mopeds and other job-related equipment. From time to time, after-work social gatherings were organised through the WeChat groups. Observing the online conversations and interactions provided a richer, contextualised

understanding of the riders' lived experiences. Screenshots and photos of the rider's app interface were collected as secondary data, as well as media reports about the platform and the platform company's official documents.

Data analysis was an iterative process consisting of both inductive and deductive phases. After data collection, we started with an inductive process of open coding, with each author coding half of the transcripts, which generated over 100 preliminary codes. The two authors then compared the codes and discussed emerging patterns, and then started generating first-order constructs and categories of codes using nodes clustering analysis and mindmapping tools in NVivo. This is similar to selective coding in a grounded theory approach (Urquhart et al., 2010).

In this process, spatial and temporal themes emerged as the most prominent theoretical elements, which became the theoretical focus of the study. This led to a substantial literature review on temporality and spatiality across multiple disciplines. The relevant conceptual constructs were then applied in the subsequent thematic analysis of the data, which was again an iterative process between the data and the concepts. As the performative view of spatiotemporality and the theoretical framework were further developed and refined, we consolidated the constructs and themes to generate the three layers of spatiotemporality in a scalar thematic framing to present the findings (similar to theoretical sampling in a grounded approach).

Therefore, while grounded theory coding techniques were used as part of data analysis, it was ultimately an integration of inductive and deductive processes. In the Appendix, Table A2 and Figure A1 provide an illustrative example of the inductive coding process that gave rise to relevant themes, whereas Table A3 shows how the four dimensions of the spatiotemporality framework shed light on the data analysis.

5 | MULTIPLE SPATIOTEMPORALITIES OF PLATFORM WORK

In this section, we use the multiplicity of scale (see three layers of spatiotemporality in Figure 1) as a framing device to present the multi-level analysis of riders' work as positioned in the broader social and institutional context of China's rural–urban migration, and in workers' daily practice of food deliveries. As explained earlier, our conception of spatiotemporality is informed by the practice-based view of space and time, which produces and is produced by, social structures (Feldman & Orlikowski, 2011). It is therefore important that we organise our data to show how the spatiotemporal order of platform work manifests at different layers.

Figure 1 presents the three nested layers: spatiotemporality of rural migrant labour in China, spatiotemporality of riders' work routines, and spatiotemporality of riders' algorithmic work. At the broadest scale of spatial and temporal movements, the restricted opportunities and resources in life, and the quest for spatiotemporal autonomy underlie riders' subscription to individualised on-demand platform work and the competition for speed and performance. The second layer rests at a medium scale of temporal and spatial work routines for the riders, that is, seasons, daily schedule, as well as the visible and invisible labour that sustain these routines. Finally, the third layer looks into the micro-politics of interacting with algorithms at a task level.

To retain the flow of the narrative, we will tell the story using the three layers presented in Figure 1 and conclude each layer with a discussion of the four conceptual dimensions of spatiotemporality (multiple, practiced, material, and political) in relation to the data, supported by Figures 2–4.

5.1 | Spatiotemporality of migrant labour in China

5.1.1 | The life trajectory of rural migrant workers

The very existence and life trajectories of rural migrant workers in China's urban areas are a unique spatiotemporal phenomenon. Economic inequality between urban and rural areas in China drives millions of rural residents to seek employment in large cities like Beijing and Shanghai. In 2019, more than 135 million rural migrants lived and worked

