Challenging but Connective: Large-Scale Characteristics of Synchronous Collaboration Across Time Zones

Lillio Mok
lillio@cs.toronto.edu
University of Toronto
Toronto, Ontario, Canada

Lu Sun
l5sun@ucsd.edu
University of California, San Diego
La Jolla, California, USA

Shilad Sen
shilad.sen@microsoft.com
Microsoft
Redmond, Washington, USA
Macalester College
St. Paul, Minnesota, USA

Bahareh Sarrafzadeh
basarraf@microsoft.com
Microsoft
Redmond, Washington, USA

ABSTRACT

Organizations are becoming increasingly distributed and many need to collaborate synchronously over great geographical distances. Despite a rich body of literature on spatially-distanced meetings, gaps remain in our understanding of temporally-distanced meetings. Here, we characterize cross time zone collaborations by analyzing 20 million meetings scheduled at a multinational corporation, Microsoft, supported by a survey on how 130 employees perceive their scheduling needs. We find that cross time zone meetings are closely associated with scheduling patterns around early morning and late evening hours, which are challenging and discordant with employees' stated temporal preferences. Additionally, the burdens of meeting across time boundaries are asymmetrically distributed among workers at different levels of the organization and different geolocations. Nonetheless, we further observe evidence that cross time zone attendees are organizationally distant and diverse, suggesting that addressing these challenges by limiting meetings would disafford employees the opportunities to connect. We conclude by sharing opportunities for facilitating cross time zone meetings that foster healthier global collaborations.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in collaborative and social computing**; **Computer supported cooperative work**.

KEYWORDS

Collaboration, remote work, time zones, connectivity

CHI '23, April 23–28, 2023, Hamburg, Germany

ACM ISBN 978-1-4503-9421-5/23/04…$15.00
https://doi.org/10.1145/3544548.3581141

ACM Reference Format:
Lillio Mok, Lu Sun, Shilad Sen, and Bahareh Sarrafzadeh. 2023. Challenging but Connective: Large-Scale Characteristics of Synchronous Collaboration Across Time Zones. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23), April 23–28, 2023, Hamburg, Germany.* ACM, New York, NY, USA, 17 pages. https://doi.org/10.1145/3544548.3581141

1 INTRODUCTION

Global teams have become vital to maintaining our increasingly interconnected social and economic infrastructure. As they continue to grow across the world, organizations from all sectors are evolving their approach and practices to foster more effective global teams [72]. For instance, having an international workforce allows businesses to enroll key specialists regardless of their physical location [45, 60] and optimize their teams with the best talent available [36, 54]. Furthermore, global teams can bring diverse and multicultural viewpoints to organizations that would otherwise rely only on the perspectives of a few locations [9, 55, 65, 69].

It is unsurprising that, therefore, a rich line of research spanning two decades has investigated how global teams can be supported and how they are affected by factors like team member distance [3, 30, 38, 39, 69, 76]. However, there are two reasons why furthering this research is nonetheless relevant and timely. Firstly, the COVID-19 pandemic has radically altered the temporal and spatial dimensions of work throughout the world. A large number of employees worked from home or other remote locations enabled by digital technologies [40], and therefore have been able to appreciate benefits like a flexible workday [87]. Consequently, globally distributed teams are predicted to present an increasingly pervasive model of work in the post-pandemic era [61, 77, 82]. From the perspective of scientific research, the forcing of previously co-located information workers to work from home (WFH) also serves as a large-scale, natural experiment stimulating further study. This has led to significant progress in the fields of computer-supported collaborative work and human-computer interaction, such as identifying the challenges associated with remote teams [6, 14, 17] and identifying factors that may lead to their success and failure [41, 98]. The altered, and potentially enhanced state of global teams after 2020 is thus one reason why there is a pressing need to revisit the characteristics of remote collaborations.

What distinguishes these remote collaborations from collaborations between people in sharing the same space? Scholars have also long postulated two aspects of distance, spatial and temporal, that change how distanced collaborations are conducted [12, 46, 69, 76]. This leads to a second reason why further research into global teams is pertinent: although spatially-distant communications is already salient in the post-pandemic WFH literature [17, 41, 97, 98], temporal distance poses a distinct set of challenges around synchronous communications. Compared to asynchronous communications, cross time zone meetings have been argued to help workers navigate complex information, coordinate with fewer delays, and access expertise quickly [3, 33, 39, 69, 91]. However, evidence suggests these meeting across time zones are difficult because of a lack of physically-immutable time overlaps [46, 69, 91, 93]. Even in their seminal paper, Olson & Olson highlighted time zone differences as a "*difficulty not predicted to be overcome with technology*" [76]. Thus, research has argued that temporal distance is more influential than geographical distance due its dependence on time zone overlaps and the magnitude of time differences [38, 81, 91, 93].

In spite of this, no large-scale characterization has been made of how these meetings are actually scheduled *in situ*. There is also no consensus as to whether cross time zone meetings are actually as difficult and as indispensable as they are reported to be in anecdotal settings [39, 76, 91] – especially in the post-pandemic era. Thus, these gaps in our empirical understanding of how temporally-distant workers synchronize motivate three areas of investigation. Firstly, cross time zone meetings are purportedly difficult due to the paucity of overlaps between time zones and the costs of scheduling them beyond the traditional work day [69, 91]. Nonetheless, the extent to which these meetings are actually held at odd hours in practice remains unclear, as existing studies focus on software engineers who constitute only a fraction of typical tech companies and take on fewer managerial duties [23, 69]. Furthermore, one may conceive that cross time zone meetings at odd hours may actually fit into increasingly flexible WFH schedules [61, 77, 82, 87]. We seek therefore to address: **RQ1** *How well do cross time zone meeting times align with workers' overall meeting time preferences?* Answering this question will clarify the temporal challenges of synchronous, collaborative work over temporal distances, and contextualize existing anecdotal findings against organic workplace practices after 2019.

Beyond the quantification of cross time zone meetings, we also lack insight into how these meetings are distributed within an organization. Many existing studies focus on the perspectives of non-managerial employees drawn primarily from US-based locations [3, 44, 46, 57, 76, 93]. To our knowledge, no study has attempted to quantify the demands of remote collaborations among, for instance, all employees based in China. Thus, we still have little knowledge of how cross time zone demands compare between employees in different geolocations and organizational levels. On the one hand, certain worker subgroups may have to schedule cross time zone meetings at less preferable hours and therefore bear disproportionately more of the meeting burden. On the other, organizations may organically have evenly-distributed distanced workloads due to an increasing adoption of remote work practices [17, 97]. We therefore ask a second research question: **RQ2**: *How equitably are cross time zone meetings distributed between collaborators?* Checking that these challenges are equitably distributed may illuminate power dynamics in the workplace [47, 85] and ensure a fairer work culture [28, 42, 48].

Answers to both of these RQs, alongside the existing work on distanced collaboration, could thus indicate that cross time zone meetings incur substantial scheduling costs to their attendees in inequitable ways. One may therefore conclude that these costs may be directly addressed by offloading synchronous collaborations to asynchronous communications such as emails [37, 69, 93]. However, organizations cannot simply limit meetings across time boundaries, on the basis that they help remote collaborators communicate [3, 30, 38, 39, 69, 76, 91] and connect [24, 68, 69, 71, 75]. Having distanced attendees meet can further serve to source more diverse viewpoints and ideas [19, 54, 65]. And yet, these observations are also often anecdotal, with little large-scale evidence showing the connectivity and diversity of cross time zone meetings. It is plausible that, due to the aforementioned difficulties of cross time zone meetings, businesses already only hold these meetings when people have established organizational connections like supervisor-supervisee relationships. This would mean, in turn, that cross time zone meetings are less connective than regular meetings. We therefore ask: **RQ3**: *To what extent do cross time zone meetings connect more diverse attendees from across an organization than same time zone meetings?* If these meetings bring people together from different parts of the business who are not only temporally distant, but also *organizationally* distant, then offloading these events to asynchronous communications may disafford employees the chance to connect.

Summary of results. In this study, we report on the large-scale characteristics of meetings held at Microsoft, a multinational technology corporation headquartered in the West Coast of the USA. To this end, we employed a mixed-methods study design. We first analyzed a telemetry trace consisting of millions of meetings scheduled into employees' calendars from January to July 2022. By inspecting employees' geolocations and positions in the organization tree, we were able to quantify when cross time zone meetings were scheduled across the entire corporation. The trace analysis was further supplemented by a separate survey of (n = 130) employees' perceptions of their scheduling habits and preferences. We invited participants to reflect on their calendars through multiple choice and open-ended questions, the latter of which we qualitatively analyzed to surface common themes.

We find that a third of all meetings span multiple attendee time zones, and are tied to hours outside of the traditional 8am-6pm work day. However, employees' general preferences for meetings lie consistently within the core of the day, illustrating that cross time zone meetings are likely to challenge personal scheduling requirements. Additionally, we map the distributions of multi time zone meetings across different regions of the world, and find that they are frequently asymmetric. A minority of employees within individual geolocations undertake a majority of cross time zone meetings, while meetings between two countries are more likely to be held at odd hours for one country than the other. Despite these challenges and apparent inequities, however, we uncover correlational evidence that cross time zone meetings connect a more

diverse and more organizationally-distant group of attendees than regular meetings. In other words, people meeting across many time zones tend to be further apart in the organization hierarchy and share less similar meeting contexts than those meeting in the same time zone. Thus, instead of addressing scheduling challenges by directly reducing cross time zone meetings, we argue that they are best tackled by testing low-overhead management strategies, improving calendaring tool design, and supporting burdened employees.

2 BACKGROUND

Geographically and temporally dispersed organizations are becoming more prevalent, allowing companies to source talent and expertise from across the world [36, 45, 54, 60]. In the wake of the COVID-19 pandemic, companies have shifted towards infrastructure and business models that enable employees to work remotely and from home [32, 98]. As a result, some studies have shown that workdays have become longer [2, 8], triple-peaked [1, 70], and blurred with personal life [6, 43]. Simultaneously, there are also signs that teams may have become less productive [41], less focused [17], and less connected [98]. Understanding the characteristics of global organizations in the post-pandemic era is therefore especially pertinent with experts predicting that remote work will be here to stay [61, 77, 82, 87].

In this study, we focus on the temporally-distanced aspects of remote collaborations. A rich line of research on collaborations spanning spatial and temporal distances trace back to Olson and Olson's seminal study [76]. Scholars have sought to characterize how (at the time) emerging technologies like conferencing systems would facilitate distanced communications [16, 30, 39, 62, 76]. Some have suggested that, while certain forms of communication can overcome the challenges of geographical distance, temporal distance is likely to remain unbridgeable due to the physical constraints of having few overlapping work hours [39, 76].

Nonetheless, a key theme underlying this literature is that synchronous communication, in the form of meetings, is necessary for temporally-distanced collaboration [33, 53, 63]. This is firstly due to the immediacy of information exchange in meetings. Media synchronicity theory, for instance, argues that synchronous communications are needed for convergence upon a shared understanding of information after it is shared via asynchronous means [33, 34]. This notion is supported by a wide range of empirical evidence. For example, synchronous communication facilitates rapid feedback and reduce delays in coordination [3, 30, 38, 39, 69, 76, 91]. Without this synchronicity, teams may need to wait for information and expertise from distant collaborators [3, 29, 69]. This is exacerbated by cross time zone work being necessarily remote, which has been shown to lead to siloed and static collaboration patterns [4, 5, 90, 98].

