



# Designing for Wellbeing: Worker-Generated Ideas on Adapting Algorithmic Management in the Hospitality Industry

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## ABSTRACT

Labor shortages have shaped many industries over the past several years, with hospitality experiencing one of the largest rates of attrition. Workers are leaving their jobs for a variety of reasons, ranging from burnout and work intensification to a lack of meaningful employment. While some literature maintains that labor-replacing automation is poised to bridge the shortages, we argue there is an opportunity for technology design to instead improve job quality and retention. Drawing on interviews with unionized guest room attendants, we report on workers' perceptions of a widely-used algorithmic room assignment system. We then present worker-generated design ideas that adapt this system toward supporting three key facets of wellbeing: self-efficacy, transparency, and workload. We argue for the need to consider these facets of wellbeing through design across the service landscape, particularly as HCI attends to the impacts of AI and automation on frontline work.

## CCS CONCEPTS

• **Human-centered computing** → **HCI design and evaluation methods.**



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## KEYWORDS

Worker voice; algorithmic management; worker wellbeing

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## 1 INTRODUCTION

### It's not a hotel without housekeeping! ★☆☆☆☆

*"No room service whatsoever – I had to make my own bed, use the same old towels for a week, and clean the room myself. I couldn't even find anyone in the hall to ask for toilet paper, what the hell is that? What's the point of going to a hotel if you need to do everything yourself just like home? I don't need this stress when I'm on vacation."*

Once an anomaly, guest reviews like the one above have become all too common in the hotel industry. As housekeeping has been reduced from daily service – and sometimes eliminated entirely during guests' stays – rooms are left with overflowing trash bins, messy beds, and unchanged towels [69]. Behind this scene are a multitude of factors. The compounded effects of the pandemic and workplace fissuring have led workers across industries to drop out of the workforce to care for their families, or leave traditional employment structures in favor of more flexible gig arrangements [4, 14, 88]. Complications from long-COVID symptoms have put

an estimated 4 million people out of work [9]. Still others suffer from burnout and intolerable workplace conditions [52]. Though the pandemic has exacerbated labor shortages in many sectors, data from the US Department of Labor shows the hospitality industry is among the most affected [86].

While many hotel properties have reduced services, some have also begun to adopt technologies toward more permanent service changes. For instance, leading hotel chains recently replaced full front-desk staff with “ambassadors” that help guests navigate digital check-in kiosks [24]. In the unique context of high-touch, face-to-face service work, the literature is in a moment of divided opinions on how workplace technologies should bridge the shortages [27, 79]. Some insist that automation will replace or enhance routine tasks performed by workers [8, 29, 38, 39] and eliminate the current worker shortage [66]. Others suggest that the seemingly low-hanging fruit of replacing routine tasks will be a slow and contested process – particularly in the service-dominated hospitality sector [8, 10, 35].

There are unfortunately few empirical studies of automation technology in hospitality [27]. Existing surveys of the current technology landscape in the industry indicate that labor-replacing automation will face resistance, predominantly from customers [74, 75, 77, 87]. Evidence also indicates that hotel employees, managers, and customers may be more open to complementary technologies [27], systems that draw upon the strengths of both human workers and AI systems [43].

The industry’s staffing problem is critical and must be addressed appropriately. As the shortage places more demands on remaining workers, roles like housekeeping become more challenging – making it even likelier for workers to seek alternative employment. In the short term, solving this spiral may take nuanced and out-of-the box thinking to ensure more sustainable hospitality jobs. In light of the industry’s labor shortages, we suggest that there is an opportunity for worker-centered technology design to support retention.

HCI and management literature shows that one crucial mechanism for retention is to increase a sense of worker wellbeing, which is comprised of physical, financial, and psychological considerations [55, 68]. After substantial wage increases did little to attract new workers [6], hospitality employers have begun to acknowledge workers’ unmet physical and psychological needs [32]. Technology vendors have responded accordingly, introducing thought leadership which encourages scheduling software to meet staff’s desired hours and provide adequate breaks [2], or in-app training materials to smooth the learning curve for new recruits [20].

Building upon recent shifts in the industry, we examine how worker participation in the adaptation of workplace technologies might be used to achieve gains along physical and psychological axes of wellbeing. We focus our attention on an existing algorithmic manager UpKeep<sup>1</sup>, which is widely deployed in hotels to coordinate guest room attendants (GRAs)<sup>2</sup> and supervisors in housekeeping service. The algorithmic manager (AM) is used to order room cleaning assignments, and mediate digital communication and task

allocation between GRAs and other departments. We explore the following research questions:

- (1) How do GRAs perceive the effects of algorithmic management on their tasks, roles, and relationships?
- (2) How might we adapt systems based on workers’ existing strategies to improve wellbeing?

To address our research questions, we conducted workshops and interviews to understand how UpKeep impacts GRAs’ daily service work. We learned that the app may cause increases in workload, from room assignments requiring floor changes to the additional labor of documenting information digitally. Drawing from these initial insights, we then conducted follow-up participatory prototyping sessions with GRAs, using an abstracted version of an algorithmic management tool as means to engage in more detailed discussions about their experiences of working with and through the app. We learned of existing workarounds, such as keeping backup paper records of tasks not readily visible to the app, or relying on peers to overcome access and usability challenges. Our preliminary findings reveal that technologically-mediated work under UpKeep may facilitate uneasy negotiations between GRAs’ tasks, roles, and capacity to help others. Finally, using cooperative prototyping techniques, we collaborated with GRAs to generate design ideas that adapted the UpKeep system toward supporting three key facets of wellbeing: 1) **Self-efficacy**, which describes a worker’s capacity for autonomous decision making, including the ability to determine one’s task flow; 2) **Transparency**, which describes how much context a worker has about system and managerial decision-making, and the broader purpose of their work; and 3) **Workload**, which describes shifts in physical and cognitive labor that are needed for various tasks. As our participants imagined ideal adaptations of the AM, we uncovered various trade-offs between these facets of wellbeing, suggesting that holistic solutions cannot be offered by technology alone.