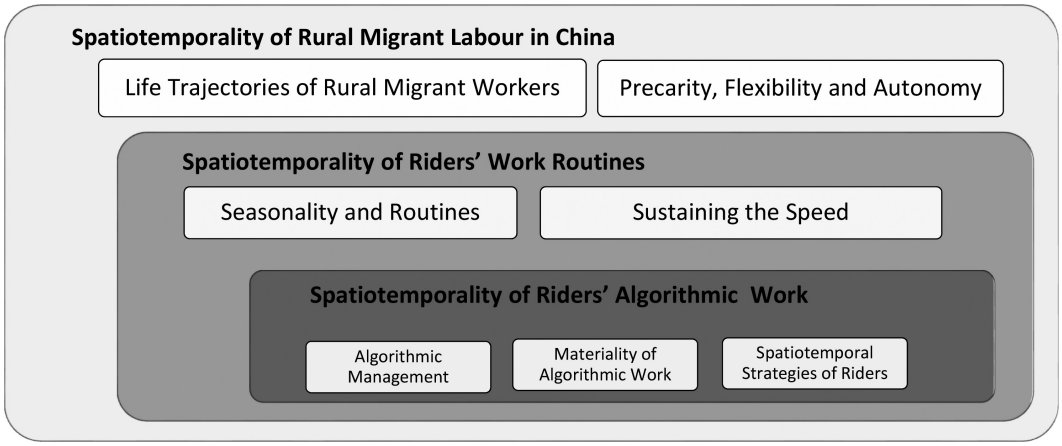

FIGURE 1 Layers of Spatiotemporality of platform work

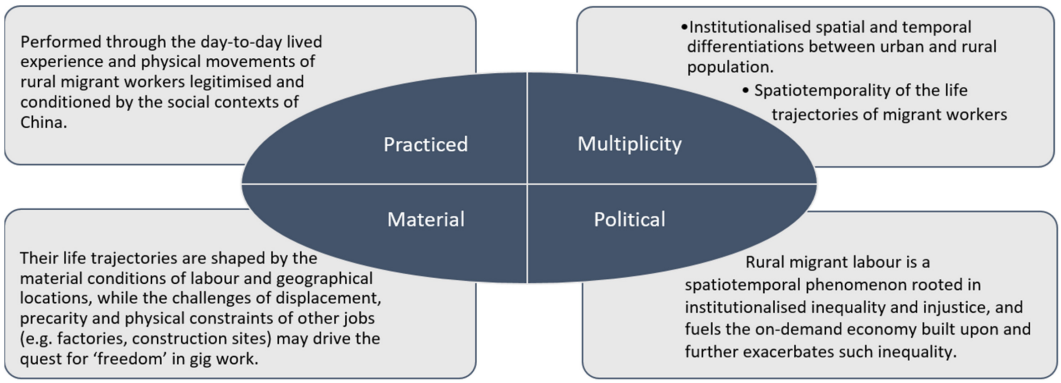

FIGURE 2 Spatiotemporality of rural migrant labour in China

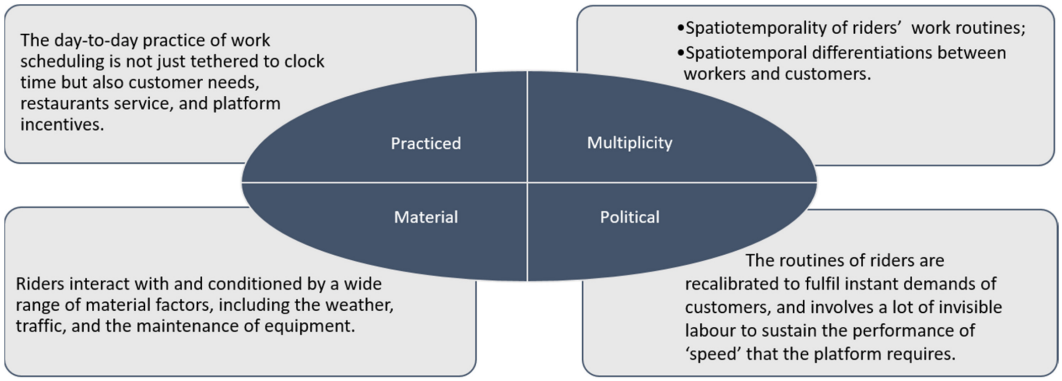

FIGURE 3 Spatiotemporality of riders' work routines

FIGURE 4 Order tracking on the customer-facing app

in urban areas due to the lack of job opportunities in rural areas. Under the *hukou* system (the national household registration that ties a citizen's identity and legal residence to the location of their birthplace), rural-to-urban migrant workers are not entitled to the same level of social welfare such as healthcare and education as local urban residents (Wong et al., 2007). Most migrant workers spend decades of their physical peak years moving between their hometown and various cities. Time and physical labour are their main resources for production, therefore working long hours and living in basic conditions allow them to maximise income and savings, which supports their family and sustains their aspiration to return and settle down with a small business near home. One of the mid-aged riders said,

> The more you work, the more money you make. What else can you do? For example, some take a nap during the day. Even when I take a nap, I am still online… I am always online [ready for accepting orders]. At my age, I have old parents and children, unlike the young ones. (R13).

5.1.2 | Precarity, flexibility and autonomy

Displaced from their hometown, rural migrant workers are referred to as the 'floating population' (Gao & Smyth, 2011), moving across time and space in a rootless, transient manner. Employers in manufacturing, construction, and the service sector see these migrant workers as cheap labour who are willing to work under harsh employment conditions in exchange for cash income. Many of the interviewees had worked previously as construction workers, truck drivers, or factory workers. Given the harsh work conditions of most of these types of jobs, the average time of changing jobs is just slightly over 2 years (Shen, 2019). In other words, short-term or temporary work is a norm, and precarity may be a mode of existence for rural migrant workers in China.

When the food delivery platform first started hiring riders, migrant workers flocking to the platform were attracted by the potential of high earnings. The opportunity to maximise income by working long hours and taking as many orders as one can manage, in addition to getting paid on a daily basis, is highly appealing to many.

> I think this job suits rural migrants in many aspects… It's flexible. I can make more money if I work harder. Flexibility is the main thing in this line of work. (R19).

> You get paid every day. The money goes into your account in the app, and it takes only 10 min to be transferred to your bank account. If you need money urgently, you can get it very fast. This is a big advantage (R11).

Platform-exclusive riders work in shifts with a base salary and have limited flexibility in terms of schedule. Nevertheless, all riders consider platform work as offering a sense of 'freedom' compared to other available jobs in construction sites, factories or restaurants, where workers are physically bound to the work site for a fixed number of hours. In these jobs, as Ahmad (2008, p. 315) puts it, they become 'prisoners of monetarized time, locked into an endless cycle of work that confines them to a tiny physical space at work and home.' In comparison, food delivery platform work provides a much higher level of spatiotemporal flexibility and autonomy. For example, a woman rider talked about the importance of being able to answer the phone:

> I have a child. If there is an emergency I can pick up the phone. I am worried about jobs that forbid us from using the phone. If something happens at home, my family won't be able to reach me (R16).

In short, at a societal level, the production of 'speed' in the food delivery platform work is built upon the labour supply of a socially disadvantaged group (rural migrant workers) whose 'temporal worth' (Sharma, 2014) is tied to their geographical displacement and socioeconomic marginalisation. The spatiotemporal order of platform work, therefore, is established at the intersection of different social groups whose experience of time and space embodies their living conditions, temporal flexibility and spatial mobility, as well as on a broader scale of their migration and life trajectories. The materialising of speed is thus contingent upon the differentiation of spatiotemporal orders that generates scalar effects (Barrett & Orlikowski, 2021) of normalising social stratification at a societal level.

5.2 | Spatiotemporality of riders' work routines

5.2.1 | Seasonality and routines

The volume of food delivery work fluctuates with time, with summer and winter being peak seasons, and meal times peak hours. In slow seasons, some riders switch jobs or take on additional jobs. They rarely take days off during peak seasons despite the presumed 'freedom' to do so. On a normal workday, most riders work between 8 and 14 h. Correspondingly, the monthly income of a top-performing gig rider in Beijing could exceed 10 000 yuan per month (approximately 1550 USD), equivalent to the average salary of a white-collar worker.

To achieve higher income, gig riders may strategically plan their work hours. For example, some choose to start in the late morning just before lunch and continue working until small hours of the next day, so as to cover the peak hours of lunch and dinner as well as the late-night snack orders. Furthermore, a discretionary bonus may be added by the platform station manager to incentivise workers to work in bad weather or slow hours. A rider talks about the advantage of working in the small hours:

> There is less traffic at night. If you have to take the lift (in apartment buildings), you don't have to wait too long… Also, the unit price is higher. You see, sometimes there is nobody on the road, just me riding freely, and it's cooler – too hot during the day (R17).

5.2.2 | Sustaining the speed

Riders are required to purchase and wear the platform company outfit but use their own electric mopeds on the job. Recharging the moped becomes part of the daily routine and needs to be factored into their work schedule in order

to sustain the desired speed. Riders have to plan their day carefully so that they can charge the battery in the gaps between peak hours. The moped and battery require regular inspection and maintenance for safety and normal functioning. It is not unusual for the battery to get stolen, damaged and, in extreme cases, even leak and burn down the moped. Furthermore, maintaining a well-functioning smartphone is also part of the hidden cost of the job, as the speed of the phone and quality of connection could give a competitive edge in snatching the 'better' orders.

To increase efficiency and to deliver as many orders as possible within a limited time, riders often break traffic rules and take risks in speeding, which could result in accidents and injuries especially in poor weather conditions.[1] Minor incidents, injuries, sickness, damages to equipment, as well as the emotional labour of pleasing customers, are usually accepted as part of the job. A woman rider recalled this incident:

> It was raining cats and dogs and I was waiting at the traffic light. A car passed by me and knocked me down, the meal was spilt…I had to apologise and place another order out of my own pocket to compensate the customer - the restaurant didn't charge me in the end. But when I delivered the meal again, just as I bowed to say sorry, they closed the door… (R7).