Secondly, there are affective reasons for having meetings in temporally-distanced teams. People who can interact in person may be more motivated [35, 69] and can more easily develop trust in one another [22, 37, 84]. Those relying on remote communications, however, may feel isolated from and have conflicts with other team members who do have in-person interactions [24, 68, 69, 71, 75, 91]. Additionally, existing research has argued that distanced meetings are necessary for enabling a diverse workplace, both in terms of different business functions and in terms of social and cultural differences across the world [9, 55, 65, 69]. Finally, meetings are especially important for temporally distant attendees because they cannot be easily replaced by other forms of synchronous communication. Informal communications in the form of "water cooler", "corridor", or "coffee" talk, which happen organically in collocated teams [31, 44], are absent from geographically and temporally dispersed groups.

Part of why cross time zone meetings are anecdotally held less frequently is that they are naturally both hard to attend and hard to schedule [69, 91]. For one, collaborators in different time zones have fewer overlaps in their work hours [29, 38, 69, 76, 91], leading to meetings being scheduled into "edge" or odd hours of the day [46, 69, 91, 93]. Since they already rely on asynchronous communications, negotiating convenient meeting hours and establishing "common ground" could also be challenges that impede scheduling efforts [14, 26, 35, 73, 74, 76]. Thus, to help enable these meetings, collaborators across temporal distances have reported using various strategies for managing meetings. For example, people may need to block off and prioritize time slots for meeting with remote attendees [91], which could further entail shifting one's entire work schedule to accommodate meetings during odd hours [46, 93]. Alternatively, some teams may hold meetings during traditional work hours in one time zone, and then rotate which time zone gets to have regular meeting hours, so attendees in that time zone can join from an office space [91].

Other strategies are less focused on finding temporal solutions like overlapping hours, and are directed more towards organizational solutions. For some businesses, collaborators with few overlapping work hours may actually be desirable so that workers can hand off work at the end of their day to others in a remote timezone, thus allowing productivity to "follow the sun" [18, 57, 93]. In certain circumstances, the actual distribution of work and team structure may be changed to aid cross time zone coordination. For instance, a few team members may take on a larger portion of the cross time zone coordination load as temporal brokers [63]. Certain teams may even arrange work around temporal distance so that global collaborations are "loosely" coupled and rely mainly on asynchronous communications [37, 69], leaving the benefits of synchronous, collocated work to tightly coupled projects [3, 38, 39, 76]. However, this is highly dependent on organizational configurations that, like following the sun, are not always feasible and may come with additional management costs [69, 93].

Relation to this work. In sum, this body of literature paints a detailed backdrop of synchronous communications across time zones, albeit in smaller-scale settings. On the one hand, temporally distanced meetings are necessary to help colleagues connect, diversify, and be motivated; on the other, these meetings are hard to attend, with scheduling strategies still empirically untested across broader worker groups. Thus, there remain several gaps in this knowledge of global collaboration that we seek to fill in the present work. Firstly, existing work focuses mostly on workers' *perceptions* of cross time zone work [3, 30, 38, 39, 69, 76, 91]. While this allows research to uncover the subtleties and nuances of how workers view temporally-distant collaboration, it does not necessarily

Label	Type	Question
Background Information		
B-JOB	*Text*	What is your work role / title? (e.g. Senior Software Engineer)
B-TZ	*Single Choice*	What is your time zone?
B-SUP	*Text*	How many people do you supervise directly?
B-DEP	*Single Choice*	Which department do you currently work under?
Scheduling Preferences		
HOD1	*Multiple Choice*	Which of the following hours are typically part of your working hours?
HOD2	*Multiple Choice*	If you had full control over your schedule, how would you distribute your work within a day?
HOD3	*Multiple Choice*	What are your preferred times of day to participate in meetings?
HOD-OPEN	*Text*	Please elaborate why these meeting hours are ideal for you.
Cross Time Zone Meetings		
TZ1	*Single Choice*	You have meetings in the early morning or late evening with time zone overlaps.
TZ2	*Single Choice*	You block off hours every week for people in different time zones to meet.
TZ3	*Single Choice*	You alternate between early morning or late evening meetings to keep hours fair.
TZ4	*Single Choice*	You hand off work to each other when one group signs off for the day to keep productivity up.
TZ5	*Single Choice*	You have designated people who coordinate between different time zones.
TZ-OPEN1	*Text*	Why do you and your collaborators use these strategies to deal with cross-time zone work?
TZ-OPEN2	*Text*	What do you think are the costs and benefits of meeting with people from a different time zone?

Table 1: Summary of survey questions and type of response elicited. For questions on scheduling preferences, participants select select any number of 1-hour blocks across the day starting. For questions on cross time zone meeting strategies, participants select one option out of never, rarely, sometimes, and often.

capture how they actually behave in the workplace. People are also known to have imperfect memories of their behavioral patterns [13, 51, 89], suggesting that the literature on cross time zone collaboration needs to be interpreted in context of workers' actual propensity to meet across temporal borders at odd hours. Contrary to expectations in prior work, for example, one could envision that workers have already adapted to these difficulties and therefore organically only hold temporally-distanced meetings at optimal times with workday overlaps. Measuring the empirical prevalence of cross time zone meetings is particularly important given that they may become even more ubiquitous in the workplace after COVID-19 [61, 77, 82, 87].

Secondly, existing interviews [91] and surveys [38, 39] are typically conducted at *small scales* and solicit *coarse-grained behaviors* that may miss variance in workers' actual labor environment. For example, it remains unclear how cross time zone workload is distributed between individual employees in different geolocations and the different levels of an organization. To our knowledge, much of the literature is concentrated on software engineers and developers [3, 44, 46, 57, 93], whereas businesses consist of workers drawn more broadly from various disciplines and locations. This is especially pertinent in light of recent concerns over how work is shared between different parts of the globe and labor inequities in the technology sector [28, 42]. Indeed, scholars have both argued that productivity aids can alleviate or exacerbate these inequities [59, 95], and some studies have pointed to power imbalances in temporally-distanced collaborations [47, 48, 85]. Beyond this work, however, research on distanced collaborations and equitable labor have thus far been conducted in separate streams – despite the former now becoming a pervasive form of labor [77]. Similarly, although the purported connective and diversifying effects of cross time zone meetings suggest that they cannot be dispensed with, these effects have also been observed in small, anecdotal settings. There are therefore multiple gaps in our understanding of temporally distanced meetings and both their challenges and benefits that need to be filled in an observational, *in situ* manner.

3 METHOD

In order to address our research questions, we utilize a mixed-methods study comprised of two main components. Firstly, we perform a large-scale trace analysis of millions of meetings conducted at Microsoft in the 6 months between January and July 2022. Secondly, we designed and distributed a survey asking employees about how they perceive their individual schedules, in which we also included questions about how they handle meetings with temporally-distant collaborators. We detail both methods below.

3.1 Trace Data Analysis

Our quantitative results are primarily derived from an *in situ* telemetric trace – i.e. recorded behavioral data – of meetings at the company from January 2022 to July 2022. We processed a sample of all events scheduled into employees' work calendars in a major commercial Web email client, the company's primary information management system. Each datapoint includes information about when the event was scheduled, its scheduled duration, the individuals who attended, and the individual who organized the event. We additionally restricted events to those recorded as meetings (as opposed to appointments or "out of office" blocks), show as busy (as opposed to tentative), and were never cancelled. Altogether, our resulting dataset contains 20 million meetings between 310 thousand individuals.

We join attendee metadata to these meetings, including the geolocation in which they are based, their job title, and their position in the organization chart. To infer attendee time zones, we parsed attendee city and country metadata and mapped them to offsets from Coordinated Universal Time (UTC), adjusted for daylight savings based on when events occur and rounded to integer offsets for ease of interpretation. Furthermore, we also use two variables to measure employees' position in the organization chart. To preserve employee privacy, we firstly reduce job titles into four managerial categories. Employees with no supervisees are considered to be individual contributors ("IC"s), and ICs with "intern" in their job titles are considered interns. Employees who supervise at least one person are labelled as managers; managers of other managers are labelled as skip-level managers. Secondly, we identify the department in which an employee works by traversing the organization chart to find the departmental leaders whom the employee reports to. This includes departments at the company that are, for example, responsible for human resources, finance, and various engineering groups. To further protect employee privacy, all potentially sensitive information like individual job titles and cities was then removed after we computed coarser-grained tags like managerial level and time zones. At no point did our data contain any explicit identifying information like names and emails. Data access was also restricted only to members of the research team with research ethics training.

3.2 Survey

We supplement our trace analysis with a survey asking employees for their perceptions of their work schedules. To inform the design of the survey, we ran eight exploratory interviews, averaging to 45 minutes in duration, focusing on eliciting an ideal arrangement of events on participants' calendars and factors that impact their scheduling decisions. Following the inductive, grounded theory approach put forth by Corbin and Strauss [25], we separated our coding into an initial open coding and subsequent axial coding to identify key research questions and themes to focus the survey.

The survey was then designed and conducted in the context of a larger research project on how people arrange their calendars, and included multiple sections on topics such as hybrid meetings, schedule fragmentation, and tool design. Here, however, we focus on three key parts relevant to our research questions. First, the survey includes an introduction that presents participants with an information sheet and asks participants for their consent. It also solicits background information such as participants' job function, timezone, number of people supervised, and department.

In the first main section, the survey asks participants to describe 3 aspects of their distribution of work across different hours of the day. This is intended to elicit stated, explicit perceptions of how employees' work is distributed across the day, and whether or not these are aligned with their preferred work cadence. The 3 questions include their:

- **Typical work hours**: "*Which of the following hours are typically part of your working hours?*"
- **Preferred work hours**: "*If you had full control over your schedule, how would you distribute your work within a day?*"
- **Preferred meeting hours**: "*What are your preferred times of day to participate in meetings?*"

Respondents are presented with 16 options: 14 1-hour blocks from 7-8am to 8-9pm, plus two options for hours before 7am and after 9pm respectively. They can select any number of options to delineate how they think their work is and should be distributed across a day, which is used for Figure 1. We additionally ask an open-ended question at the end of this section about preferences for meetings across the day: "*Please elaborate why these meeting hours are ideal for you.*"

In the second main section, we ask participants for their perceptions specifically of cross time zone collaboration. This section is prefaced with a question asking participants whether they worked with people in a different time zone within the last two months. If participants answers negatively to this question, they are skipped to the next to keep the survey short. We then present participants with a block of 5 questions on the strategies they use in their work to manage meeting across temporal boundaries. These were selected through our exploratory interviews and by identifying the commonly mentioned strategies in the existing literature:

- Meeting at **odd hours** or the "edge" of the day [46, 69, 91, 93]: "*You have meetings in the early morning or late evening with time zone overlaps*".
- **Blocking off time** to prioritize remote attendance [69, 91]: "*You block off hours every week for people in different time zones to meet.*"
- **Alternating** between attendees who need to attend at odd hours [91]: "*You alternate between early morning or late evening meetings to keep hours fair.*"
- **Following the sun** by handing off work [18, 57, 93]: "*You hand off work to each other when one group signs off for the day to keep productivity up.*"
- Designating **temporal coordinators** or brokers [63, 69]: "*You have designated people who coordinate between different time zones.*"

Each question is answerable with 1 choice out of 4 representing frequencies of use: never, rarely, sometimes, and often. Two open-ended questions are then asked at the end of this section. The first prompts employees to reflect on these strategies: "*Why do you and your collaborators use these strategies to deal with cross-time zone work?*". The second probed for perceived outcomes tied to cross time zone meetings: "*What do you think are the costs and benefits of meeting with people from a different time zone?*"

In total, we obtained $n = 140$ responses to the survey, of which $n = 130$ qualified as eligible employees (we removed those in sensitive or identifiable positions, such as C-suite level workers) and a further $n = 119$ said they had recently worked across time zones. To protect participant privacy, we removed all identifying information and did not link responses to our trace data. Respondents' ages ranged from 18 to 55 years (M = 41.8, SD = 9.1), with 37% identifying as female and 61% identifying as male. Respondents came from a diverse set of roles ranging from product managers and software developers to consultants and administrative assistants; the majority had been working at the company for more than 6 years (52%). For our qualitative analysis, we followed the same inductive, grounded theory approach described at the beginning

of this section to code open-ended survey responses. We report on salient themes alongside corresponding quantitative results to contextualize our findings.