In the sections that follow, we trace related scholarship on labor-supporting AMs, and provide brief context for the role of AMs in the hospitality industry. We next describe our methods for engaging GRAs. We report on GRAs’ perceptions of service under UpKeep, and propose worker-generated design ideas for improving wellbeing. Finally, we present future directions for AM-related design interventions that seek to advance worker wellbeing with minimal trade-offs. Taken together, this work contributes to ongoing discussions in the literature on how design research may support workers in their labor [18, 22, 30, 92] and improve worker retention in other high-touch service sectors.

## 2 RELATED WORK

### 2.1 Worker-centered algorithmic management

Jarrahi et al. establish algorithmic management as a sociotechnical concept, noting how its development is shaped by organizational choices and long-running power dynamics between workers and managers [40]. First popularized by gig work platforms, AMs are built on a tradition of Taylorism that views work performed by humans and machines similarly, by cost, speed, and efficiency [85]. To understand the emerging role of AMs in organizations, Jarrahi

<sup>1</sup>We use a pseudonym throughout this paper to preserve the anonymity of both the vendor and the participants.

<sup>2</sup>Guest room attendants (GRAs) work as part of the housekeeping department at a hotel, and may be known more colloquially as housekeepers.

et al. urge researchers to move from binary questions of “replacement or substitution” toward more nuanced questions of “balance, coordination, contestation, and negotiation” [40].

Recent research has recognized the alarming ways in which AMs can undermine worker wellbeing [44, 51, 55, 60] and explores various frameworks through which to design alternatives. Unruh et al. offer a human rights based approach to technology design, beginning with a conceptual framework for understanding and improving the impact of AMs on human autonomy [85]. Park et al. describe workers’ relationship to an algorithmic human resource management system, and discuss how their experience may be improved with increased transparency, interpretability, and human intervention [72]. Tomprou and Lee focus on psychological contracts, exploring how AMs can become more responsive to employees’ perceptions of their own and their employers’ mutual obligations [82].

Many scholars are also considering how traditional AM functionalities might be used to enforce labor protections. Khovanaskaya and Sengers trace the roots of this approach to the data-driven practices of mid-century American labor unionists, who led the first worker-centered effort to appropriate the techniques Taylorism towards advocacy [47]. Lamers et al. have since expanded the focus of AM literature to discuss how AM affordances may actively promote dignity at work [53]. WeClock, a worker-cooperative tool, was developed to employ self-tracking measures to account for invisible labor, skipped breaks, and overtime [22]. Others contribute models of stakeholder participation that help workers negotiate developments in their workplace. Lee et al. facilitate workers’ input towards their shift schedules and their views of managerial fairness, leading to insights about workers’ own preferences [55]. In previous work Lee et al. developed a collective participatory framework that enables multiple stakeholders to align on algorithmic policy [54].

Other scholars propose participatory design approaches to surface “algorithmic imaginaries” – ideals of AM functionality, reimagined directly by workers [92]. Rather than simply responding to users’ mental models of how technology already works, researchers introduced prompts to capture gig workers’ desired solutions. Because stakeholder needs can be difficult to align, Park et al. explore how to identify tensions and potential solutions for building trust between various stakeholders in the design of a human resource management system [73]. Our work contributes to this body of scholarship by contextualizing AMs in the future of work within unionized service employment, which differs from more highly studied gig contexts [92]. We similarly draw on historical efforts to use participatory design alongside unionized workers. Historical PD efforts were focused on rebalancing the scales of efficiency and quality of work life [81]. Then as now, researchers and practitioners were concerned with the deleterious effects of computer-assisted deskilling and dislocation, which were seen as extensions of existing managerial control [45, 46]. Since this earlier work, technical systems are capable of exerting even greater control over workers. We thus draw on the participatory methods first established with unionized workers, including participatory prototyping, to extend the recently waning [67] but crucial collaborations between design research and unions. Responding to the industry’s labor

shortages, we draw from these literatures to elevate design goals which support worker wellbeing and retention.

## 2.2 Use of algorithmic management in hospitality

Various AM technologies have been adopted in the hospitality industry for the past two decades [68]. Hotels use AMs to forecast and keep track of demand, inventory, employee tasks, and hotel-wide communications, as well as manage reservations and revenue [80]. Other AMs track foods, linens, and other goods throughout the hotel property with the goal of streamlining operations [80]. Some AMs apply simple artificial intelligence, using it for monitoring, predictive analytics, and advanced decision-support towards business processes [79]. AMs are also particularly well suited to seeking efficiencies – including tracking and reporting on worker productivity – which became a cost-cutting measure for the industry at the start of the pandemic [84].

In response to the current shortage, hotels are exploring how technology can help firms improve performance benchmarks to pre-COVID-19 levels [6, 76]. For instance, as housekeeping shifted to on-demand guest requests during the pandemic, hotels increased their use of algorithmic management software to keep track of customer demand [1]. Bowen and Morosan (2022) suggest ways that hotels can use automatic systems to reduce human interaction to overcome labor demands, such as by assessing and reordering for inventory management, or adopting in-room voice assistants that allocate tasks for workers [66]. However, there is substantial evidence that by focusing on psychological and physical worker wellbeing, firms can improve productivity and profits in the long term – more so than eliminating labor costs in the short term [11, 16, 49, 71].

## 2.3 Wellbeing amidst labor shortages

Now more than ever, hospitality workers are considering the benefits and drawbacks of employment on their wellbeing. Wellbeing is an umbrella term taken up by many scholars across various disciplines. For the purpose of this paper, we draw from labor economists Mutari and Figart’s definition of worker wellbeing [68]. According to Mutari and Figart, workers are motivated not only by financial compensation, but by the intangible physical and psychological benefits of the work experience [68]. We employ this definition, which includes: 1) intangible physical wellbeing as the minimization injury and illness due to preventable hazards, and opportunities for rest on the job; and 2) intangible psychological wellbeing, which includes the decrease of stress and the increase of self-efficacy, such as by allowing workers’ control over their hours, schedules, and work processes [55, 68] and a sense of dignity and purpose and advocating for one’s needs [37, 68]. Finally, we note that having the power to make change is defined as a necessary characteristic of wellbeing at work, and depends on the existence of intangible psychological factors like dignity and self-efficacy [37].