Another rider commented on the physicality of sustaining the speed:

> For short-distance deliveries, you have to run upstairs and downstairs all the time. I couldn't handle it. I did it before, for a few days, running from the ground floor to the sixth floor, and my hands started to shake. (R12).

Nearly every rider we interviewed gave examples of how they struggle with poor weather and deal with various adverse conditions on the job. Sustaining their own body and physical conditions is a critical part of accomplishing the 'speed' that the platform demands.

In sum, riders have to recalibrate their work routines, temporally and spatially, in accordance with the requirements of the job, fluctuations of customer needs, as well as the changes of seasons, peak hours, weather, traffic and a myriad of material conditions. In this sense, we have highlighted what Jackson (2016) refers to as hidden temporalities and invisible material labour behind the common perception and customer experience of 'speed' in an on-demand era.

5.3 | Spatiotemporality of riders' algorithmic work

The different temporalities performed by different actors in the food delivery platform work can cause tension and conflict: the platform sets a timeframe within which an order must be delivered to the customer; the restaurant has its tempo and routine in preparing food; the customer has an expectation of receiving their food by a certain time. All of these interweaving timelines shape the temporal structure of the work, but they are not always in harmony. In this section, we show how a rider's movement across space and time is regulated, monitored and managed digitally, and how riders negotiate with the algorithmic parameters and compete with fellow riders to excel in a gamified sociotechnical system.

5.3.1 | Algorithmic management of spatiotemporal movement

Once a customer places an order from their customer-facing app, the order is processed in the platform's backend system. The system provides both historical and real-time data to aid delivery coordination, including geographical and temporal distribution of orders, individual rider's performance, overall operational performance of a station, and

a series of managerial tools to monitor and manage peak-time and unexpected order spikes (e.g., due to bad weather). The backend system is monitored by station managers, each overseeing a service area covering a three-to-five-kilometre radius.

As the rider's app is always synchronised with the backend system, the delivery work is monitored by the system in real-time. The synchronisation of data on space and time across different interfaces creates a sense of transparency (for customers) and temporal uniformity (for all parties). Once an order is processed, a customer will be able to track the rider's whereabouts on a map and see a time series with key events. The rider's app provides even more detailed spatiotemporal information, as they are required to check in on the app as the job progresses, for example, arrival at the restaurant, pick up the order, delivery of the order, and so forth. As a station manager explains:

> A rider has to enable location tracking on their mobile app; the restaurant has a location on the map, and so does the customer. It [the platform algorithm] maps all the locations… Location tracking, delivery delay, time limit – all standardised (S2).

Delivery time and travel route are algorithmically calculated by the platform based on the geolocations of the rider, the restaurant, and the customer. Station managers seem to have great confidence in the platform system's geo-positioning and algorithmic capabilities.

> Because a rider's mobile phone must be geolocation-enabled, and the restaurant and the customer also have their geolocations, the system will automatically measure the distances. If the distance is greater than 200 meters, or whatever number [as determined by the algorithm], we then know the rider didn't lie, or the customer didn't lie, or the restaurant didn't lie. Through geodata, we check and then assess whose responsibility it was (S3).

However, the GPS positioning of these locations can be inaccurate and the algorithm-generated routes do not accommodate road barriers, constructions, or a last-minute change of address by the customer – all these factors could lead to severe delays. A rider thus expressed his frustration:

> They said I was 500 meters away from the restaurant. I said you must be kidding me. I was right outside the restaurant and [tried to] check-in on the app… I was there, the place was there, but I was not able to tap [on the app to report the arrival at the destination].(R18).

As a result, experienced riders often ignore the algorithm-generated routes and plan their own routes:

> I don't look at it [algorithm-generated route]. I go my own way. … Let's say we go from here to [place name] and the system would suggest you take the footbridge. Now you tell me - how I can go up to the footbridge on my moped? The platform's route planning is problematic. Not just this one; all platforms are designed the same way. (R23).

The platform system and the rider's app not only monitor the riders' spatial movements but also constantly record a series of KPIs, such as the percentage of on-time delivery, delays and serious delays, incompletion rate, lunch peak completion rate, customer rating, customer complaints, average delivery time, number of successful deliveries, and total mileage. Customers can also leave comments and ratings on their app, which form part of the riders' overall performance and appear on the rider's profile, visible to the public. Some of the default comments in the customer-facing app include ‘Speedy and Timely’, ‘Polite and Warm’, ‘Clean and Tidy (in Appearance)’, ‘Dressed in Uniform’, and ‘Braving the Bad Weather’.

The KPIs, customer comments, and the backend system constitute a digital panopticon surrounding each rider whenever they are on the job. Nevertheless, while these measurements may sound excessive, the total surveillance appears less repressive when it is cleverly converted into a competitive game to motivate the workers. With a ranking based on KPIs, riders are positioned at different levels - diamond, platinum, gold, silver and bronze. Reaching a higher level is rewarded with benefits, such as a cash bonus and certain 'privileges' to pick and choose orders. As a rider explains,

> Privilege means you can go wherever you prefer to go…I can select what areas to pick up food orders from and what areas to deliver to… For example, I can set a radius of 300 meters, from restaurant to destination, so I can even just walk within that distance. (R8).

Penalties are also part of the game. All our interviewees expressed their anxiety over missing the delivery time set by the system because it would incur a penalty. As one rider put it: 'The biggest challenge [of this job] is … you don't know the route and then you exceed the time limit. (R10)' The penalty is not only financial – a rider would lose at least half of the delivery fee for delays – but also affects their ranking in the system, which could result in further financial loss. For instance, a lower score of punctuality could mean losing current 'privileges' in selecting orders. In some cases, a rider could be blacklisted if their KPIs drop below a certain threshold:

> If the system detects that you have gone overtime too many times, it would automatically shut your app down. … It forces you to 'rest' for a day to reflect on why you are blacklisted… As the KPI now is the rate of punctual deliveries, you won't be able to get away with going overtime too often. (R11).

The algorithmic measurements thus impose a rigid and standardised view of spatiotemporality, which often collides with the in-situ performativity of speed. As we have shown, when the collision occurs, it is by and large the rider who bears the consequences.

5.3.2 | Materiality of algorithmic work

From the time a customer places their order to the time the order is delivered, a number of behind-the-scene events take place: the rider moves from their current location to the restaurant; the rider waits for the restaurant to prepare the food; the rider travels from the restaurant to the customer's location (Figures 5 and 6). Each of these spatiotemporal events could go astray due to constraints or unpredictability of material conditions.

One of the greatest grievances our rider interviewees reported was a delay in food cooking at the restaurant:

> Some restaurants are hopelessly slow in preparing the food. There is nothing I can do about it. … In many cases, we went overtime simply because the restaurants were slow. We actually don't have much time for delivery. … They ignore you, or keep telling you "almost ready" no matter how long it actually takes! (R22).