4 RESULTS

Before directly addressing our research questions, we begin by providing a high-level overview of meetings across the world in our dataset. As a large organization headquartered in the Northwest United States, an unsurprising majority of meetings are scheduled in Pacific Standard Time (42.0%) and Eastern Standard Time (9.1%). However, there are multiple loci of meetings around the globe, including those in India Standard Time (12.5%), Central European Time (8.1%), UTC itself (6.3%), and UTC+8 (5.7%) – encapsulating all of China and parts of Australia.

Looking at the distribution of meetings in our dataset, we find that approximately one third (33%) of meetings have employees attending from different time zones. The number of time zones spanned by meetings follows a near-perfect power law [79], with two-thirds of the meetings having attendees in the same time zone, two-ninths with two time zones, and so on[1]. Cross time zone meetings also have, on average, 36% more attendees, so an individual employee can expect 47% of the events in their calendars to span multiple attendee time zones. These observations represent the first *in situ* measurement of cross time zone meetings in a large organization, and also reflect perhaps a surprisingly high frequency of these kinds of meetings. Together with the litany of work establishing their importance to distanced collaboration [30, 38, 69, 76, 91], the prevalence of cross time zone meetings motivates the need to more deeply investigate their characteristics at scale.

4.1 RQ1: Alignment of meeting time and preferences

Our preliminary statistics illustrate the global nature of the corporation we study and the prevalence of cross time zone meetings held across the world. However, they do not clarify whether employees find these meetings difficult to attend as indicated by existing work [69, 91]. Thus, in this section we turn to our first research question.

> **RQ1:** *How well do cross time zone meeting times align with workers' overall meeting time preferences?*

General meeting time preferences. To address this question, we first characterize the hours during which people prefer to hold meetings in general. Given a HOD question on typical work hours, preferred work hours, and preferred meeting hours (see Table 1), we total the number of times each hour block is selected by participants. We then normalize this count by the total number of hour blocks selected by all participants for that question. This yields the probability that each hour block is viewed as being reflective of employees' actual work hours, their prefered work hours, and and their preferred meeting hours. These values are shown in Figure 1 respectively as the blue, orange, and green lines.

We find that people have very clear preferences for holding meetings within the traditional work day. Employees' preferred meeting hours are more clustered towards the middle of the day than what they believe their typical meeting hours are. Typical working hour responses include every hour between 6am and midnight (blue line), with 13.5% of typical hours outside of 8am-6pm. Respondents stated more flexibility in their temporal preferences for non-meeting work (orange line; 7.4% outside of 8am-6pm). However, only 3.5% of response hours before 8am and after 6pm are preferable (green line), with preferable meeting times being >95% likely to fall within the core of the day. In addition to the lack of meetings outside of the 8am-6pm range, people generally avoid meeting at 12pm for lunch (which is validated by their open-ended responses below) and have a slight preference for morning meetings over afternoons.

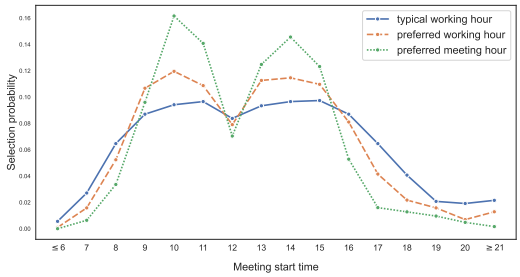

Figure 1: Probability that a given hour of the day is selected by participants in our survey as representative of their typical working hours, their preferred working hours, and their preferred hours for holding meetings.

A strong majority (91%) of open-ended survey responses stated that traditional or "normal" working hours are the best for them to hold meetings, e.g. "*Eastern time zone working hours that best mesh with my family and volunteer schedules*" (P26) with lunch a salient point of time protection, e.g. "before and after lunch are best times and being done by 4 is usually preferable as I like to start work around 8 am" (P21). 14% of participants further mentioned the need for energy in conjunction with the core of the day. P127 stated that the "*middle of the day is when I am most engaged in interacting with my team and other stakeholders*", while P32 hinted at our next analysis, sharing that "*after 5pm energy is low but sometimes TZ differences in global project require late meetings.*" 38% of respondents also highlighted the need to preserve the edge of the day for focused, non-meeting work: "*I like to have thinking and planning time at the start and end of the day*" (P46). 9% of respondents pointed to family-related scheduling constraints outside the typical work day. For example, "*being a parent with a small child, morning and evening hours are quite busy*" (P34). Thus, while working hours may be diverging from the traditional work day, core hours are perceived to be more desirable for synchronous collaborating in meetings.

Meeting time practices. Although Figure 1 illustrates the *stated* preferences of employees, it may not represent what employees actually do in practice. Nonetheless, we find very similar patterns in our telemetry data, suggesting that employees' calendars reflect *revealed* preferences for traditional work hours on aggregate. Figure 2**(a)** illustrates the distribution of meetings based on their start times at various hours of the day from the perspective of its attendees. Two patterns arise from this visualization. Firstly, meetings

[1]Exact numbers excluded to protect privacy.

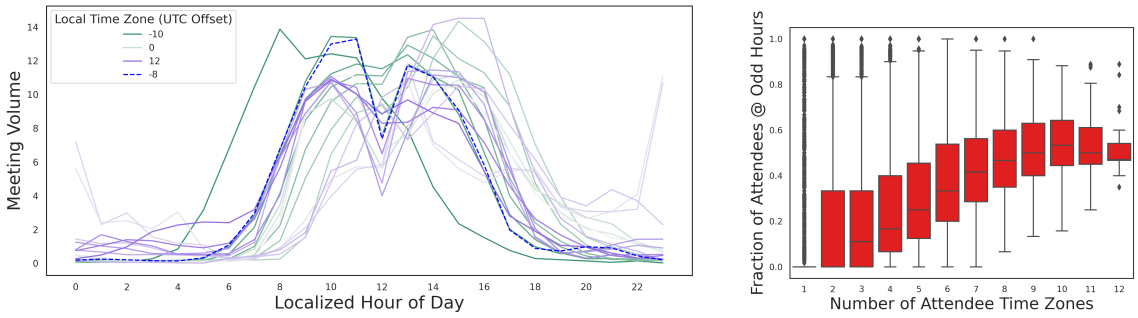

Figure 2: *Left (a)*: Line plot showing the percentage of meetings that start at various hours of the day in their scheduled time zone. *Right (b)*: For meetings of various sizes, boxes show the empirical fraction of attendees that have to attend during odd hours in their local time zone.

are generally concentrated around the core of the day, with a dip in activity between 12pm-1pm. This aligns with existing work on the distribution of work across a typical day [17]. Concretely, 89.4% of the events in the average employee's calendar happen during the hours between 8am and 6pm. Secondly, there is obvious variance in these distributions based on where employees are temporally located. For instance, those in time zones ahead of UTC, represented by purple lines, have meeting distributions that are also shifted forwards in their local hour of day.

Scheduling cross time zone meetings at odd hours. How do these preferences align with meetings across time boundaries? Existing small-scale studies suggest that meetings for temporally-distant collaborations at the edge of the day are scheduled out of necessity, rather than preference [46, 69, 91, 93]. Given that we find that most users prefer meetings during the 8am - 6pm window, and most meetings do occur in that window, we next hone in on how often cross-timezone meetings occur outside of these preferred meeting times. We operationalize *odd-hours meetings* as meetings that start before 8am or end after 6pm. As a baseline, 10.6% of all meetings occur at odd hours. Figure 2**(b)** further stratifies this data by showing the fraction of meetings that occur at odd hours for meetings that include attendees from a given number of different time zones. For example, once meetings include more than 5 attendee time zones, they would on average be at odd hours for more than one third of their attendees. This effect also persists when controlling for the typical increase in attendees for meetings spanning more time zones. In fact, cross time zone meetings are *2.6 times more likely* to be at odd hours than single time zone meetings with the same number of attendees.

The strong empirical association between the temporal boundaries crossed by a meeting and the likelihood that workers will need to attend at odd hours is corroborated by our survey. Indeed, $n = 21$ participants mentioned time zones in their responses to the open-ended question about their preferred meeting hours (HOD-OPEN) – even before they saw any explicit prompts about time zones. For instance, P32 said that "*after 5pm energy is low but sometimes TZ differences in global project require late meetings*", while P33 (in UTC+1) noted "*evening hours are needed to collaborate with the UTC-8 timezones*". Similarly, P76 stated that "*I work both my time zone (EET) & Seattle time so for evening meetings I don't really have much choice*", highlighting the demands for odd-hour attendance for distanced collaborators.

Furthermore, responses to our survey question on cross time zone meetings occurring at odd hours reinforced the ubiquity of this phenomenon (question TZ1). Of $n = 119$ participants who recalled working with employees in a different time zone, only 5 said they never had to meet at odd hours, of which 4 are US-based. In comparison, a majority of respondents said they sometimes (20%) or often (63%) have to meet at odd hours to facilitate time zone overlaps. With regards to RQ1, our findings therefore provide large-scale evidence for the close relationship between global collaborations and meetings at odd hours, which is validated by our supplementary survey. Thus, cross time zone meetings appear to be generally misaligned with workers' scheduling preferences.

4.2 RQ2: The Asymmetric Challenges of Crossing Temporal Boundaries

Together, our findings in Section 4.1 provides large scale evidence complementing existing work on how cross time zone meetings are generally challenged by odd-hour or edge of day scheduling [46, 69, 91, 93]. However, there is to date no disambiguation of how these challenges are shared between the many groups of people with different roles collaborating across distances in a large organization. One may intuit, for instance, that employees in remote geolocations may have a disproportionate need to meet with different timezones. Motivated both by this gap in the literature and by recent concerns over global labor equitability in the technology sector [28, 42], we investigate the distribution of cross time zone workload across various countries in this section.