It is no surprise that hospitality workers who left their positions amidst the pandemic cited burnout [26], a lack of meaningful employment [52, 61], and mistreatment by employers and customers [61]. By January 2023, 79% of hotels were experiencing serious staffing shortages [7], even as the national average hotel wages

increased to \$22 [6]. The pandemic has had a particularly acute effect on GRAs, with 58% of AHLA-surveyed hotels citing housekeeping as their biggest recruitment challenge [6]. The majority of housekeeping roles are performed by women, who have shouldered disproportionate caretaking responsibilities over the course of the pandemic [28] and may be more prone to leaving the workforce.

Participants in our workshops and interviews characterized additional difficulties inherent to their roles. Housekeeping work is physically demanding, there is a lot of it, and GRAs cite constant time pressures to finish their daily assignments [36]. Studies of Latina GRAs have further shown consistent and characteristic musculoskeletal disorders, including low back pain, back and shoulder injuries, and bursitis of the knee (known as ‘housemaid’s knee’) [36]. These hazards are made worse by intensifications in pace [59] since the advent of “green choice” programs, which offer guests points for turning down housekeeping. By reducing daily cleaning, green choice assignments demand more intense cleaning for checkout rooms, which are prepared for the next guest’s stay [18]. Cleaning reductions have only increased since the pandemic and subsequent retention challenges. GRAs additionally cite psychological challenges to wellbeing, including issues of workplace power [36] and the unpredictable nature of their assignments [78]. As the needs of a property change day by day, GRAs must work around trashed rooms, spikes and lulls in their workload, and unforeseen requests from guests and supervisors.

In this paper, we gather input on a room-assignment AM used by GRAs, a role experiencing high rates of attrition. Despite the hardships imbued in their working conditions, the unionized GRAs we spoke to reported a wide range of experiences with making change and envisioning alternatives to increase their wellbeing. For the purposes of our design investigation, we narrow in on three aspects of worker wellbeing – self-efficacy, transparency, and workload – which surfaced through our engagements with GRAs and overlap with the characteristics of good work described in the literature. As the use of workplace AMs grows, our preliminary study highlights how such systems can support wellbeing by increasing workers’ experiences of self-efficacy and transparency, while decreasing their relative workload.

### 3 METHODS

This research is in collaboration with an international labor union. Together, we seek to understand the changing landscape of automation in the hospitality industry and to help union members design, deploy, and effectively utilize new technologies. We began our research by seeking to understand how GRAs perceive the effects of algorithmic management on their roles, tasks, and relationships. To answer this question, we collected and analyzed data from workshops and semi-structured interviews with workers. To further understand how we might adapt systems to improve wellbeing, we generated insights from follow-up participatory prototyping sessions with individuals from our workshop series.

Between 2020–2022, we conducted workshops, interviews, and participatory prototyping sessions with a total of 75 participants, all of whom were unionized GRAs identifying as women. To ensure accessibility, workshops were held in English with Spanish translation to account for different native languages. Participants

were recruited directly by the union leaders and analysts on the research team. We also note that the majority of participants included in this research were heavily involved in making change in their workplaces, and had a sophisticated understanding of UpKeep. This is not the case for all GRAs, some of whom are not familiar with technology and struggle with the app’s basic functionality. We refer to participants using pseudonyms in the sections that follow.

#### 3.1 Workshops & interviews

We began the research by conducting three 1.5 hour-long workshops with GRAs (69 total participants) to examine workers’ perceptions of an algorithmic management app (which we call UpKeep) that structures tasks and room assignments. We first inquired about GRAs’ feelings around technological change, and asked them to describe changes in their work before and after the introduction of UpKeep. We then solicited their desires for alternative future technologies [41], and ended by discussing what makes individuals feel proud in their work. We conducted a situational analysis [62] of our workshop findings, using visual mapmaking to represent the social interaction around work. Later interviews were used to probe deeper on topics that had come up repeatedly during the workshop series. For example, we asked participants what they do when they have a problem with UpKeep, and if they had ever made suggestions for improving UpKeep to supervisors or the union.

#### 3.2 Participatory prototyping sessions

Several participants who were particularly fluent with the UpKeep technology had strong views on what they wanted to improve and shared tips and tricks viewed as helpful to other GRAs in the sessions. We invited these 5 individuals to join follow-up participatory prototyping sessions. The goal of these sessions was to learn more about GRAs’ workarounds with the existing technology, and develop design ideas to further adapt the system.

Over the span of 10 weeks, we conducted two 60-minute 1:1 iterative sessions with each GRA, in which we first discussed their needs and then prototyped bespoke design ideas based on an abstracted mockup of a room assignment AM. We drew on established prototyping methods to surface workers’ priorities and concerns related to wellbeing [19, 21, 31], a process we describe below.

*3.2.1 Existing workarounds and imagining new features.* In Session 1, we sought to learn about existing workarounds and design ideas. We first elicited workers’ strategies around UpKeep’s accessibility and ease of use, technologically mediated assignment workflows, and changes to their communication with coworkers and managers. Within each theme, we asked participants to suggest new features or technologies that could support them. Sessions were conducted on Zoom.

After completing Session 1 with each participant, we used Figma, a web-based collaborative design interface tool, to create prototypes of participants’ design ideas. We modified the abstracted version of a room assignment manager to reflect suggestions and ideas gathered from the sessions. The resulting prototypes were mid-fidelity digital renderings of an AM app interface, displayed in Figma.

**3.2.2 Reviewing designs through their relationships with others.** In Session 2, we reconvened with the same participants to show the Figma prototypes that they had generated in Session 1. To ensure participants felt their stake in the design process, we first showed individuals the prototypes that were most inspired from their testimony, before reviewing all remaining prototypes in random order. We discussed whether the prototypes might address the problems that GRAs cared about most, and explored ideal solutions independent of technical feasibility. Finally, we sought to uncover potential consequences for their relationships with other users. For instance, our situational analysis uncovered that GRAs could be marked up for incomplete tasks. Though we eliminated technical constraints, we probed GRAs to describe how their design ideas might affect their practical ability to complete work alongside peers, guests, and managers [15, 33].

### 3.3 Analysis

Our research team collaboratively synthesized findings from workshops, interviews, and participatory prototyping sessions. We used an inductive approach to analyze a total of 19 transcripts [23]. Our initial round resulted in 102 codes. We developed memos describing early themes and then reviewed them together during weekly meetings. We then iteratively revisited and refined our interpretations around workers' challenges, existing strategies, desired interventions, and values around wellbeing. We organize our findings according to thematic patterns of wellbeing that emerged within and across our data.