In addition, there are various material factors that a rider has to consider on their trip from the restaurant to the customer's location. Apart from the usual traffic conditions, red lights and road work, they need to think about possible shortcuts or detours that may affect travel time. There could also be severe delays waiting for the elevator in a 30-floor high-rise office tower at lunch time. Some hotels and apartment buildings only allow riders to take the back door and the slower goods lift. Gated residential estates often restrict riders on the moped, so they have to enter on foot to search for the right building. It is a common sight to see food delivery workers running around in large estates with several bags in hand. The material of food packaging is thus also crucial. As Chinese meals often contain soup

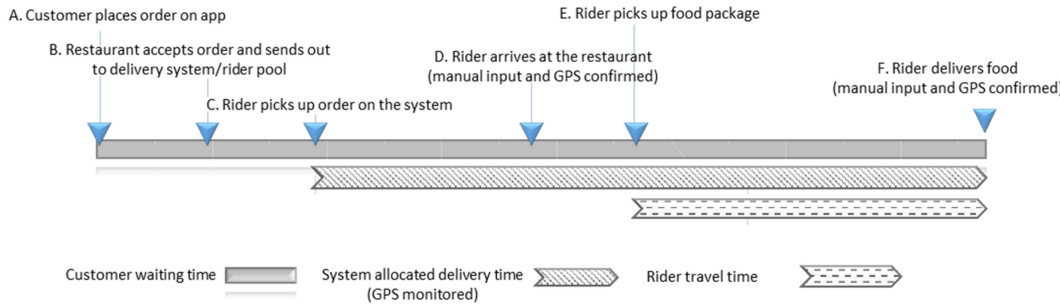

FIGURE 5 Timeline of a single order

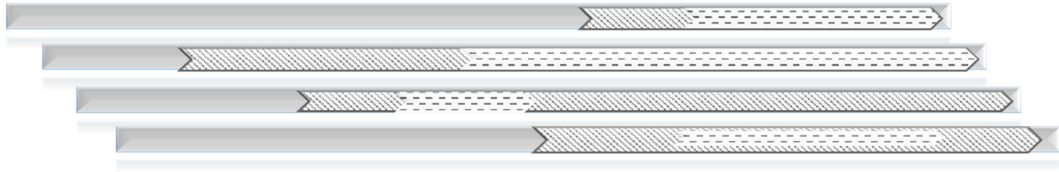

FIGURE 6 Multiple timelines of orders being delivered simultaneously

and multiple dishes with sauce, leakage and spillage could easily occur, in which case, the hapless rider might have to cover the cost for the customer or risk getting a complaint.

For these reasons, riders' performance often depends on the ability to quickly identify the 'better' orders (e.g., more accessible destination) and to snatch them quickly:

> Some people don't get many orders. Why? First and foremost, your judgement – once an order appears, you must react at the fastest speed. Hand, brain, eyes, all in one! … In the blink of an eye, you must decide if you should "snatch" this order. One moment of hesitation it will surely disappear. (R15).

A 'blink-of-an-eye' order-snatching decision involves processing a fair amount of information concerning spatial, temporal, and material conditions involved in the delivery. For example, when asked what sort of orders he would like to snatch, a rider answered:

> Ground-floor business premises, not-too-tall buildings – I don't like tall buildings, nor apartment complexes. They are not easy to get into and get around. … I rarely go there these days. (R17).

The researcher then probed: 'Well, if you don't take these orders, would someone else take them?' The rider replied,

> Yes. I just need to delay a bit, hold on for a little while, then someone else would take it – the newbies. There is always a newbie who takes it. I used to be a newbie; I took these too, but not anymore.

(R17).

These quotes suggest that a rider's movement through space and time is not independent of other actors in the sociomaterial system. The enactment of algorithmic management by one rider creates different, yet interconnected, sociomaterial realities for other riders. A newbie or low-ranking rider, who has less experience of controlling the

spatiotemporal parameters of their job, needs to make more effort and take home less income. In other words, the moment-to-moment activity of riders co-constitute, and collectively shape, the spatiotemporal orders and socio-material realities of each other unfolding a 'dance of agency' (Pickering, 1995) between human and non-human actors in the 'flow' (Baygi et al. 2021).

5.3.3 | Spatiotemporal strategies of riders

To maximise income, riders try to simultaneously fulfil as many orders as possible in order. This means they must juggle and weave multiple orders and adapt the delivery routes ad hoc. A rider's job performance is therefore closely linked to their capability of order selection, time estimation, and route planning for multiple orders. As one seasoned rider said:

> How can I complete many orders, earn more money, stay within a time limit, and deliver food to customers as early as possible? You need to turn these things over in your head! (R14).

As shown in Figures 5 and 6, when a rider carries several orders at a given time, they are tethered to the multiple spatiotemporal trajectories of different orders. While Figure 6 only shows four orders as an example, a competitive rider could be delivering 10 or 12 orders in a round trip. They need to assess various spatiotemporal factors carefully in deciding which and how many orders to take up. For example, is this delivery too much of a detour? What is the efficiency of the restaurant in food preparation? How long has the customer been waiting? What should be the sequence of delivery? Finally, how many orders could I take at this point without causing delay?

Hence, what seems to be a simple delivery job becomes a complex process that involves bold yet careful calculations, precise estimation of travel time to different places, optimal routing through traffic and built-up environment plus on-the-fly decision-making based on human, algorithmic, and material conditions. As a rider explains:

> When you pick up three orders, a route should naturally appear in your head. You have a sense when the restaurants can get the food ready, then you can judge which route to take. During evening peak hours, there will be traffic jam, and you need to know which junction may be congested. …You need to allow extra time, as you may have to wait at the traffic light, get blocked by something else, or if the customer doesn't pick up the phone, etc. Random things [may happen], and you need to calculate all of these. (R15).

Another rider described why he sometimes travels in circles when delivering multiple orders:

> If time is too tight, I have to travel in circles. That means I prioritise deliveries that are further away … then return [to deliver the nearer ones]… If you follow the original sequence of order, you will run out of time. Moving in circles gives me more time … When you finish all of them, you are back right here ready for new orders. (R11).

As these interview excerpts show that, while the platform system monitors and regulates riders to an extensive extent by setting specific spatiotemporal boundaries, riders still exert a strong agency in enacting various spatiotemporal practices depending on a myriad of social and material factors. The same algorithm is met with a wide range of spatiotemporal strategies and micro-tactics, engendering various movements and activities, risks and challenges, as well as rewards and penalties.