> **RQ2**: *How equitably are cross time zone meetings distributed between collaborators?*

We present four key findings: first, that meetings are distributed unequally between organizer and attendees; second, that this load is distributed unequally within individual geolocations that are temporally further from UTC-8; third, that meetings between pairs of geolocations are asymmetrically likely to be scheduled at odd hours; fourth, that employees are generally cognizant of attendee

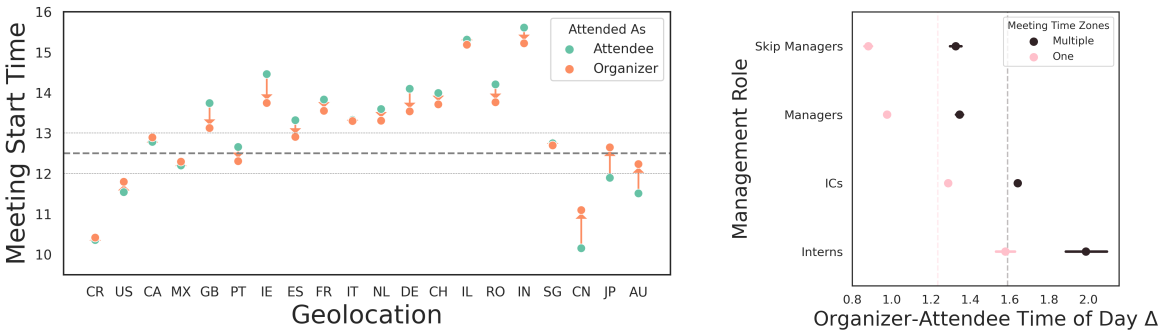

Figure 3: *Left (a)*: The expected localized start time of meetings from the perspective of meeting organizers (orange) versus regular attendees (green). Grey lines visualize 12pm-1pm, around which survey respondents mentioned they prefer to hold meetings. Country codes available in Appendix A. *Right (b)*: The delta between organizers' time of day for meetings and attendees' time of day for meetings. This is split by whether meetings are single (pink) or cross (black) time zone, and the different managerial roles that employees can take. Vertical lines are mean deltas across all employees for the different meeting types.

fairness in their responses to our survey. Together, these observations highlight potentially inequitable, structural asymmetries in how cross time zone work loads are shared across an organization.

Asymmetry between organizers and attendees. It is possible organizers of meetings may have more awareness of their own preferences and priorities than attendees and therefore their meeting times and organizers may have fewer scheduling constraints than non-organizer attendees [10, 94]. Given these dynamics, meeting times should be closer to organizers' temporal preferences than to attendees' preferences. Figure 3**(a)** illustrates this difference across the top 20 countries by meeting volume. Systematically, we observe that organizers (orange points) schedule meetings closer to the core of the day around the 12pm-1pm lunch hour, shown as dotted grey lines. From the perspective of regular attendees (green points), however, meetings happen closer to the edges of the day. There is, on aggregate, a 1.2 hour difference ($p < 0.0001$ in an unpaired t-test) between the scheduled meeting time for employees when they are organizers compared to when they are regular attendees.

As may be expected from their association with odd-hours scheduling, cross time zone meetings have larger organizer-attendee gaps (1.6 hours, $p < 0.0001$). Not only does this persist for the geolocations in Figure 3**(a)**, but they are also present across employees with different managerial demands in Figure 3**(b)**. The organizer-attendee gap in meeting times is larger for individual contributors and interns, who generally have fewer meeting obligations than managers with multiple reportees to meet with. This is consistent with non-managerial employees having even fewer constraints when scheduling, and thus placing meetings closer to their preferred times. Thus, these behavioral patterns indicate that attendees have on average a larger per-meeting odd-hour load than organizers, which is exacerbated by meetings spanning multiple time zones. This suggests that organizing collaborators generally schedule meetings towards preferred hours, whereas attending collaborators are less able to do so.

Distribution within geolocations. Our results so far point to asymmetric scheduling constraints between organizers and attendees of cross time zone meetings. To what extent do these asymmetries extend to potentially inequitable meeting loads for employees around the world? We characterize this via a bivariate Gini index over each employee's share of regular and cross time zone meetings relative to their locations. This measure is given by $G = 1 - \sum_{i=0}^{n-1}(Y_{i+1} + Y_i)(X_{i+1} - X_i)$, where X and Y are respectively a cumulative population measure and a cumulative health indicator over n population divisions [15, 67, 88]. This has been used over, e.g., the number of health practitioners (Y) per populace count (X) in a country's n regions [15, 67]. Here, we quantify the frequency of cross time zone meetings (Y) among all meetings (X) for all n employees in a country. We use this method because it normalizes for single time zone meeting volume, which would heavily confound the standard Gini measure over simple counts of cross time zone meetings[2].

This Gini index for the top 20 countries with the most meetings in the world is shown in Figure 4, with two baselines: a Gini coefficient computed over all countries as one large geolocation (shown in grey), and a Gini coefficient computed only for employees located in the headquarter region of the company (shown in blue). We find that geolocations whose time zones are further away from North American time zones generally have elevated Gini indices. This suggests that a smaller fraction of workers takes on a larger portion of the cross time zone meeting load in these locations. For example, countries like Japan, the Netherlands, and Germany have substantially higher Gini coefficients than the rest of the world. Countries in North America, in contrast, have Gini coefficients that are lower than the worldwide baseline and fall close to the Gini of employees at the corporation's headquarters. These observations thus provide empirical evidence that cross time zone work is asymmetrically

[2]We also computed the Gini measure over the ratio of cross time zone meetings to all meetings [20] and found it both to be fairly correlated ($r = 0.76$) and to yield qualitatively similar results.

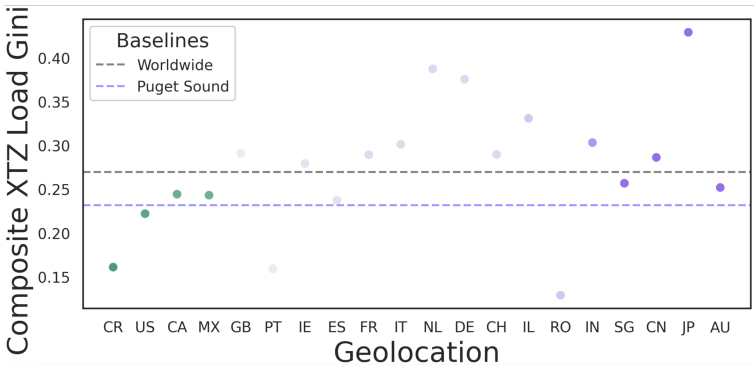

Figure 4: Two-variable Gini coefficient [15] measuring how equally distributed cross time zone meetings are amongst all meetings, for each individual employee in a country (codes available in Appendix A). Grey and blue lines are baselines derived respectively from everyone in the world and employees close to the company's headquarters in the Seattle area of West Coast USA.

distributed among workers in different geolocations. They also motivate the need to probe further into both the power dynamics of temporally distant workers [47, 48, 85] and the equity of labor in global technology corporations [28, 42].

Meetings between geolocation pairs. Two follow-up questions arise naturally out of these asymmetries within individual countries. Firstly, are cross time zone meeting loads also asymmetrically distributed *between* geolocations? Secondly, given the coupling between cross time zone meetings and odd-hours scheduling, is the need to meet at *odd hours* also asymmetrically distributed? To address both questions we consider all geolocation-pair meetings (n = 2.8 million), i.e. meetings in which attendees are based in exactly two countries C_1 and C_2. Note that this is nonequivalent to meetings with two time zones as many countries span multiple time zones. We then measure the probability P_{C_1,C_2} that these meetings will fall at localized odd hours (i.e. outside of 8am-6pm, as defined in Section 2) from the perspective of attendees in C_1, normalized for the number of C_1 attendees in the meeting. As a baseline, we additionally measure the probability P_{C_1,C_1} that *same-geolocation* meetings for C_1 will occur at odd hours. We therefore obtain an odds ratio $OR = \frac{P_{C_1,C_2}}{P_{C_1,C_1}}$ of how much more likely C_1 attendees are to meet at odd hours with C_2 attendees, versus when C_1 attendees only meet among themselves. We plot the log odds ratio $log_2(OR)$ of each geolocation pair for the top 20 countries by meeting volume in Figure 5, with C_1 in the rows and C_2 in the columns.

Two key observations emerge from this analysis. Firstly, meetings between geolocations that are temporally further apart are clearly associated with the need to meet at odd hours. This is visually obvious for attendees from North America or the EMEA region, many of whom are much more likely to have to meet at odd hours for geographically-distanced meetings. Take, for instance, US-India meetings ($n = 373k$), which from US-based participants' perspectives are 6.5 times more likely to be at odd hours than US-only meetings, and similarly 4.6 times more likely from India-based participants' perspectives. This reinforces existing findings on the relationship between geographical and temporal distance in meetings [38, 69, 91], and further mirrors survey responses we analyzed in Section 4.1. One US-based participant reflected specifically on US-India collaborations in their response to question TZ-OPEN1: "*I come in early, which is still within time zones of my collaborators in EMEA. People in India don't want to have early morning meetings they prefer late at night which suits my early morning*" (P11).

A second observation is that different geolocations have asymmetric burdens of meeting at odd hours when collaborating across the globe. For instance, from the perspective of workers based in Japan, they are the most likely to have to meet at odd hours with another geolocation compared to Japan-only meetings (3.1 times more often). Employees in the US, Canada, and Australia also have similar probabilities (meeting with other geolocations respectively 3.1, 3.0, and 3.0 times more often at odd hours). These asymmetries are also evident from the perspective of the *alter* geolocation. Attendees meeting with those based in the US are the most likely to have to hold meetings at odd hours – 4.3 times more often – than when they meet with others from their own countries. Indeed, participants across the world are especially likely to have to meet at the edge of the day with attendees from North America, with Mexico (3.0 times), Canada (2.8 times), and Costa Rica (2.7 times) also falling within the top 5 geolocations by this metric. In contrast, groups of spatially close geolocations are less likely to have to meet at odd hours, which is visually noticeable in Figure 5 as blue-shaded squares corresponding to groups of countries within North America, Europe, and East Asia. Thus, the challenges of having to meet at odd hours are also skewed from the perspective of alter geolocations, especially those with workers who collaborate frequently with North America.

Fairness in open-ended responses. Our results thus far demonstrate that cross time zone meetings occur at odd hours, which many people consider to be challenging, and that they are asymmetrically shared by colleagues in different geolocations. These asymmetries indicate that cross time zone collaborations could potentially lead to fairness challenges. Nonetheless, 14% of survey participants mentioned fairness in response to our open-ended

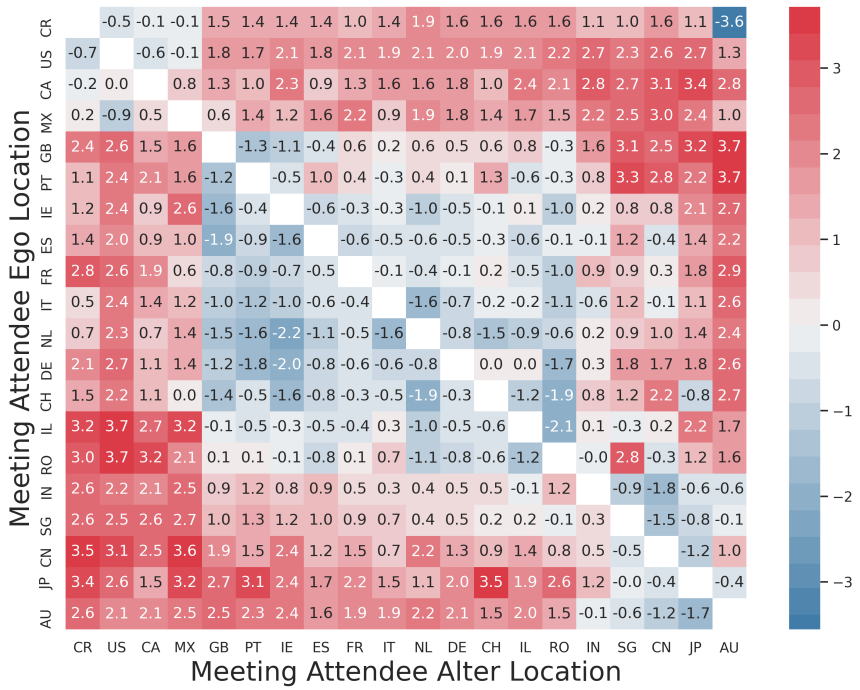

Figure 5: Heatmap visualizing meetings at odd hours when two geolocations collaborate. Cells represent log odds ratios (LOR) of how much more likely attendees from a country are to attend 2-country meetings at odd hours than 1-country meetings at odd hours. LORs are shown from the perspective of the row country when they meet with the column country.

question on management strategies (TZ-OPEN1), suggesting that employees are already conscientious of demands on remote collaborators. For example, P122 reflected on their use of prioritized time blocks (TZ2) to "*accommodate everyone and make collaboration fairer*". P129, who reported using every strategy at least sometimes (except following the sun, TZ4), also stated their purpose is "*to try to make it fair to everyone, so we do not have one region/person always at night.*" Accommodating general preferences for traditional work hours is also mentioned by P66: "*we try to not ask certain team members to work outside their normal working hours too often.*" This extends also to preferences for avoiding odd hours: "*we have some individuals who don't cope well with [odd hours] and we squeeze their meetings in. For example, we have a Redmond person who cannot be alert enough before 9am PST to meet*" (P57). Fairness remains a concern even for collaborations within North America: "*Usually finding a suitable time that is equitable between EST and PST*" (P12).