Finally, we acknowledge that participatory prototyping research does not always result in tangible follow-through for participants [17]. Unionized GRAs were excited to collaborate due to a belief that lending their voice to this research would lead to material improvements for their work. We intend to continue our collaboration with workers to ensure they can benefit from this research. In the meantime, we hope that GRAs' ideation can catalyze small-scale change in their own workplaces.

## 4 FINDINGS

*"Housekeeping is the source. It's the source of everything."* – **Hyacinth, Lead GRA, Participatory Prototyping Session.**

Hyacinth has worked as a lead GRA for more than 40 years. Through her work, she interacts with many departments in the hotel, from the front desk to maintenance and facilities. Her tasks span cleaning rooms, accounting for broken items, answering questions from guests, tracking supplies across the hotel, assisting and training her coworkers, and more. Her favorite part of the job, however, are the people she gets to work with:

*"My interaction is beautiful with my team members, with my coworkers from different departments. Each morning, I look forward to seeing them to have a good talk. We'd laugh, sit down sometimes, and have a cup of tea or coffee and toast. I also love to interact with the guests."*

The social aspects of housekeeping work, as explained by Hyacinth above, have been meaningfully impacted by the introduction of an algorithmic manager. Just like the expansive nature of

housekeeping, UpKeep does much more than manage cleaning assignments. As an operations tool, UpKeep has redefined how departments communicate, and how GRAs work with the physical nature of the property – including rooms, floors, carts, linens. Workers employ various strategies in negotiating their tasks under UpKeep, a system which has improved aspects of traditional housekeeping while also introducing new challenges.

The GRAs in our study have a vested interest in retaining autonomy over their work process, increasing communication with peers and supervisors, and avoiding work intensification. These desires represent workers' broader values for wellbeing at work, which GRAs already champion in their workplaces through various means. Many of the participants we spoke to were not only union members, but serve as shop stewards, co-chairs on safety committees, and active organizers for their local unions.

Two of our participants talked about the unending support they lend to training new recruits, even helping veterans to use new technologies. One participant negotiated a \$75 yearly budget for GRAs to replace their shoes that get water damaged when cleaning showers. Another made significant gains with her local to reduce the number of checkout rooms allowed by contract. These worker-led initiatives, both big and small, contribute to GRAs' wellbeing and dignity in their workplaces. Our data suggest that making change encourages GRAs to stay in their roles, and remain engaged in bettering their work.

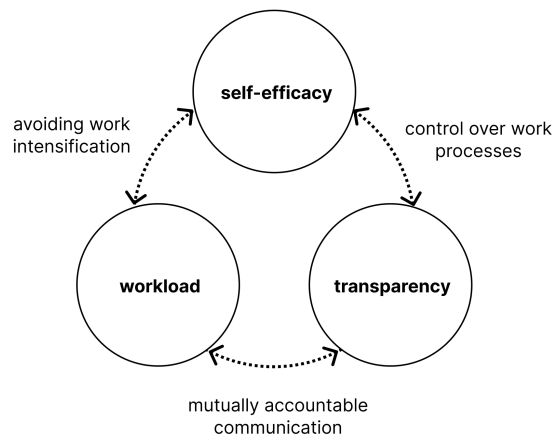
The prototyping sessions revealed workers' ideas about how an AM tool might be adapted to support workers' existing efforts towards increasing wellbeing. We identified three key themes of wellbeing: self-efficacy, transparency, and workload (Figure 1). These themes draw directly from our analysis of worker input, and arose inductively. Unsurprisingly, these themes replicate Mutari and Figart's definitions for the intangible physical and psychological characteristics of wellbeing, and correspond closely to concepts in labor relations and economics literature that define characteristics of good work [3, 68].

We use this framework to surface trade-offs between workers' tasks, roles, and capacity to help others. For instance, our findings reveal how UpKeep may shift, or in some cases intensify workload in the quest for self-efficacy and transparency. We contextualize worker-generated design ideas around these three themes, and consider design opportunities to advance worker wellbeing in the presence of AMs.

It is important to note that due to the fragmented nature of hotel properties, UpKeep is implemented differently in different properties. Our data reiterated these differences. Some of the features requested by participants, including translation settings, may exist in some configurations of UpKeep but not others. Therefore, the ideas presented in our data are indicative of workers' needs within (and beyond) AMs.

### 4.1 Self-efficacy

Self-efficacy describes a worker's capacity for autonomous decision making, including the ability to determine one's task flow, timing for work completion, and the right to set boundaries around work requests. Our participants reveal how UpKeep creates possibilities for increased self-efficacy in some areas, such as documenting work,



**Figure 1: Three interrelated themes of wellbeing that emerged from data analysis. Worker-generated design ideas may require trade-offs between each theme.**

while reducing it in others, like GRAs' ability to self-sequence work-flows. Before the introduction of UpKeep, GRAs would be given a list of daily assignments on a paper and clipboard, and could complete their rooms in the order of their choosing. GRAs' ability to control their own task flow now depends on the configuration of UpKeep within their hotel properties. Some configurations retain self-sequencing functionality by allowing GRAs to autonomously order room assignments within the app. This can be important for GRAs who have developed individualized workflows, such as changing all of their rooms' linens before returning to clean bathrooms. Most of the configurations used by our participants do not allow GRAs to order their own assignment order, which we take as a given in subsequent design ideas. One participant describes a loss in self-efficacy when this configuration of UpKeep sends her far and wide for assignments:

**Liza, GRA, Workshop:** “[The software assigns a room but] I have another room I can do. And I do my own first. I don’t need to go far away or [to a] new [room]. So [that would] waste my time... We think we can control that. That’s only the software that controls that.”

UpKeep creates additional opportunities for documentation which may actually increase feelings of self-efficacy. Before UpKeep, GRAs reported roadblocks by memorizing complex service codes, which they relayed to supervisors and the front desk over room phones. More involved communication had to be done in-person, and required travel throughout the hotel. While workers and managers may still employ paper records, UpKeep offers GRAs several communication options that help document their tasks and roadblocks. When encountering trashed or occupied rooms that typically slow workflow, GRAs employ strategies such as logging these events as “rooms in progress” within the app, allowing them to return to these rooms later. GRAs may also rely on UpKeep to keep track

of how many “credits” they have left. Housekeeping departments use the credit system to assign a certain number of points to room assignments, which are part of a GRA’s contract for each working day. GRAs use UpKeep to pace their work and track credits, and to set boundaries when an assignment goes beyond the daily credit limit:

**Kate, GRA, Interview:** “I always go to the device and click the little flag and it tells me, how many floors and how many credits as well, and then, what I still have to finish still.”