As Figure 7 shows, this section focuses on the moment-to-moment spatiotemporal practices such as order selection decisions, route planning strategies and physical movements of the riders in achieving the speed required by the

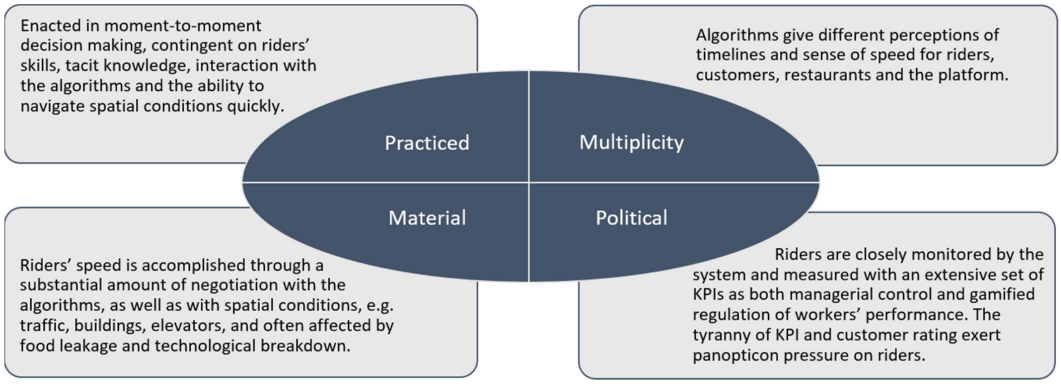

FIGURE 7 Spatiotemporality of riders' algorithmic work

platform. Multiple spatiotemporal perceptions, expectations and practices are at work, often in contention with each other. The production of speed, at a micro-level, is performed through the enactment and negotiation with the algorithms, artefacts and the diverse spatiotemporal conditions for delivery. While the platform exerts power over workers, not so much through direct control but through extensive digital monitoring, geo-tracking, customer rating, KPI ranking and gamification, the riders demonstrate a high level of agency, learning capability, tacit knowledge and embodied skills in producing the speed.

6 | DISCUSSION

Guided by a performative view of spatiotemporality as *practiced*, *material*, *multiple* and *political*, our data analysis shows that digital labour platform algorithms are not exogenous technical entities that exert direct control over workers but are performed in the sociomaterial processes that (re)configure the multiple layers of spatiotemporality inscribed with existing social inequalities.

Table 2 below summarises key insights of the study in relation to the four conceptual dimensions of our performative view of spatiotemporality in platform work. In the rest of this section, we further elaborate on how this study contributes to understanding and theorising the production of speed in the on-demand economy.

6.1 | The practice of speed

Most IS research on algorithmic management in platform work has focused on the operation of algorithms and implications for management. In contrast, this study examines how the 'speed' of on-demand platform work is accomplished through the enactment of algorithms in spatial and temporal structuring (Orlikowski & Yates, 2002). We present a rich case of food delivery platform workers with a focus on the enactment of speed in practice. The study examines in detail the situated practices and routines of riders, their interactions with algorithms, platforms and other stakeholders, and their tactics and strategies to negotiate with dynamic spatiotemporal conditions while seeking to improve their performance at work.

In doing so, we also broaden the discussion on labour process in platform work in the non-IS literature to incorporate the multiple spatiotemporal orders in the analysis. The notion of 'speed' applies not only to individual work practices of the riders, but the 'scale effects' (Barrett & Orlikowski, 2021) of acceleration mediated through digitisation, grounded and performed in multiple practices in time and space. The practice lens sensitises us to

TABLE 2 The four dimensions of spatiotemporal performance of riders' platform work

Multiple scales	Multiple ST orders	ST as practiced	ST as material	ST as political
ST of rural migrant labour in China	The different ST relations with the urban environment between rural migrant workers and local residents.	Spatiotemporality is legitimised and conditioned by the societal context of China, and performed through the lived experience of rural migrant workers.	Migrant workers' life trajectories are shaped by their bodily condition (age, physical health) and geographical displacement.	Rural-to-urban migrant labour is a spatiotemporal phenomenon rooted in institutionalised inequality and injustice.
ST of riders' work routines	The different ST orders of 'speed' and the maintenance of 'speed' in breakdowns and repairs.	The day-to-day practice of work scheduling is not just tethered to clock time but also customer needs, restaurants service, and platform incentives.	Work routines are performed along with a wide range of material factors, including the weather, traffic, and the maintenance of equipment.	Work routines are recalibrated to fulfil the instant demands of customers and the 'speed' required by the platform.
ST of algorithmic work	The distinct ST orders of multiple stakeholders: riders, customers, restaurants, and platforms.	The delivery work is enacted in moment-to-moment decision-making contingent on riders' skills, tacit knowledge, interaction with the algorithms and the ability to navigate spatial environments.	Work speed is accomplished through negotiating with and working around the platform algorithms as well as material parameters such as traffic, buildings, elevators, food packaging, and devices.	Riders' spatiotemporal movement is closely monitored and measured by the platform system as both panoptic control and gamified regulation of workers' performance.

Abbreviations: ST, spatiotemporality.

situated activities in platform work and reveals how they are consequential in producing social structures (Feldman & Orlikowski, 2011). This study illustrates how digital platforms engender the reconfiguration of spatiotemporal relations among multiple stakeholders in the on-demand economy, while to a large extend reproducing existing social stratifications.

6.2 | The materialisation of speed

In answering how speed is produced, the paper contributes to the discourse on the materiality of digital technology (Orlikowski & Scott, 2008; Wajcman & Dodd, 2016), not in terms of technical design and functionalities but on the entanglement and enactment of digital artefacts (e.g., algorithms) in the materiality of everyday life and embodied experiences, affects and events (Thrift, 2008).

Algorithmic management involves not just a set of independent technical codes and managerial processes that direct and control riders, but are sociomaterially performed in the interactions between riders and technology, as well as in the encounters of a myriad of other human and non-human actors. Each delivery is embedded in a complex Web of relationships among a number of actants, including customers, restaurants, station managers, co-workers, technological artefacts (mobile phone, apps, GPS devices), transportation tools, spatial conditions (roads, traffic, buildings, architecture, entry points), and even weather and the packaging material of the food, which all come together in what might be perceived as a simple and linear task of food delivery. It is in the enactment and interaction of the heterogeneous assemblage (Introna, 2013) that 'speed' is produced and sustained over time.

The production and sustaining of speed depend on material, but sometimes invisible, labour to recalibrate (Sharma, 2014) life schedules, routines, body clocks and movements. 'Speed' requires the maintenance of physical and technical functioning of human bodies and artefacts, as well as withstanding the frictions and costs of spatiotemporal 'breakdowns' (Jackson, 2016), be it physical injuries and sickness, GPS failures, food spillage, or leaking moped battery.