In addition to asymmetric demands on others, 3 additional participants also brought up asymmetric demands on themselves. P69 stated that they are "*trying to accommodate regional partners that don't typically work outside their business hours*", while for P126 (in UTC-5) "*most of the team is based in Redmond so [P126] accommodates their schedule.*" P71 went further to highlight the incompatibility between attendees' generally altruistic intentions and the lack of practical time slots: "*My colleagues are spread across a number of time zones, so they try to find a time that works for most, not everyone. Unfortunately, there are fewer of us in the Pacific time zone, so we typically make the sacrifice.*" Indeed, others indicated that strategies for ensuring fairness may not sufficiently offset attendee pains: "*alternating for fairness is socially best but sucks the most for really bad time zones (PST to IDC for example)*" (P79). Similarly, P70 posited that meeting "*times early/late in the day with appropriate time zone overlaps are the most fair...everyone is SLIGHTLY inconvenienced always. Feels much better than alternating when one side is hugely inconvenienced and it's normal hours for the other side*".

These responses show that workers think about and evaluate their collaborations for equity when meeting across time zones. They also hint at a clear opportunity for improving the health of global teams. While people are often thoughtful of their temporally-distant colleagues who have to meet at odd hours, they do so through best-effort practices over which there is no general consensus. Furthermore, they again reinforce our results in Section 4.1: workers view odd hours as not only difficult for themselves, but also difficult for their collaborators when they attend cross time zone meetings. We therefore discuss the implications of participant responses in Section 5 alongside our telemetry results.

4.3 RQ3: Connecting Organizationally Distant and Diverse Attendees

Our results thus far paint a picture of global teams coordinating around odd hours of the day to accommodate meetings that span multiple time zones. Nonetheless, workers both behave as if and state explicitly that these odd hours are challenging and unequally distributed – challenges that are asymmetrically and potentially inequitably distributed between different parts of the organization.

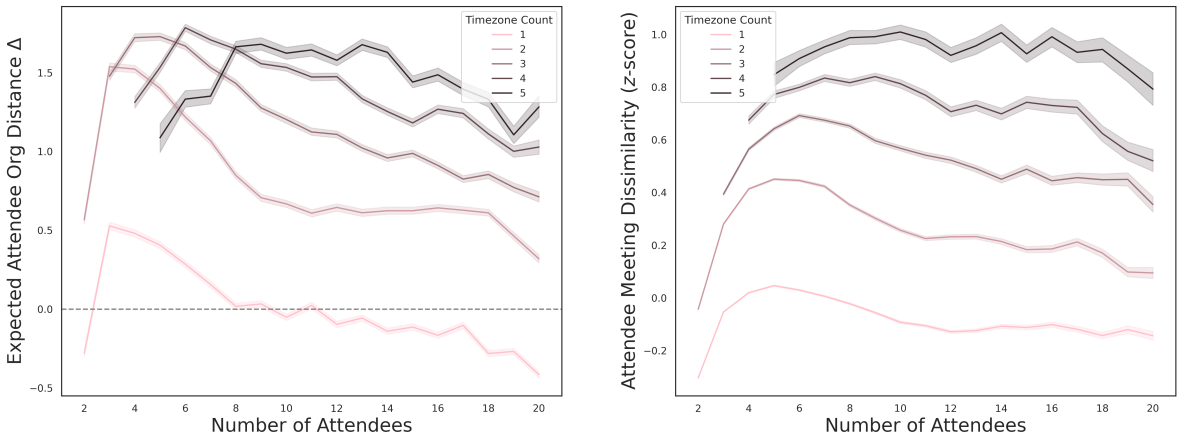

Figure 6: *Left (a)*: How far apart meeting attendees are in the organization tree, compared to their expected distance given their departments. Represented as a Δ between the empirical and expected distances; a Δ of 0 (grey line) indicates attendees are separated by the mean organization tree distance in meetings. *Right (b)*: Diversity of meeting attendees, operationalized as attendees' cosine dissimilarity in a meeting embedding. This is normalized over all meetings as z-scores for ease of interpretation.

One may therefore wonder if "loosely" coupling cross time zone work and offloading communication to asynchronous means, such as emails, can reduce these costs and inequities [37, 69]. However, existing evidence around synchronous communications suggests that this is rarely feasible for most organizations [33, 34, 69, 93]. Research on the balancing of synchronous and asynchronous communications also illustrates the need for real-time meetings to reduce communication barriers [3, 30, 38, 39, 69, 76, 91], connect isolated collaborators [24, 68, 69, 71, 75, 91], and bring together diverse viewpoints [9, 14, 55, 65, 69].In this section we therefore contribute to this body of work through a large-scale analysis of

> **RQ3**: *To what extent do cross time zone meetings connect more diverse attendees from across an organization than same time zone meetings?*

Here, we present large-scale, observational evidence that cross time zone meetings bring together organizationally distant and diverse collaborators. We consider two measures of organizational distance for each meeting. Firstly, we measure distance in the organization tree, i.e. the supervisor-supervisee network, which encapsulates the organization's reporting structure and whose leafs are individual contributors. For example, the distance between an employee and their direct manager is 1. Because different departments in the organization have different heights and structure, we also control for the expected distance for each meeting given the departments each attendee belongs to. Thus, the *organizational distance delta* for a meeting is how much further distanced attendees are than expected, based on their departments.

However, this metric only captures distance through the lens of the company's administrative structure, and ignores the empirical collaborative behaviors between employees. Given two employees, how far apart are their empirical communication patterns? To answer this question we use a second measure of *meeting diversity* derived from a meeting attendee embedding. We re-purpose and train the Word2Vec algorithm using skip-gram and negative sampling [64] on our telemetry data, for which every meeting is considered a "sentence" of shuffled attendee "words". Conceptually, attendees are placed into a 50-dimensional space such that employees who meet more often with one another are located closer together. We represent meetings by a centroid of attendee embeddings, and calculate attendee similarity as the average over the cosine-similarity between each attendee and the meeting centroid. We then measure diversity as 1− attendee similarity, and normalize diversity as z-scores.

This proxies how diverse and distant attendees are in their empirical meeting patterns, and is a method used in domains spanning social platforms and content streaming services [7, 66, 96]. It also has several advantages. For one, the embedding allows us to proxy contexts without measuring content [58], e.g. titles of meetings and emails, which could otherwise contain very sensitive information about employees. Additionally, it can capture distance beyond the first order, e.g. if meetings are scheduled frequently by A to B and by B to C, then A and C will be closer together in the embedding [64].

We illustrate both distance measures in Figure 6, separated by the number of attendees in (x-axis) and the number of time zones spanned by (color) the meeting. Across all metrics, we find that attendees in cross time zone meetings are organizationally more distant than single time zone meetings of the same size. This is visually evident by the substantial spread of colored lines contrasted to the slope of the lines, which is further supported by direct comparisons of different meeting arrangements. If communications in a non-siloed business requires meetings between people who span 1 step more than expected in the org chart, then this is much more likely to occur for e.g. a 4-person meeting across 2 time zones than a 20-person meeting in 1 time zone ($p < 0.0001$). Likewise, the attendees in a typical 2-time zone, 4-person meeting have communication patterns that are 0.5 standard deviations more diverse than attendees in a 1 time zone, 20-person meeting ($p < 0.0001$). Both metrics thus consistently indicate that the more time zones spanned

by a meeting, regardless of its attendee count, the more likely that its attendees would be organizationally distant and diverse.

Connectivity and diversity in open-ended responses. The notion that cross time zone meetings are associated with connectivity and diversity is also reflected in how survey participants answered question TZ-OPEN2. As may be expected, a large portion of participants either stated that the primary reason for meeting across time zones is that it is a requirement for global organizations (26%) or mentioned no benefits at all (8%). For instance, P63 noted that they "*work in a global team so need to do this in order to get work done*", and P48 stated that "*we are a global company and a national organization that supports global customers.*" P43 was unequivocal about cross time zone meetings: "*the only benefits are that those meetings are necessary / mandatory.*" This also appeared to be job-sensitive, with P56 claiming succinctly that the meetings are "*part of my role*" and P120 saying theirs "*is a global role and if I didn't meet with people in different timezones I wouldn't be doing my job.*"

However, a similarly large fraction of participants (26%) also mentioned diversity as a key reason for meeting across time boundaries. For many, this is a question of cultural inclusiveness and multiplicity. P9 posited that "*it is important to have the global perspective. Hearing these thoughts and insights from international folks is vital to the business*", while P29 asserted "*often meeting with people in different time zones means they are in a different cultural environment so they can bring a different lens to the meeting.*" P93 also argued that cultural diversity can lead to important learning experiences: "*its amazing to understand the culture and traditions of a certain time zone, we get the human side of things like what the customer is doing and why he is doing. It would be really boring to have no clue what other sub or country is doing and without having the option to share ideas and collaborate together.*" Others also emphasized the range of expertise brought together by cross time zone meetings: "*meeting with wider audience with different experience, expertise or perspective with ability to quickly get help or help others*" (P102). P104 further stated that collaborating across time zones can attract recruits: "it expands our talent pool as it allows employees to collaborate with each other wherever everyone happens to work from". These responses were especially surprising because diversity was never mentioned in any area of our survey in Section 3, indicating that it could potentially be a very salient issue for global teams.

Likewise, another noticeable fraction of participants (17%) also highlighted the need to connect through cross time zone meetings. Alluding again to diversity, P36 said that "*connecting globally prevents a completely Redmond centeric view of the world*". Connecting through cross time zone meetings further reduces perceived communication delays: "*teams overseas and in different time zones very much appreciate if I make it possible to communicate in person (via Teams[3]) rather than via a disconnected eMail chain over multiple days*" (P67). Indeed, they "*keep the various team members engaged and updated overall*" for P22. P116 was also concerned about their colleagues' affective well-being: "*the benefits are I connect with my skips and that helps them feel like they belong*". As the only individual explicitly stating they found no costs of cross time zone meetings, P87's response was striking: "*Enhances collaboration. Don't see any downside.*"

[3]Microsoft's primary video-conferencing application.

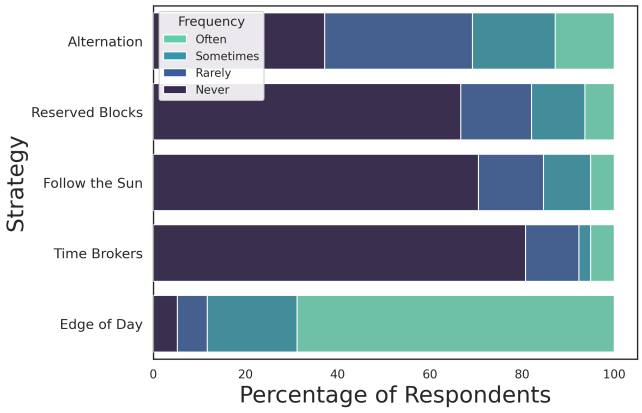

Figure 7: Strategies that survey participants report using to manage cross time zone collaborations.