While this strategy may help GRAs to enforce visible credit boundaries, it may also increase the potential for surveillance – especially for tasks that do not affect credits within the app. Our participants reported that there are many tasks (or parts of tasks) which remain invisible or uncredited in UpKeep. These range from being stopped in the hallway for a guest request, to helping deliver supplies when housemen are short, or responding to verbal assignments from front desk staff. Participants described the undocumented labor they perform to ensure guest satisfaction:

**Dulce, GRA, Participatory Prototyping Session:** “In the rooms they supposedly already told us to not provide service, they call us anyway to get the garbage, to give them towels. Many times they remove their sheets and ask for sheet sets, pillows. We still provide service. And many times, these rooms are not even on our list. We can’t say the room is not on our list, I can’t give it to you. We have to do the extra work too.”

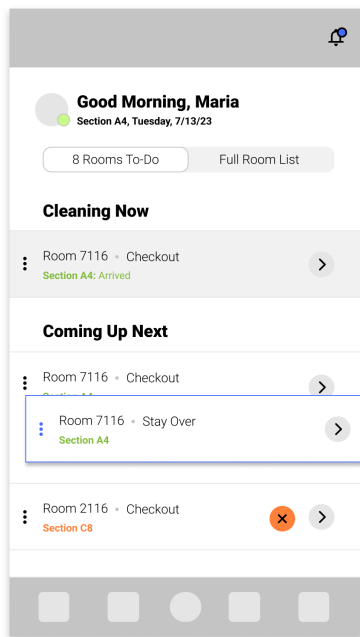
Participants also described how the app may not account for supply shortages, which prolongs their work. Previously, there were few avenues to report roadblocks like linen shortages; GRAs would spend time running between closets, even stealing supplies from one another to protect their room record. Now, many GRAs rely on the app’s chat function to communicate with management when an assigned room could not be completed due to factors outside their control. We heard examples of supervisors providing helpful guidance to GRAs, assisting with roadblocks. Other workers describe more oppositional relationships with supervisors, often due to the intensification of their workload. One GRA said that when she is missing supplies, she calls or texts managers directly and does not work on the room until supplies arrive:

**Maria, GRA, Workshop:** “There are not enough linens. The rooms are left incomplete. I leave them the list of what is missing in rooms, this room hasn’t been done. I give them a big list. I don’t care. They are always telling me ‘Hey Maria, again you haven’t completed your rooms again.’ The other day I had an argument with the supervisor. I said ok give me what I need to do my job. They can’t demand that I finish them. There is a problem with the linen. We are always short on linens.”

For some participants, using the app has made it easier to set boundaries around work requests with supervisors. However, due to the power differentials between GRAs and managers, most are unable to express complaints related to additional workload. This type of behavior could be understood as insubordination, and subject the GRA to discipline or even termination. One GRA we spoke to

reported hesitating to even report out-of-scope problems (ex: linen shortages), describing how the task will become the responsibility of other workers who have to “run around like crazy” to ensure timely completion. To empower GRAs in communication around roadblocks and extra work, our participatory prototyping sessions surfaced design ideas which build upon the existing documentation options in UpKeep.

**4.1.1 Worker-generated design ideas to increase self-efficacy.** GRAs seek to feel respected for their knowledge and hard work, and take pride in a job well done. We considered how offering more options for indirect in-app documentation may help maintain autonomy over their task flow.



**Figure 2: Prototype of a GRA view showing the user’s ability to order their room assignments.**

Participants reflected a desire for a structured way to log roadblocks within the app. For example, one participant suggested the app should offer a binary selection for whether the room could be completed or could not be completed. If a room could not be completed, a GRA could then be provided with further options to document the situation, including Guest Declined Service or Missing Supplies. When a GRA is missing supplies necessary to complete the room, she can tap to select images of all the missing items, or can add a custom field. After documenting the issue, the app will automatically organize her request for specific items into separate ticket requests, to be routed to the appropriate parties. In this way, GRAs who cannot refuse work directly can still maintain a clear record of external roadblocks. This may prove especially useful in union grievance hearings or future negotiations.

Participants suggested a mechanism to account for time spent working on tasks that are not assigned within the app. Recall Dulce’s

concern with the extra work of providing service to guests who were not assigned to her. To allow GRAs greater control over their timing for work completion, we developed prototypes for a flexible in-app status update. GRAs could use the status to communicate when they are busy working on a guest request, or on extra tasks assigned by the front desk. Such documentation could lead to the recognition of GRAs’ labor beyond their cleaning assignments, and adjust workloads to account for extra tasks – especially in environments with reduced daily cleaning. These design ideas reveal how documentation can help GRAs maintain autonomy and boundaries around their work. Our participants also felt that access to these forms of documentation would allow GRAs’ to perform more of the tasks they find rewarding, such as spending extra time to build relationships with guests, while reducing the potential for stress (or punitive measures) when unable to complete a room.

Finally, every participants expressed the desire to self-sequence assignments by ordering their room lists in UpKeep. These affordances would increase GRAs’ autonomy to flexibly respond to the changing demands of their properties. For instance, issues like supply shortages may cause GRAs to step outside the AM-designated assignment flow. When situations requiring flexibility inevitably arise, a self-sequencing configuration would acknowledge GRAs as experts in their work.