The materialisation of 'speed' involves not just technologies but more complex social-material processes on a societal scale. The institutional and sociomaterial reproduction of rural migrant workers as a 'floating population', including the ongoing enactment of bodily and affective labour in their spatiotemporal life trajectories, reinforce conditions for their 'structural vulnerability' (Gandini, 2019).

6.3 | The multiplicity of speed

While technology has often been attributed to time–space compression in modern societies (Harvey, 2006), our analysis highlights the uneven 'compression' across diverse social groups in the digital labour platform's speed-making assemblage. Platform capitalism enables consumers to achieve 'speed' by directly purchasing the labour of those with lower temporal worth (Wajcman & Dodd, 2016) both on an unprecedented scale and on an ad hoc basis. In practice, the provision of on-demand speed at scale is accomplished and reproduced through the intersection of multiple spatiotemporal orders, entangled with power differentiation among various social groups: riders generating speed to meet the platform's performance criteria and to gratify intensifying demands of customers; restaurants recalibrating their food preparation speed to align with the pace and timeline set by the platform company, which in turn fuels the expectation of instant gratification of the customers. As such, speed is produced in the interaction of multiple actors in a power structure, where riders are often the most powerless.

Our analysis on the multiplicity of spatiotemporality in platform work contributes to 'the sociology of speed' (Wajcman & Dodd, 2016) by illustrating the sociological significance of the on-demand economy in producing, yet concealing at the same time, the sociomaterial dynamics in work and structural inequalities in society. As shown in the detailed accounts of riders' algorithmic work, a significant amount of embodied skills, creativity and tacit

knowledge are required to navigate dynamic spatiotemporal landscapes in a presumably 'low-skilled' job. Any of the diverse components in the sociomaterial assemblage could cause friction and slow down the algorithm-defined spatiotemporal flow. Again, the consequences of breakdown and slowdown are usually borne by the riders and rendered invisible by the platform's relentless pursuit of scale and speed.

6.4 | The politics of speed

Following the discussion above, it becomes evident that 'speed' is inherently political as algorithms reconfigure the spatial and temporal relations among workers, platforms, consumers, and the urban environment to achieve a unified speed of service provision. The digital platforms, through promising 'anytime anywhere' on-demand service to consumers while imposing spatiotemporal management on workers, reinforce and fuel the contemporary society's obsession with speed. Our study shows how the production of speed and the popular perception of 'convenience' in the on-demand economy is performed through 'a negotiated social order… under new arrangement of space and time' (Sewell & Taskin, 2015, p. 1524) but at the expense of the interests of the underprivileged group of rural migrants.

The performative view sensitises us to the embeddedness of the particular kind of gig work in social structural dynamics. At a micro-level, the algorithms, implemented through the platform and mobile apps, impose rules and disciplines prescribed by the platform to regulate the in-the-moment spatial and temporal movements of workers. On the other hand, the algorithmic logic is also enacted, negotiated and performed through the workers' spatial and temporal practices, which are embedded and intertwined with broader spatiotemporal structures of inequality and neoliberal precarity in the gig economy.

To this end, our study resonates with what Sharma (2014) calls the politics of 'recalibration' of time, by providing a vivid account of how 'individuals and social groups synchronise their body clocks, their senses of the future or the present, to an exterior relation – be it another person, pace, technology, chronometer, institution, or ideology' (p.18). At the organisational level, the temporal worth of different social groups manifests through the unilateral rating of riders by consumers, the algorithmic panopticon, and ranking and gamification of task performance. On the societal scale, the migrant workers' transient and unstable connections to the urban environment and workplaces, their limited social security and protection against the risk of 'speed', all contrast the glorification of the 'freedom' of gig work and underlie the material foundation of labour supply for the rapidly expanding on-demand economy.

7 | IMPLICATIONS AND CONCLUSION

In the recent MISQ special issue on the next generation of IS theories, Hovorka and Peter (2021) argue that IS research has world-making effects and it is researchers' responsibility to reflect on the implications of technologies for the future of societies. This paper echoes such calls and proposes a performative view of spatiotemporality on platform work to unpack the complexity and politics of food delivery labour in China.

Firstly, as our literature survey has shown, time and space are important themes in social science research but under-developed in the IS discipline. With a small number of exceptions, the time has often been treated as linear clock time, whereas space has mostly been viewed as an objective container in which human activities take place. Limited research has paid attention to the materiality, multiplicity and politics of spatiotemporality. As presented in Tables 1 and 2 and elaborated in the discussion above, we have built a performative view of spatiotemporality to provide a more sophisticated theoretical understanding of time and space for IS researchers. By showing that spatiality and temporality are co-constitutive, enacted in day-to-day socio-material practices yet generating structural and political effects, we have not only extended existing IS literature on time and space but also suggested a theoretical framework for future research.

Secondly, tackling a topic that has rarely been addressed in the IS literature, the study problematises the ambivalent notion of 'speed' in the on-demand economy and seeks to unpack the 'production of speed' in the day-to-day practice of algorithmic work and how such practice reproduces social structures. The socio-material performance of speed in on-demand platform work is enacted and sustained in the intersections of social stratifications. We thus advance the view that platform algorithms are not mechanistic control and automation of labour but embody the temporal and spatial structuring in social life.

Finally, contrasting with existing IS research that mostly focuses on the operation and management of algorithms, we connect micro-level algorithmic work with macro-level social structure and power relations, thus shedding light on the societal implications of algorithmic management. In doing so we respond to the call for studying the 'scale effects' of sociotechnical systems. By showing how the effects are enacted not just in the spatiotemporal regulation of workers but also in the reproduction of social stratification, this study adds to the existing discourses on the politics of platform capitalism, such as the congregation of data in the hands of platforms through surveillance and data extraction (Zuboff, 2015), and the individualisation and precarity of platform labour (Gandini, 2019; Griesbach et al., 2019; Purcell & Brook, 2020).

The study is limited in that it focuses on a small group of food delivery riders in one of the largest cities in China, where there is a high percentage of rural migrants participating in platform work. The food delivery service in smaller Chinese cities may reveal variations of social composition and spatiotemporal routines. Future research could broaden the scope by including riders in different geographical areas and investigate the locality of spatiotemporal practice in the digital labour platform ecosystem. It would also be fruitful to compare algorithmic design and technology affordances of different digital labour platforms to see how spatiotemporal orders are structured and experienced differentially in China and globally. Critical scholars may further explore the role of digital technology in transforming the future of work in relation to power dynamics and labour relations. We believe that a practice-based, performative view of spatiotemporality offers fresh insights into critiquing and designing socially responsible platform systems for a more equitable society.