Together, these results show firstly that organizationally distant and diverse attendees gather in cross time zone meetings, and secondly that employees also perceive these meetings as connective and diverse. This provides strong empirical evidence that cross time zone meetings serve as connective events. Note that our work does not identify whether limiting cross time zone meetings to manage their challenges would *causally* lead also to a drop in connectivity. However, on the basis of our correlational findings, such constraining interventions may disafford employees the opportunities to diversify their communication patterns and feel less isolated.

5 DISCUSSION AND OPPORTUNITIES FOR FACILITATING CROSS TIME ZONE MEETINGS

In summary, our study reveals two large-scale characteristics of cross time zone meetings. Firstly, we find strong empirical support that the need to schedule meetings at odd hours is challenging for workers, and that these difficulties are distributed unequally across different levels of businesses and different parts of the world. However, organizationally distant and diverse members of the company gather in cross time zone meetings, thus providing support for their necessity as a means of keeping collaborators connected across the globe. In their responses to our survey, employees also highlighted the need to continuously balance these challenges and needs in order to undertake their work. Thus, although geographically-distanced work is already salient for many global organizations in the post-pandemic WFH era [17, 41, 97, 98], these results suggest that more attention and effort needs to be paid to the tensions of challenging but necessary temporally-distanced collaboration. Furthermore, our findings reinforce small-scale evidence that cross time zone meetings face physically-unchangeable difficulties [69, 76, 91] by identifying their pervasiveness in a global technology corporation. How, therefore, can these challenges and necessities be reconciled? By consulting the existing literature and our present results, we identified key opportunities for various stakeholders to better facilitate cross time zone meetings. For **employees**, multiple

scheduling strategies remain untested *in situ*; for **system designers**, calendaring tools need to be guided by how workers actually schedule in practice; for **policy makers**, organizations need to support workers who take on skewed temporally-distanced workloads – not only because this workload is challenging, but also because it serves to connect the organization. These opportunities contribute not only to opening pathways to adapting current organizational practices for the WFH era, but also empirically inform the design of productivity aids like calendars with the burgeoning availability of telemetry data [17].

Experimenting with more cross time zone management strategies. Despite employees acknowledging the difficulty and necessity of cross time zone meetings, few management strategies from the literature [63, 69, 91, 93] have actually been implemented *in situ*. This is shown in Figure 7, which illustrates participant responses to questions TZ1-5 in Section 3. For example, blocking off prioritized time slots for cross time zone attendees appears to be a low-cost scheduling strategy that remains rarely used. A majority of workers collaborating across time zones said they meet during odd hours at least sometimes (86%), but few tried to block off hours to prioritize distant attendees (19%). Some of those who do use these blocked hours like P122 and P129 mentioned fairness in Section 4.2 as a key motivator. Others also mentioned that it was consistent, like P31 who only ever used blocked hours (and meeting at odd hours): "*it's always the same, predictable and folks are accommodating about it.*" P113 concurred: "*having a pre-defined times for meeting across timezones make things predictable so you can plan around it.*" Additionally, the overhead is relatively small relative to other strategies, making it suitable for a wider variety of team structures: "*the team is small - there is not capacity to coordinate across time zones or hand off to someone else*" (P7, who rarely uses other strategies except blocking times). As a point of comparison, P70 thought that meeting times "*early/late in the day with appropriate time zone overlaps are the most fair...everyone is SLIGHTLY inconvenienced always. Feels much better than alternating when one side is hugely inconvenienced and it's normal hours for the other side.*"

Thus, there is an immediate, low-cost but possibly high-impact opportunity for cross time zone collaborators to collectively find a blocked time period in which everyone prioritizes temporally-distant meetings. What factors do workers need to consider when finding a fixed time block? For one, although we uncovered a widespread inclination for keeping meetings within the traditional work day, there is still substantial variance in which hours are perceived as ideal. Many survey respondents favor the morning ($n = 28$), e.g. P75 ("*I'm a morning person. I'm more focused in the morning*") and P103 ("*I'm fresh during the morning*"), while others ($n = 13$) prefer later in the day, e.g. P48 ("*I am a slow starter. There are a lot of family activities that have to be done in the morning. I also try to schedule doc appointments in the morning*") and P57 ("*I would like to have time in the morning to catch up on email and Teams before meetings start*"). Perhaps more crucially, our findings also suggest that team members who are temporally furthest apart may have to bear disparately more of the cross time zone burden. It is thus necessary for groups of workers to negotiate hours with each other to explicitly address issues of equitability and accommodate distant individuals. Helping workers block off time slots that are fairer for distant collaborators is one concrete direction for future work on calendaring practices.

Empirically informing tool design for scheduling. One reason why fairness and temporally distant workers need more consideration in the scheduling process is that current calendaring systems do not provide workers with sufficient information about their colleagues' preferences. Existing systems afford limited solutions to scheduling across multiple time zones, as P110 noted: "*I wish the calendar let me add 5 time zones. I need Japan, Australia, India, England, Dallas, and Seattle.*" They often require supplemental information, such as when P120 is "*scheduling a meeting with someone outside US in another TZ to me or across multiple timezones I use a timezone app to see what hours each person is in so I can work out when is the best time to meet for everyone.*" Furthermore, these external tools are typically not be grounded in how people *actually* schedule meetings across time zones. For instance, in the process of developing Figure 5, we discovered that more US-India meetings occur at late evenings (40% between 8:30pm-12:30am) than even mild morning hours (26% between 8:30am-12:30pm) for India attendees. This reflects P11's experiences with US-India collaborations in Section 4.2. And yet, we noticed that morning slots like 7:30am for India are frequently suggested for US-India meetings in our tests of tools like `timeanddate`[4] and `timezonewizard`[5].

Our study thus uncovers new possibilities for designing tools to help negotiate the scheduling demands of cross time zone collaborations. For example, telemetry analysis could be used to provide empirical guidance for future designs of tools to support scheduling across time boundaries. Existing studies has explored automated scheduler systems that learn from human behaviors [11, 52, 78, 83] and human-centric, non-learning calendaring aids [21, 27, 50, 56, 86, 94], but rarely (to our knowledge) calendaring aids that draw from how organizations empirically schedule their own meetings. For instance, one can envision providing supplemental information to workers like P110 and P120 about when their peers meet most often. Any actual deployment of similar tools would obviously require much more research; however, evidence from the literature indicates that even raising awareness of other colleagues' scheduling practices can help teams reach a consensus or "common ground" [14, 26, 35, 73, 74]. Thus, empirically-guided calendaring tools, *qua* empirical guidance, could potentially serve as starting points to inform workers of better and more accommodating scheduling practices.

Supporting workers with disproportionate cross time zone workloads. A central theme across our work is the need for policy makers to be aware of *who* needs accommodation. Our results in Section 4.2 are consistent with a minority of workers taking on disproportionately more cross time zone meeting loads, as if they were brokers across time barriers. Although few people said that they explicitly designate cross time zone coordinators in Figure 7, fairness is nonetheless a salient issue in many open-ended responses. It is therefore important for organizations to support and acknowledge subgroups who are responsible for this asymmetric work – both for fairness and for effective collaborations. Regarding fairness,

[4] https://www.timeanddate.com/
[5] https://timezonewizard.com/

crossing time boundaries in meetings mandates attendance at odd hours and being a temporal broker is associated with greater cognitive loads [63]. Alongside concerns about labor equitability in the technology sector [28, 42], for which productivity aids have been proposed as both solutions [59] and aggravators [95], this suggests that attention should be paid to subgroups facing unfair workloads. Disparities in the power dynamics of the workplace can be especially tangible when those with power are temporally separated from those without [47, 48, 85]; thus, supporting remote colleagues may help address these disparities. Regarding collaborative effectiveness, since employee connectivity is coupled to cross time zone meetings, successful collaborations across the organization may also be coupled to successful temporal brokerage [69, 98]. Furthermore, both our survey participants and existing work emphasized the benefits of team diversity [9, 55, 65], adding another reason why brokers can help foster effective teams. Therefore, fairness aside, enabling workers with the most skewed cross time zone workloads could nonetheless be desirable to keep global organizations communicating smoothly.

Like our suggestion for empirically guiding designs of future scheduling tools, we also speculate that telemetry analysis could potentially guide policy decisions on making cross time zone collaborations fairer. As a concrete example, our work surfaces employee perceptions of their schedules by surveying them directly. This is, however, a method that is hard to scale for large corporations like the one we study [92]. Nonetheless, the metrics in Section 4.2 can be used to quantify the cross time zone workloads that employee groups need to undertake, and therefore to direct surveys to the people with the most challenges. They can then be asked about the costs of their work and the support they need as coordinators between different time zones – an even more salient concern in the remote work era after COVID-19 [49, 80]. Additionally, this again speaks to raising awareness across the organization [14, 26, 35, 73, 74, 76]. While frequent cross time zone workers are conscious of the challenges both to themselves and their collaborators, it is unclear whether these difficulties are visible broadly to those who primarily work within one time zone. We therefore hope that our results raise awareness of these potentially invisible coordination costs to the leaders and stakeholders of global organizations, so that they can, in turn, encourage recognition of colleagues who take on these responsibilities.

6 LIMITATIONS

Throughout, we have endeavored to improve this study's validity by combining worker behaviors, obtained from a large-scale trace data analysis, and worker perceptions, obtained from a survey with targeted questions about scheduling preferences. However, our results should still be interpreted in the context of several limitations. Firstly, the telemetry data we used should be understood as behaviors around how people schedule cross time zone meetings in the *status quo*, rather than explicit signals of people desiring certain calendar arrangements. Because this data is ambiguous about workers' perceptions of their meetings, we sought to use our survey as a way of validating the patterns we observed in the data. We also kept our survey responses separate from the telemetry data to protect employee privacy, so differences between our analyses of the digital traces and responses may differ due to non-representativeness. Nonetheless, we stress that our results between both sources are strongly consistent with cross time zone meetings being scheduled at challenging hours for attendees, but nonetheless helping workers connect for their collaborations.

Similarly, as with most observational research on organizational behaviors [17, 41], our work does not pinpoint whether cross time zone meetings directly cause detrimental outcomes in the workplace. It also does not identify causal ways of improving employees' scheduling experiences with cross time zone meetings. Instead, we have synthesized evidence across both employee behaviors and perceptions to suggest opportunities for future research in Section 5. More work remains to evaluate direct interventions from these opportunities, such as recommending that employees block off time periods to prioritize meetings with temporally-distant attendees.

Thirdly, our study is conducted from the perspective of a single corporation headquartered in the West Coast of the USA. Behavioral variance is evident even within this one organization (see Section 4.2), so readers should interpret our results with the caveat that businesses around the world are likely very heterogeneous. Do organizations based in, for example, UTC have different demands for cross time zone meetings at odd hours? Are cross time zone meetings as connective and as diverse in business with less geographical dispersion? These are questions that remain unanswered in this study and merit further investigation.