## 4.2 Transparency

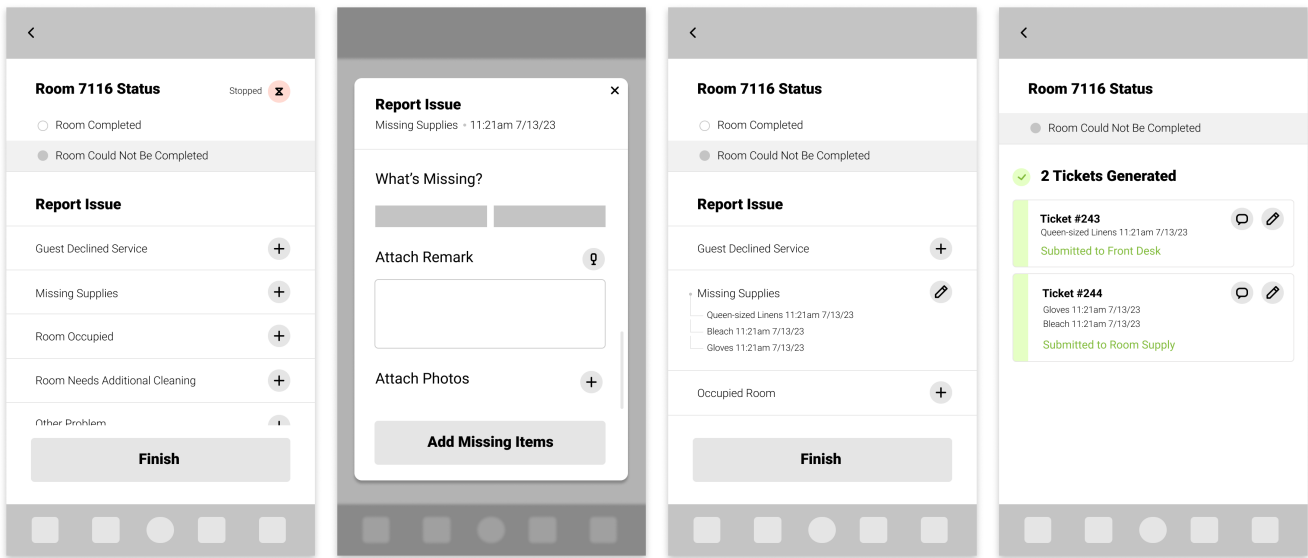
Transparency describes how much context a worker has about system and managerial decision-making, and the broader purpose of their work. Our participatory prototyping sessions revealed ideas that address two aspects of transparency: the need for transparent assignments, and the need for transparent communications.

**4.2.1 Transparency around room assignments.** Our participants described the importance of transparent assignments, beginning with the desire to see their whole room list at once. While almost none of the UpKeep configurations we discussed allowed for self-sequencing, many did allow GRAs to see their whole board. Only in the most limited configurations, GRAs were instead shown one assignment at a time – a configuration which many found stressful. In the often-chaotic service context, receiving their full room list each morning allowed GRAs to mentally prepare for their day. GRAs described how, by working together with management, many were able to eventually phase out the one-room-at-a-time configuration in their assignments.

However, even GRAs who were able to see full room lists contended with just-in-time rush assignments [40] as property needs changed. Rush assignments would re-organize the room list on a moment’s notice, shifting unexpected labor onto workers with little context. Participants described their stress when supervisors added rush rooms via UpKeep, as GRAs now felt responsible for their full room record. When resources (from time to linens) were already scarce, many also expressed that they could not deliver the highest level of service, which decreased their pride in the work. GRAs told us how they help each other to make sense of unanticipated and often stressful assignments within the app:

**Kate, GRA, Interview:** “It’s like, wait a minute, why, and then, you ask the coworker next to you, did they add more rooms to you. And we all have to figure out





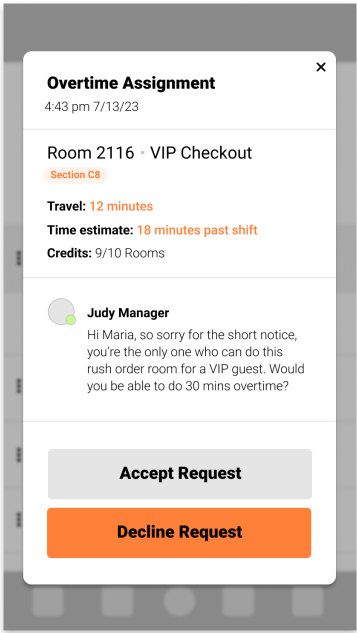
**Figure 3: Prototype of a documentation flow where a GRA reports that her room could not be completed, reports a missing supplies issue, and generates two tickets based on her request.**

*like wait, they just added five more rooms like what’s going on.”*

Traditionally, rush room assignments were handled over the phone or in person, during which a supervisor could provide context about why extra rooms were being assigned (e.g., someone calling out sick, influx of guests due to a weather event). In many properties that employ UpKeep, dedicated supervisors continue walking the floor to respectfully discuss assignments with staff and make sure everyone receives the tasks best suited for them. These properties are also likely to have morning meetings during which supervisors brief workers on special events which drive room spikes. However, GRAs reported that the move to digital assignments limited their ability to discuss workload with supervisors face-to-face. To ensure the wellbeing of GRAs across properties, our sessions surfaced ideas for how UpKeep can provide the context typically given by supervisors in-person.

**4.2.2 Worker-generated design ideas to increase transparency around room assignments.** In our prototyping sessions, participants experimented with ideas for providing context around routine and rush room assignments. They first suggested ways for supervisors to add short notes to rush assignments, room switches, or other special requests. Kate describes the stress and confusion she feels when receiving a sudden influx of assignments. To relieve experiences like Kate’s, a GRA receiving a rush room could also receive a short communication from a supervisor which explains the last minute assignment and thanks her for taking the room.

Other participants suggested that assignments should not be added directly to the GRAs’ boards, but could instead be displayed as requests which a GRA may accept or reject. While this possibility seemed initially promising during our conversations in Session 1, our Session 2 feedback revealed that GRAs could not realistically



**Figure 4: Prototype of a GRA’s view, showing a request for an overtime room assignment from a manager.**

assert in-app rejections without fear of termination. Once more, participants cited power differentials and personal precarity, but also acknowledged the necessity of supporting peers through heavy workloads. As one participant said, “There’s too much to do, and if



I don't do it, someone else has to." We also note that assignment rejections may further exacerbate workplace hierarchies, wherein work rejected by senior GRAs could fall to more junior colleagues. Participants instead suggested options for more concrete rejections, such as assignments that require overtime, which GRAs may have more choice around based on their individual situations.

Another concept participants suggested was a way for supervisors to provide GRAs with a view into the global context of their assignments. GRAs envisioned two ways to operationalize supervisor briefings through the app. To account for sudden disruptions, like a weather related rush, they suggested an alert mechanism which could be pushed to all staff in real-time. Alternatively, participants discussed the idea of a digital bulletin board within the app, which GRAs could check for information they might receive during a morning meeting – for example, the service needs of an upcoming event at their property.