ENDNOTE

[1] For example, in the first half of 2019, Shanghai recorded 325 traffic accidents including 5 deaths that involve delivery workers, and the two largest food delivery platforms accounted for two-thirds of the accidents and 2 deaths. Source: http://www.xinhuanet.com/yingjijiuyuan/2019-07/08/c_1210184562.htm

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available upon reasonable request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

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APPENDIX A: DATA COLLECTION AND DATA ANALYSIS

A.1. | Interview Protocol

1. When did you become a food-delivery rider in Beijing? What was your previous job?
2. Why did you choose to become a rider? How did you find this particular job?
3. How does the food-delivery job compare to your previous jobs?
4. What do you like about this job? What do you dislike?
5. Tell me about how you schedule your day of work.
6. Tell me about a particularly good day, and a really bad one.
7. What do you think are the main challenges of this job? How have you been dealing with these challenges?
8. Walk me through how you use the rider's app to complete a delivery order.
9. What do you think of the rider's app? How is it helpful and/or unhelpful? Give me some examples.
10. If you are to modify the app, what function or feature would you change?
11. How is your job performance evaluated by the platform? What do you think of those evaluation criteria?
12. How do you feel about being constantly monitored and managed by the platform?
13. Are customer feedback/ratings important to you? How do you deal with unreasonable customers? How does the platform handle customer complaints?
14. What is your relationship with the restaurants?
15. What are your strategies to optimise your job performance?
16. When do you usually have your breaks (in a day and in a week)? What do you do during the break and after work?
17. Do you collaborate or interact with other riders at work? Do you socialise with them after work?
18. How long do you plan to stay in this job? What are your plans for the future?

TABLE A1 Details of the interviewees

Rider	Gender	Age	Contract type	Time in job	Interview duration (in minutes)
R1	M	24	PE	18 months	51
R2	M	27	PE	16 months	51
R3	M	34	PE	> 2 years	57
R4	M	28	EC	18 months	70
R5	M	36	PE	18 months	28
R6	M	30	EC	> 2 years	59
R7	F	28	PE	5 months	64
R8	M	21	EC	12 months	56
R9	M	45	EC	19 months	68
R10	F	26	EC	4 months	41
R11	M	40	EC	19 months	74
R12	M	34	EC	12 months	49
R13	M	40	EC	8 months	57
R14	M	37	EC	> 3 years	58
R15	M	27	EC	2 years	40
R16	F	28	EC	27 months	43
R17	M	27	EC	> 2 years	47
R18	M	32	EC	3 years	43
R19	M	26	EC	18 months	34
R20	F	42	PE	9 months	49
R21	M	46	EC	16 months	44
R22	M	33	EC	10 months	52
R23	M	43	EC	10 months	44
R24	M	29	EC	5 months	62
R25	F	43	EC	4 months	No recording
R26	M	23	EC	18 months	No recording
R27	M	30	PE	15 months	47
Station managers					
S1	F			Unknown	35
S2	M			> 2 years	42
S3	M			6 months	54

Abbreviations: EC, externally crowdsourced; PE, platform exclusive.

TABLE A2 An illustration of the coding process

Sample interviewee quotes	Open codes	Code categories	Themes: Multiple scales of spatiotemporality
"At the end of the day I am doing this for my family – my wife and kids. If there is a better option, I will definitely go for it. I came here because I have no other options." [R4]	Family background; living conditions; future plans; daily income	Life as a migrant	Spatiotemporality of migrant labour
"I like this job. … I have a child. If there is an emergency I can pick up the phone. I am worried about jobs that forbid us from using the phone."[R16]	Previous jobs; job comparison; reasons to become a rider; freedom	Precarity	
"I go out at 7:30 am. Work till 1:30 pm, take a lunch break and resume working from 3 pm to 8 pm. … I usually take a day off on Mondays."[R8]	Scheduling; seasons; peak times; daily work hours; flexibility	Seasonality and routines	Spatiotemporality of work routines
"One day the system malfunctioned. I took four delivery orders and four [customers' phone] numbers were all invalid."[R20]	System breakdowns; moped; uniform; mobile phones	Maintenance of equipment (to sustain speed)	
"The main thing is smile. When you speak with customers, you must smile and be polite."[R4] *"We do not want to waste a single second. … Sometimes on the road I feel like I would be struck by a car at any moment, but I still have to rider as fast as I can."[R24]*	Physical labour; emotional labour; injuries; breaking traffic rules	Maintenance of the body (to sustain speed)	
"The system will set the route for us … the incoming orders assigned to you will be on the same route." [R1] *"Let us say now you have reached 'Gold-1' status. You must complete 750 orders per month. If you do not meet this target, you will be downgraded."[R9]*	Algorithmic control of movement; KPI; gamification; face recognition	Algorithmic management	Spatiotemporality of algorithmic work
"My phone is two years old; the memory is full and it's unusable now. … the signal is not too good … sometimes [the app interface] could not refresh."[R12] *"I do not like tall buildings, nor apartment complexes. They are not easy to get into and get around."[R17]*	Rider's mobile phone; rider's app; restaurants; food packaging; traffic, weather; spatial conditions	Materiality of algorithmic work	
"My strategy is - take less orders at a time, run, and come back quickly."[R9] *"In the blink of an eye, you must decide if you should 'snatch' this order. One moment of hesitation it will surely disappear."[R15]*	Selection of orders; snatching orders; route planning; tacit knowledge	Rider strategies	

TABLE A3 Thematic analysis using the spatiotemporality framework

Multiple scales of ST	Four dimensions	Illustration	Example from data
Spatiotemporality of rural migrant labour in China	Practiced	Spatiotemporality is legitimised and conditioned by the societal contexts of China, and performed through the lived experience of rural migrant workers.	*"I like this job. … I have a child. If there is an emergency I can pick up the phone. I am worried about jobs that forbid us from using the phone."(R16)*
	Material	Migrant workers' life trajectories are shaped by their bodily condition (age, physical health) and geographical displacement.	*"I am in my 40s and have been in Beijing for 16 years… This year I only went home for 3 days for my father's birthday…I have ankylosing spondylitis… and have to rest when my back hurts. So I usually take around 40 orders a day." (R11)*
	Multiple	The different ST relations with the urban environment between rural migrant workers and local residents.	*"I think this job suits rural migrants in many aspects. It's flexible. I can make more money if I work harder. Flexibility is the main thing in this line of work. Moneywise, you get paid every day – it's convenient" (R19).*
	Political	Rural-to-urban migrant labour is a spatiotemporal phenomenon rooted in institutionalised inequality and injustice.	*"At the end of the day I am doing this for my family – my wife and kids. If there is a better option, I will definitely go for it. I came here because I have no other options." (R4)*
Spatiotemporality of riders' work routines	Practiced	The day-to-day practice of work scheduling is not just tethered to clock time but also customer needs, restaurants service, and platform incentives.	*"I usually get up after 10 am and come here at 11 am, when I start taking orders, all the way to 3 o'clock in the morning" (R15).*
	Material	Work routines are performed along with a wide range of material factors, including the weather, traffic, and the maintenance of equipment.	*"There is less traffic at night. If you have to take the lift (in apartment buildings), you do not have to wait too long… Also the unit price is higher. You see, sometimes there is nobody on the road, just me riding freely, and it's cooler – too hot during the day." (R17).*
	Multiple	The different ST orders of 'speed' and the maintenance of 'speed', i.e. breakdowns and repairs.	*"It was raining cats and dogs and I was waiting at the traffic light. A car passed by me and knocked me down, the meal was spilt…I had to apologise and place another order out of my own pocket to compensate the customer - the restaurant did not charge me in the end. But when I delivered the meal again, just as I bowed to say sorry, they closed the door…" (R7)*
	Political	Work routines are recalibrated to fulfil the instant demands of customers and the 'speed' required by the platform.	*"There is no such thing as a free lunch… The more you work, the more money you make. What else can you do? For example, some take a nap during the*