7 CONCLUSION

Our study reveals the scheduling tensions in cross time zone meetings at a multi-national software corporation. On the one hand, these meetings are substantially more likely to occur at less preferred times than meetings within a single time zone, and their scheduling challenges are also distributed in potentially inequitable ways. On the other, organizationally distant and diverse workers are brought together by cross time zone meetings, adding to the body of evidence that synchronous communications over temporal distances are necessary for effective collaborations. Many open questions therefore remain in developing better scheduling practices for these meetings. For instance, our findings of asymmetrically-distributed challenges suggest that the power dynamics of who gets to schedule for whom in the workplace should be further interrogated. Furthermore, while we strove to capture geolocation-specific differences in our analysis of international collaborations, cultural differences in scheduling patterns remain understudied in the largely US-centric existing work [3, 57, 76, 93]. Filling these gaps in our knowledge would help organizations achieve fairer and more effective collaborations across time boundaries, for example by building scheduling tools that accommodate distinct cultural preferences.

REFERENCES

[1] 2021. The Rise of the Triple Peak Day. Microsoft 2021. https://www.microsoft.com/en-us/worklab/triple-peak-day Accessed: 2022-09-13.
[2] 2022. Great Expectations: Making Hybrid Work Work. Microsoft WorkLab: Work Trend Index 2022. https://www.microsoft.com/en-us/worklab/work-trend-index/great-expectations-making-hybrid-work-work Accessed: 2022-09-13.
[3] Par J Agerfalk, Brian Fitzgerald, Helena Holmstrom Olsson, Brian Lings, Bjorn Lundell, and Eoin Ó Conchúir. 2005. A framework for considering opportunities and threats in distributed software development. (2005).

[4] Manju K Ahuja and Kathleen M Carley. 1999. Network structure in virtual organizations. *Organization science* 10, 6 (1999), 741–757.

[5] Manju K Ahuja, Dennis F Galletta, and Kathleen M Carley. 2003. Individual centrality and performance in virtual R&D groups: An empirical study. *Management science* 49, 1 (2003), 21–38.

[6] Tammy D Allen, Kelsey Merlo, Roxanne C Lawrence, Jeremiah Slutsky, and Cheryl E Gray. 2021. Boundary management and work-nonwork balance while working from home. *Applied Psychology* 70, 1 (2021), 60–84.

[7] Ashton Anderson, Lucas Maystre, Ian Anderson, Rishabh Mehrotra, and Mounia Lalmas. 2020. Algorithmic effects on the diversity of consumption on spotify. In *Proceedings of The Web Conference 2020*. 2155–2165.

[8] Mohamad Awada, Gale Lucas, Burcin Becerik-Gerber, and Shawn Roll. 2021. Working from home during the COVID-19 pandemic: Impact on office worker productivity and work experience. *Work* Preprint (2021), 1–19.

[9] Fadi S Batarseh, John M Usher, and Joshua J Daspit. 2017. Collaboration capability in virtual teams: examining the influence on diversity and innovation. *International Journal of Innovation Management* 21, 04 (2017), 1750034.

[10] Pauline Berry, Melinda Gervasio, Bart Peintner, and Neil Yorke-Smith. 2007. *Balancing the needs of personalization and reasoning in a user-centric scheduling assistant*. Technical Report. SRI INTERNATIONAL MENLO PARK CA ARTIFICIAL INTELLIGENCE CENTER.

[11] Pauline Berry, Melinda Gervasio, Tomas Uribe, Karen Myers, and Ken Nitz. 2004. A personalized calendar assistant. In *Working notes of the AAAI Spring Symposium Series*, Vol. 76.

[12] Pernille Bjørn, Morten Esbensen, Rasmus Eskild Jensen, and Stina Matthiesen. 2014. Does distance still matter? Revisiting the CSCW fundamentals on distributed collaboration. *ACM Transactions on Computer-Human Interaction (TOCHI)* 21, 5 (2014), 1–26.

[13] Jeffrey Boase and Rich Ling. 2013. Measuring mobile phone use: Self-report versus log data. *Journal of Computer-Mediated Communication* 18, 4 (2013), 508–519.

[14] Thomas Breideband, Poorna Talkad Sukumar, Gloria Mark, Megan Caruso, Sidney D'Mello, and Aaron Striegel. 2022. Home-Life and Work Rhythm Diversity in Distributed Teamwork: A Study with Information Workers during the COVID-19 Pandemic. *Proceedings of the ACM on Human-Computer Interaction* 6, CSCW1 (2022), 1–23.

[15] Malcolm C Brown. 1994. Using Gini-style indices to evaluate the spatial patterns of health practitioners: theoretical considerations and an application based on Alberta data. *Social science & medicine* 38, 9 (1994), 1243–1256.

[16] Christine V Bullen and John L Bennett. 1990. Groupware in practice: An interpretation of work experience. (1990).

[17] Hancheng Cao, Chia-Jung Lee, Shamsi Iqbal, Mary Czerwinski, Priscilla NY Wong, Sean Rintel, Brent Hecht, Jaime Teevan, and Longqi Yang. 2021. Large scale analysis of multitasking behavior during remote meetings. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–13.

[18] Erran Carmel. 1999. *Global software teams: collaborating across borders and time zones*. Prentice Hall PTR.

[19] Traci Carte and Laku Chidambaram. 2004. A capabilities-based theory of technology deployment in diverse teams: Leapfrogging the pitfalls of diversity and leveraging its potential with collaborative technology. *Journal of the Association for Information Systems* 5, 11 (2004), 4.

[20] Carlos Castillo-Salgado, Cristina Schneider, Enrique Loyola, Oscar Mujica, Anne Roca, and Tom Yerg. 2001. Measuring health inequalities: Gini coefficient and concentration index. *Epidemiol Bull* 22, 1 (2001), 3–4.

[21] Xiang'Anthony' Chen, Sebastian Boring, Sheelagh Carpendale, Anthony Tang, and Saul Greenberg. 2012. Spalendar: visualizing a group's calendar events over a geographic space on a public display. In *Proceedings of the International Working Conference on Advanced Visual Interfaces*. 689–696.

[22] Ok-Kyu Choi and Erin Cho. 2019. The mechanism of trust affecting collaboration in virtual teams and the moderating roles of the culture of autonomy and task complexity. *Computers in Human Behavior* 91 (2019), 305–315.

[23] Ricardo Colomo-Palacios, Edmundo Tovar-Caro, Ángel García-Crespo, and Juan Miguel Gómez-Berbís. 2010. Identifying technical competences of IT professionals: The case of software engineers. *International Journal of Human Capital and Information Technology Professionals (IJHCITP)* 1, 1 (2010), 31–43.

[24] Cecily D Cooper and Nancy B Kurland. 2002. Telecommuting, professional isolation, and employee development in public and private organizations. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior* 23, 4 (2002), 511–532.

[25] Juliet M Corbin and Anselm Strauss. 1990. Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology* 13, 1 (1990), 3–21.

[26] Catherine Durnell Cramton. 2001. The mutual knowledge problem and its consequences for dispersed collaboration. *Organization science* 12, 3 (2001), 346–371.

[27] Justin Cranshaw, Emad Elwany, Todd Newman, Rafal Kocielnik, Bowen Yu, Sandeep Soni, Jaime Teevan, and Andrés Monroy-Hernández. 2017. Calendar.help: Designing a workflow-based scheduling agent with humans in the loop. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 2382–2393.

[28] Kate Crawford. 2021. *The atlas of AI: Power, politics, and the planetary costs of artificial intelligence*. Yale University Press.

[29] Jonathon N Cummings. 2011. Geography is alive and well in virtual teams. *Commun. ACM* 54, 8 (2011), 24–26.

[30] Jonathon N Cummings, J Alberto Espinosa, and Cynthia K Pickering. 2009. Crossing spatial and temporal boundaries in globally distributed projects: A relational model of coordination delay. *Information Systems Research* 20, 3 (2009), 420–439.

[31] Daniela E Damian and Didar Zowghi. 2002. The impact of stakeholders' geographical distribution on managing requirements in a multi-site organization. In *Proceedings IEEE Joint International Conference on Requirements Engineering*. IEEE, 319–328.

[32] Evan DeFilippis, Stephen Michael Impink, Madison Singell, Jeffrey T Polzer, and Raffaella Sadun. 2020. *Collaborating during coronavirus: The impact of COVID-19 on the nature of work*. Technical Report. National Bureau of Economic Research.

[33] Alan R Dennis, Robert M Fuller, and Joseph S Valacich. 2008. Media, tasks, and communication processes: A theory of media synchronicity. *MIS quarterly* (2008), 575–600.

[34] Alan R Dennis and Joseph S Valacich. 1999. Rethinking media richness: Towards a theory of media synchronicity. In *Proceedings of the 32nd Annual Hawaii International Conference on Systems Sciences. 1999. HICSS-32. Abstracts and CD-ROM of Full Papers*. IEEE, 10–pp.

[35] Paul Dourish and Victoria Bellotti. 1992. Awareness and coordination in shared workspaces. In *Proceedings of the 1992 ACM conference on Computer-supported cooperative work*. 107–114.

[36] Deborah L Duarte and Nancy Tennant Snyder. 2006. *Mastering virtual teams: Strategies, tools, and techniques that succeed*. John Wiley & Sons.

[37] Line Dubé and Daniel Robey. 2009. Surviving the paradoxes of virtual teamwork. *Information systems journal* 19, 1 (2009), 3–30.

[38] J Alberto Espinosa, Jonathon N Cummings, and Cynthia Pickering. 2011. Time separation, coordination, and performance in technical teams. *IEEE Transactions on Engineering Management* 59, 1 (2011), 91–103.

[39] J Alberto Espinosa and Cynthia Pickering. 2006. The effect of time separation on coordination processes and outcomes: A case study. In *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06)*, Vol. 1. IEEE, 25b–25b.

[40] V Eurofound. 2020. Living, working and COVID-19. *In: Publications Office of the European Union* (2020).

[41] Michael Gibbs, Friederike Mengel, and Christoph Siemroth. 2021. Work from home & productivity: Evidence from personnel & analytics data on IT professionals. *University of Chicago, Becker Friedman Institute for Economics Working Paper* 2021-56 (2021).

[42] Mary L Gray and Siddharth Suri. 2019. *Ghost work: How to stop Silicon Valley from building a new global underclass*. Eamon Dolan Books.

[43] Jonna Häkkilä, Mari Karhu, Matilda Kalving, and Ashley Colley. 2020. Practical family challenges of remote schooling during COVID-19 pandemic in Finland. In *Proceedings of the 11th Nordic conference on human-computer interaction: Shaping experiences, shaping society*. 1–9.

[44] James D. Herbsleb and Audris Mockus. 2003. An empirical study of speed and communication in globally distributed software development. *IEEE Transactions on software engineering* 29, 6 (2003), 481–494.

[45] Pamela Hinds, Sara B Kiesler, and Sara Kiesler. 2002. *Distributed work*. MIT press.

[46] Helena Holmstrom, Eoin Ó Conchúir, J Agerfalk, and Brian Fitzgerald. 2006. Global software development challenges: A case study on temporal, geographical and socio-cultural distance. In *2006 IEEE International Conference on Global Software Engineering (ICGSE'06)*. IEEE, 3–11.

[47] Soraj Hongladarom. 2002. The web of time and the dilemma of globalization. *The Information Society* 18, 4 (2002), 241–249.

[48] Haiyan Huang and Eileen M Trauth. 2010. Identity and cross-cultural management in globally distributed information technology work. (2010).

[49] Dodi Wirawan Irawanto, Khusnul Rofida Novianti, and Kenny Roz. 2021. Work from home: Measuring satisfaction between work–life balance and work stress during the COVID-19 pandemic in Indonesia. *Economies* 9, 3 (2021), 96.