These ideas reveal that our participants want to feel partnership with their co-workers. Even when refusal is unrealistic, GRAs expect and appreciate the context that makes assignments feel like requests. Transparency in operations can help elevate GRAs' sense of purpose when providing service.

**4.2.3 Transparency around communications.** Participants also suggested design ideas to improve the ease and transparency of communications in UpKeep. While using the app, GRAs are expected to input location details, to record start and stop times, and to manually input additional requests. These represent a new set of tasks added to an existing workload. While our participants experienced this work as an additional burden, it is clear that incomplete or incorrect information may result in extra work. One participant relayed how a late assignment request from the front desk negatively impacted her room record:

**Olivia, GRA, Workshop:** *"I think this the worst thing ever. Sometimes they'll put it [the late assignment] in the iPad. Sometimes they forget it, then put it in there an hour later. So when it comes to me, it says I had it for an hour already and I just got it and I get in trouble for that."*

Another GRA described how front desk staff may unintentionally send her on double assignments, which requires extra vigilance:

**Min, GRA, Workshop:** *"With the iPad, it happened to me yesterday. I got an order for room 6088. I did it, around like 12:30pm and then the same order came back, and I called the office. I'm like, 'Why did I, why am I getting this call again?' So this is where I think they write the call down, and don't put it in the iPad. And then when they do put it in the iPad, they don't remember if they put it in the iPad and they put it in the iPad again. So if you don't remember that you went to that room in the morning, you're going to go back again in the afternoon. That's taking up a whole lot of time."*

When such issues arise, GRAs want more responsive communications from their supervisors. While GRAs are expected to check their devices frequently, many feel as if the results of these efforts are not regularly seen by supervisors:

**Sandra, GRA, Workshop:** *"We are allowed to text our supervisors and stuff like that. Especially when we don't have any rooms to do. 'I don't have a room. Can you send me a room?' And then they don't check the device either. You know, they come at us because we are not [putting in orders how we are supposed to] or the orders we put in are wrong, but when we tell them what's wrong it will be an hour later, two hours later, that's when they are going to call you. I didn't have any rooms two hours ago, but now I have all my rooms and I'm falling behind and [supervisors] didn't check [their] device."*

Communications are further complicated for non-English speakers and GRAs who are not computer literate. Our participants, who felt relatively comfortable with the technology, explained how their peers sometimes asked for help documenting requests. They noted that typing in UpKeep can take a long time, and that using walkie-talkies is faster for certain tasks. While this workaround may overcome usability challenges in the short term, it means that GRAs have less documentation to rely on.

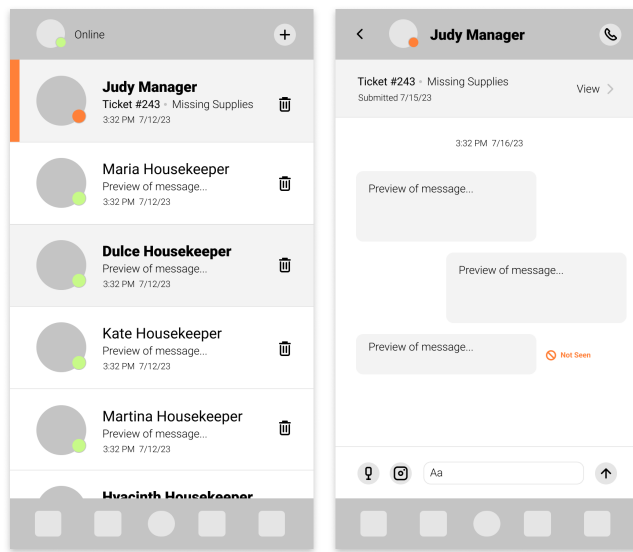
**4.2.4 Worker-generated design ideas to increase transparency around communications.** To increase transparency in communication, participants prototyped a few modifications to the UpKeep interface. To ensure accountability for messages received and seen, they suggested showing messages as sent, not received, or read by the recipient. They also suggested allowing GRAs and supervisors to flag some messages as high priority. This could help supervisors prioritize their responses to address concerns like Sandra's, who describes the significant time sink of being left without a room assignment.

To reduce duplicate assignments and long response times, others envisioned linking chat messaging and the room ticket interface. For example, when a GRA submits a ticket about a guest refusing service, the ticket could be attached to their message to supervisors when they ask for a new assignment. Increasing the transparency of communication may be strengthened by integrating bodies of data that have been traditionally siloed, such as chat data. This may allow both senders and receivers to more easily reference common documentation, reduce the occurrence of duplicate requests, and be more responsive to high priority communication.

Participants also asked for voice-based communication. AI-based conversational agents may help GRAs save time by enabling hands-free communication, saving time for those who find typing in the app challenging. For example, a GRA can say, "UpKeep, start room now" or "UpKeep, report broken lamp." While collapsing the UI with a conversational agent could reduce personal workload, we note that the complexity of voice-based assistance may introduce new problems which are difficult to overcome in practice (e.g., see [34, 91] for issues with CUIs recognizing accents). Regardless, these design suggestions reveal the importance of developing mechanisms to facilitate communication.

## 4.3 Workload

Workload describes the amount of physical and cognitive labor that is required to complete assigned tasks. Participants surfaced design



**Figure 5: Prototype of a chat interface in the app, demonstrating how a “Missing Supplies” ticket would be linked to a message thread with a supervisor.**

ideas to make labor visible and potentially reduce GRAs’ workload using UpKeep.

For example, GRAs described how the workload associated with rooms where customers have checked out is not reflected in UpKeep. While checkout rooms require the most cleaning, not all checkouts are created equal. One important factor in the difficulty of a checkout room is whether the room belongs to a GRAs’ “station,” which describes a block of rooms that individual GRAs are always responsible for cleaning. GRAs develop intimate relationships with their stations, enabling them to interact with return guests, clean rooms more efficiently, and take deep pride in their work:

**Candice, GRA, Participatory Prototyping Session:**

*“You know, every corner, every outlet, every faucet, every linen closet, every elevator, you know it very well. And it allows you to become more efficient and effective and attached.”*

Managers may use some configurations of UpKeep to assign GRAs work outside of their daily stations, which typically results in more physical labor. When working on an unfamiliar checkout room, one GRA complained that it is impossible to know when the room last had a deep cleaning, so she invests the labor to do so every time.