TABLE A3 (Continued)

Multiple scales of ST	Four dimensions	Illustration	Example from data
			day. Even when I take a nap, I am still online…"(R13)
Spatiotemporality of algorithmic work	Practiced	The delivery work is enacted in moment-to-moment decision-making contingent on riders' skills, tacit knowledge, interaction with the algorithms and the ability to navigate spatial environments.	*"Many people do not get many orders. Why? First and foremost, your judgement – once an order appears, you must react at the fastest speed. Hand, brain, eyes, all in one! … In the blink of an eye, you must decide if you should 'snatch' this order. One moment of hesitation it will surely disappear. "(R15)*
	Material	Work speed is accomplished through negotiating with and working around the platform algorithms as well as material parameters such as traffic, buildings, elevators, food packaging, and devices.	*"For short-distance deliveries, you have to run upstairs and downstairs all the time. I could not handle it. I did it before, for a few days, running from the ground floor to the sixth floor, and my hands started to shake." (R12)*
	Multiple	The distinct ST orders of multiple stakeholders: riders, customers, restaurants, and platforms; and among riders themselves.	*"I do not look at it [algorithm-generated route]. I go my own way. … Let us say we go from here to [place name] and the system would suggest you take the footbridge. Now you tell me - how I can go up to the footbridge on my moped? The platform's route planning is problematic. Not just this one; all platforms are designed the same way."(R23)*
	Political	Riders' spatiotemporal movement is closely monitored by the platform system and measured with an extensive set of KPIs as both panoptic control and gamified regulation of workers' performance.	*"If the system detects that you have gone overtime too many times, it would automatically shut your app down. … It forces you to 'rest' for a day to reflect on why you are blacklisted… As the KPI now is the rate of the punctual deliveries, you will not be able to get away with going overtime too often."(R11)*

Abbreviation: ST, spatiotemporal.

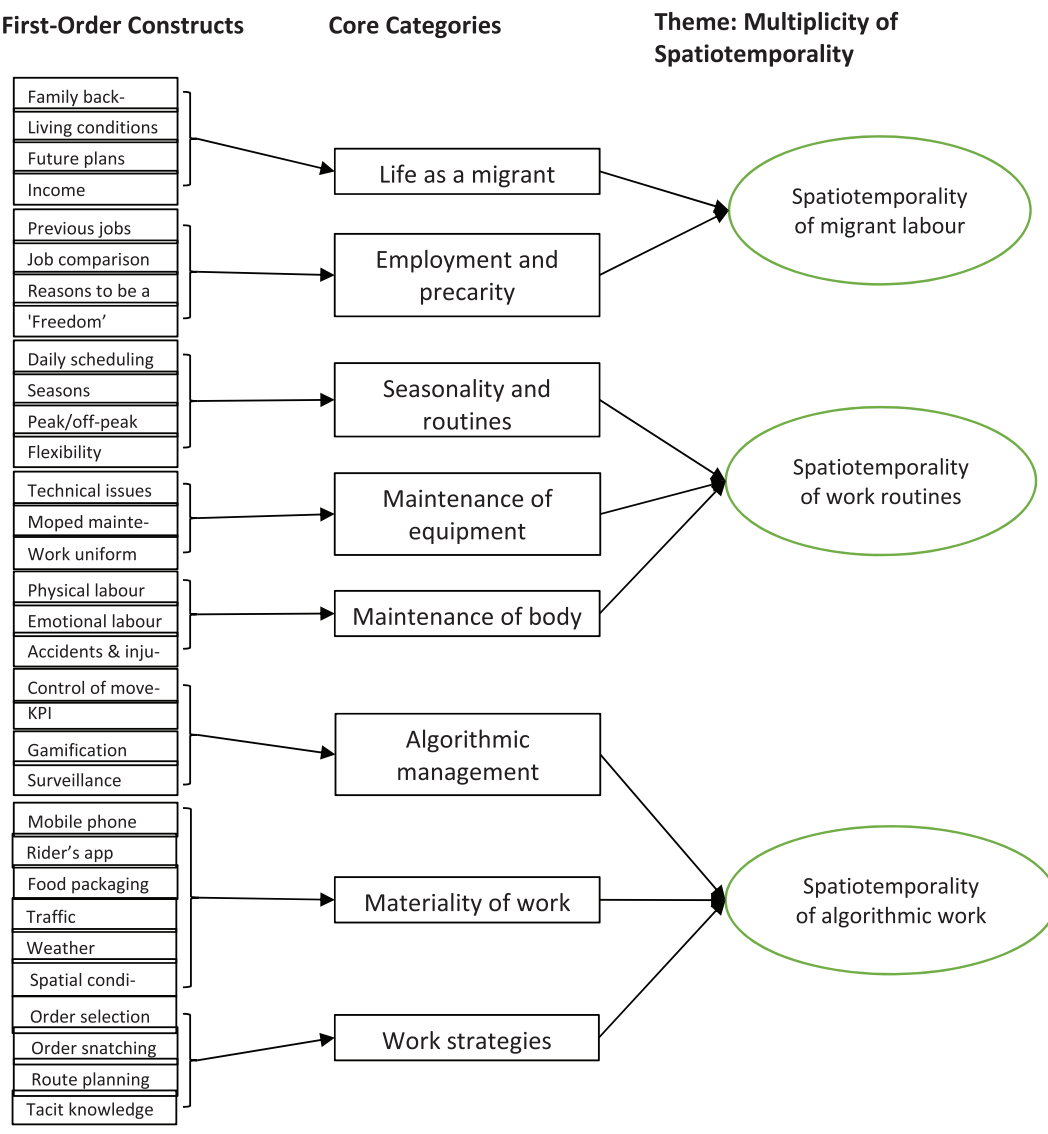

FIGURE A1 Coding of data