[50] Sarah Janböcke, Alina Gawlitta, Judith Dörrenbächer, and Marc Hassenzahl. 2020. Finding the inner clock: A chronobiology-based calendar. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–7.

[51] Reynol Junco. 2013. Comparing actual and self-reported measures of Facebook use. *Computers in Human Behavior* 29, 3 (2013), 626–631.

[52] Donghyeon Kim, Jinhyuk Lee, Donghee Choi, Jaehoon Choi, and Jaewoo Kang. 2018. Learning user preferences and understanding calendar contexts for event scheduling. In *Proceedings of the 27th ACM International Conference on Information and Knowledge Management*. 337–346.

[53] Bradley L Kirkman and John E Mathieu. 2005. The dimensions and antecedents of team virtuality. *Journal of management* 31, 5 (2005), 700–718.

[54] Bradley L Kirkman, Benson Rosen, Paul E Tesluk, and Cristina B Gibson. 2004. The impact of team empowerment on virtual team performance: The moderating role of face-to-face interaction. *Academy of Management journal* 47, 2 (2004), 175–192.

[55] Bradley L Kirkman and Debra L Shapiro. 2005. The impact of cultural value diversity on multicultural team performance. In *Managing multinational teams: Global perspectives*. Emerald Group Publishing Limited.

[56] Rafal Kocielnik, Saleema Amershi, and Paul N Bennett. 2019. Will you accept an imperfect ai? exploring designs for adjusting end-user expectations of ai systems. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–14.

[57] Josiane Kroll, Sajid Ibrahim Hashmi, Ita Richardson, and Jorge LN Audy. 2013. A systematic literature review of best practices and challenges in follow-the-sun software development. In *2013 IEEE 8th International Conference on Global Software Engineering Workshops*. IEEE, 18–23.

[58] Srijan Kumar, William L Hamilton, Jure Leskovec, and Dan Jurafsky. 2018. Community interaction and conflict on the web. In *Proceedings of the 2018 world wide web conference*. 933–943.

[59] Toby Jia-Jun Li, Yuwen Lu, Jaylexia Clark, Meng Chen, Victor Cox, Meng Jiang, Yang Yang, Tamara Kay, Danielle Wood, and Jay Brockman. 2022. A Bottom-Up End-User Intelligent Assistant Approach to Empower Gig Workers against AI Inequality. In *2022 Symposium on Human-Computer Interaction for Work*. 1–10.

[60] Jessica Lipnack and Jeffrey Stamps. 1997. Reaching across space, time, and organizations with technology.

[61] Anne Mäkikangas, Soile Juutinen, Jaana-Piia Mäkiniemi, Kirsi Sjöblom, and Atte Oksanen. 2022. Work engagement and its antecedents in remote work: A person-centered view. *Work & Stress* (2022), 1–25.

[62] Joseph E McGrath and Andrea B Hollingshead. 1994. *Groups interacting with technology: Ideas, evidence, issues, and an agenda.* Sage Publications, Inc.

[63] Julija N Mell, Sujin Jang, and Sen Chai. 2021. Bridging temporal divides: Temporal brokerage in global teams and its impact on individual performance. *Organization Science* 32, 3 (2021), 731–751.

[64] Tomas Mikolov, Ilya Sutskever, Kai Chen, Greg S Corrado, and Jeff Dean. 2013. Distributed representations of words and phrases and their compositionality. *Advances in neural information processing systems* 26 (2013).

[65] Frances J Milliken and Luis L Martins. 1996. Searching for common threads: Understanding the multiple effects of diversity in organizational groups. *Academy of management review* 21, 2 (1996), 402–433.

[66] Lillio Mok, Samuel F Way, Lucas Maystre, and Ashton Anderson. 2022. The Dynamics of Exploration on Spotify. In *Proceedings of the International AAAI Conference on Web and Social Media*, Vol. 16. 663–674.

[67] Salih Mollahaliloglu, Mahmut Yardım, Tahsin G Telatar, and Sarp Uner. 2021. Change in the geographic distribution of human resources for health in Turkey, 2002–2016. *Rural and remote health* 21, 2 (2021).

[68] Mitzi M Montoya-Weiss, Anne P Massey, and Michael Song. 2001. Getting it together: Temporal coordination and conflict management in global virtual teams. *Academy of management Journal* 44, 6 (2001), 1251–1262.

[69] Sarah Morrison-Smith and Jaime Ruiz. 2020. Challenges and barriers in virtual teams: a literature review. *SN Applied Sciences* 2, 6 (2020), 1–33.

[70] M. Morshed, J. Hernandez, D. McDuff, J. Suh, E. Howe, K. Rowan, M. Abdin, G. Ramos, T. Tran, and M. Czerwinski. 2022. Advancing the Understanding and Measurement of Workplace Stress in Remote Information Workers from Passive Sensors and Behavioral Data. In *Proceedings of 10th International Conference on Affective Computing and Intelligent Interaction (ACII)*.

[71] Mark Mortensen and Pamela J Hinds. 2001. Conflict and shared identity in geographically distributed teams. *International Journal of Conflict Management* (2001).

[72] Tsedal Neeley. 2015. Global teams that work. *Harvard Business Review* 93, 10 (2015), 74–81.

[73] Carman Neustaedter, AJ Bernheim Brush, and Saul Greenberg. 2009. The calendar is crucial: Coordination and awareness through the family calendar. *ACM Transactions on Computer-Human Interaction (TOCHI)* 16, 1 (2009), 1–48.

[74] Karin Niemantsverdriet, Harm Van Essen, Minna Pakanen, and Berry Eggen. 2019. Designing for awareness in interactions with shared systems: the DASS framework. *ACM Transactions on Computer-Human Interaction (TOCHI)* 26, 6 (2019), 1–41.

[75] Michael Boyer O'Leary and Mark Mortensen. 2010. Go (con) figure: Subgroups, imbalance, and isolates in geographically dispersed teams. *Organization science* 21, 1 (2010), 115–131.

[76] Gary M Olson and Judith S Olson. 2000. Distance matters. *Human–computer interaction* 15, 2-3 (2000), 139–178.

[77] Kim Parker, Juliana Menasce Horowitz, and Rachel Minkin. 2020. How the coronavirus outbreak has–and hasn't–changed the way Americans work. (2020).

[78] Gourab K Patro, Prithwish Jana, Abhijnan Chakraborty, Krishna P Gummadi, and Niloy Ganguly. 2022. Scheduling Virtual Conferences Fairly: Achieving Equitable Participant and Speaker Satisfaction. In *Proceedings of the ACM Web Conference 2022*. 2646–2656.

[79] Carla MA Pinto, A Mendes Lopes, and JA Tenreiro Machado. 2012. A review of power laws in real life phenomena. *Communications in Nonlinear Science and Numerical Simulation* 17, 9 (2012), 3558–3578.

[80] Agota Giedrė Raišienė, Violeta Rapuano, Kristina Varkulevičiūtė, and Katarína Stachová. 2020. Working from home—Who is happy? A survey of Lithuania's employees during the COVID-19 quarantine period. *Sustainability* 12, 13 (2020), 5332.

[81] Narayan Ramasubbu, Marcelo Cataldo, Rajesh Krishna Balan, and James D Herbsleb. 2011. Configuring global software teams: a multi-company analysis of project productivity, quality, and profits. In *2011 33rd International Conference on Software Engineering (ICSE)*. IEEE, 261–270.

[82] Darja Reuschke and Alan Felstead. 2020. Changing workplace geographies in the COVID-19 crisis. *Dialogues in Human Geography* 10, 2 (2020), 208–212.

[83] Daniel M Romero, Katharina Reinecke, and Lionel P Robert Jr. 2017. The influence of early respondents: information cascade effects in online event scheduling. In *Proceedings of the Tenth ACM International Conference on Web Search and Data Mining*. 101–110.

[84] Saonee Sarker, Manju Ahuja, Suprateek Sarker, and Sarah Kirkeby. 2011. The role of communication and trust in global virtual teams: A social network perspective. *Journal of Management Information Systems* 28, 1 (2011), 273–310.

[85] Suprateek Sarker and Sundeep Sahay. 2004. Implications of space and time for distributed work: an interpretive study of US–Norwegian systems development teams. *European Journal of Information Systems* 13, 1 (2004), 3–20.

[86] Florian Schaub, Bastian Könings, Peter Lang, Björn Wiedersheim, Christian Winkler, and Michael Weber. 2014. PriCal: context-adaptive privacy in ambient calendar displays. In *Proceedings of the 2014 acm international joint conference on pervasive and ubiquitous computing*. 499–510.

[87] Nicole V Shifrin and Jesse S Michel. 2022. Flexible work arrangements and employee health: A meta-analytic review. *Work & Stress* 36, 1 (2022), 60–85.

[88] StatsDirect. 2000. Gini Coefficient of Inequality. https://www.statsdirect.com/help/default.htm#nonparametric_methods/gini.htm

[89] Sebastian Stier, Johannes Breuer, Pascal Siegers, and Kjerstin Thorson. 2020. Integrating survey data and digital trace data: Key issues in developing an emerging field. , 503–516 pages.

[90] Ayoung Suh, Kyung-shik Shin, Manju Ahuja, and Min Soo Kim. 2011. The influence of virtuality on social networks within and across work groups: A multilevel approach. *Journal of Management Information Systems* 28, 1 (2011), 351–386.

[91] John C Tang, Chen Zhao, Xiang Cao, and Kori Inkpen. 2011. Your time zone or mine? A study of globally time zone-shifted collaboration. In *Proceedings of the ACM 2011 conference on Computer supported cooperative work*. 235–244.

[92] Donald Tomaskovic-Devey, Jeffrey Leiter, and Shealy Thompson. 1994. Organizational survey nonresponse. *Administrative science quarterly* (1994), 439–457.

[93] James J Treinen and Susan L Miller-Frost. 2006. Following the sun: Case studies in global software development. *IBM systems Journal* 45, 4 (2006), 773–783.

[94] Joe Tullio, Jeremy Goecks, Elizabeth D Mynatt, and David H Nguyen. 2002. Augmenting shared personal calendars. In *Proceedings of the 15th annual ACM symposium on User interface software and technology*. 11–20.

[95] Judy Wajcman. 2019. The digital architecture of time management. *Science, Technology, & Human Values* 44, 2 (2019), 315–337.

[96] Isaac Waller and Ashton Anderson. 2021. Quantifying social organization and political polarization in online platforms. *Nature* 600, 7888 (2021), 264–268.

[97] Bin Wang, Yukun Liu, Jing Qian, and Sharon K Parker. 2021. Achieving effective remote working during the COVID-19 pandemic: A work design perspective. *Applied psychology* 70, 1 (2021), 16–59.

[98] Longqi Yang, David Holtz, Sonia Jaffe, Siddharth Suri, Shilpi Sinha, Jeffrey Weston, Connor Joyce, Neha Shah, Kevin Sherman, Brent Hecht, et al. 2022. The effects of remote work on collaboration among information workers. *Nature human behaviour* 6, 1 (2022), 43–54.

A APPENDIX: COUNTRY ABBREVIATIONS

Table 2: Countries by alpha-2 codes.

Code	Country	Code	Country
AU	Australia	IL	Israel
CA	Canada	IN	India
CN	China	IT	Italy
CH	Switzerland	JP	Japan
CR	Costa Rica	MX	Mexico
DE	Germany	NL	Netherlands
ES	Spain	PT	Portugal
FR	France	RO	Romania
GB	Great Britain	SG	Singapore
IE	Ireland	US	United States of America