As daily housekeeping is not available at many hotel properties, the manual intensity of cleaning a checkout room continues to be great. One participant described her experience cleaning checkouts rooms that do not receive daily cleaning:

**Sandra, GRA, Workshop:** *“The towels are dried and stiff like pork rinds from so many days without service. And obviously, a room like this can’t be cleaned at the same time in 30 minutes. [...] The problem is when I have to clean the room, it is cleaning a room that hasn’t*

*been serviced in four days. Those bathtubs can’t be cleaned. The bathtubs are black. They can’t be cleaned.”*

They described how with reduced daily cleaning, stayover assignments – which represent important rest points – decrease in number:

**Dulce, GRA, Participatory Prototyping Session:**

*“When you see 8 checkouts, you’re frustrated. You need to be able to rest, you can’t keep just 8 straight checkouts. That’s overwhelming. So what we did is said, ‘We need two checkouts then [stayover], two checkouts and then [stayover], and we’ll be able to finish the rooms like that because mentally it stresses you out.’”*

Finally, some configurations of UpKeep request GRAs to travel between multiple floors of a hotel to complete their assignments. A GRA describes the toll of pushing a 400 pound cart over several floors and wings of a large hotel property:

**Maria, GRA, Workshop:** *“So you have to travel carrying your cart with you everywhere. That’s the only struggle that I encountered, especially when my cart is full. And then, you know, it’s really hard. I really have a hard time pushing my cart, my back aches.”*

GRAs described several strategies to mitigate the intense physical workload. GRAs who have the option to self-sequence their work organize their workflows to maximize the stayover assignments to maximize face-to-face interactions with stayover guests. GRAs who don’t have the option to self-sequence depend on their supervisors to intentionally alternate stayover assignments between checkouts to ensure moments of rest. In some locations, recent union efforts have also phased out UpKeep configurations which automated assignments across stations, thereby reducing travel distances for GRAs. If self-sequencing is not possible, these strategies can ensure that supervisors can use a number of methods to distribute room assignments to better meet workers’ needs.

**4.3.1 Worker-generated design ideas to manage workload.** Our participants suggested a number of design ideas to better manage their workload within UpKeep. Participants experimented with design ideas that communicate the difficulty of an assignment on a room-by-room basis, and highlight undue workloads for GRAs and supervisors to see. They suggested that assignment cards could track and surface credits, room type (checkout / stayover), days between cleanings, and the estimated travel time from assignment to assignment. Assignments that are too labor-intensive could be highlighted. GRAs suggested the app could also calculate the proximity of an assignment to the end of a GRA’s shift, and allow GRAs the option to accept overtime.

In configurations of UpKeep that limit self-sequencing, participants envisioned openly representing assignment difficulty on a supervisor dashboard. Using this information could support supervisors in minimizing travel and allocating assignments to increase rest points. Participants also wondered if an AM could automatically generate routes according to GRAs’ workflow preferences, for supervisors to augment as needed. Accounting for these workload nuances would require significant buy-in from GRAs to determine the conditions of their work.

Finally, one participant wondered if an app could functionally prevent managers from over assigning checkout rooms – as dictated by her union contract. In response, we experimented with design adaptations to limit contract violations within the app. If, by chance, a supervisors' assignment exceeds the union's room maximum, the app would highlight the discrepancy and grays out the "assign room" button. These interventions could remove the burden of filing grievances from GRAs, while also helping supervisors to negotiate between workload and wellbeing for their staff.

## 5 DISCUSSION

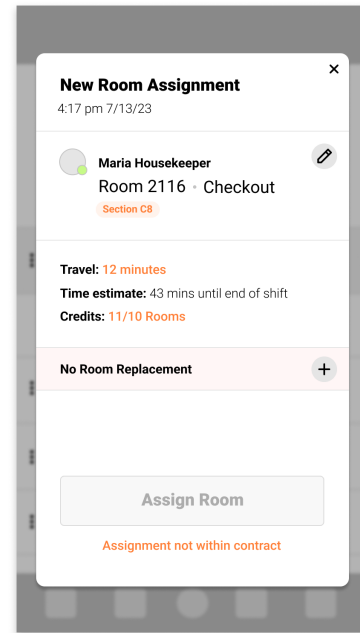
Prior scholarship on workplace AMs illustrates the negative impacts to job quality when deployment fails to take worker experiences into account [12, 44, 70, 93], and suggests reframings to ensure equitable deployment [40, 58, 89, 92]. Evidence shows that increased worker voice is not only an important determinant of retention [65], but that the effective integration of technology and worker strategies generates higher productivity [50]. It is also crucial for unions to have a seat at the table when designing and integrating new technology into the workplace [50].

In this paper, we explore how incorporating worker voice into an AM, using participatory prototyping methods, may contribute to enhanced aspects of worker wellbeing. Drawing on workshops, interview data, and participatory prototyping sessions with unionized GRAs, we examine the ways in which GRAs' experiences using UpKeep were guided by trade-offs meant to support their ability to 1) maintain control over their work processes and document extra labor, 2) ensure transparency and mutual accountability for communications, and 3) avoid work intensification. In the section that follows, we consider these trade-offs in more depth and describe how the adaptations GRAs imagined cannot be offered in isolation; instead, they must work alongside broader efforts of workplace advocacy and policy protections.

### 5.1 Considering the trade-offs

According to the GRAs we spoke with, work under UpKeep introduced additional tasks and under-delivered on promises for workplace cohesion. They instead imagined alternative designs that might address these challenges, and proposed "ideal" versions that included receiving immediate and accurate communication from supervisors and the ability to use their devices hands-free via AI-enabled voice assistance. They also described versions of the technology that would offer GRAs the option to accept or deny assignments, functionally limiting supervisors' ability to overassign checkout rooms or floor changes without credit reductions. With each iteration, GRAs revealed the deep complexities of their work and relationships. Key to each of their ideas was the desire to preserve the most rewarding aspects of their jobs, which included having discretion over their own work, fostering collaboration and teamwork, and prioritizing the social aspects of hospitality work.

**5.1.1 Self-efficacy vs. workload.** GRAs in our interviews and workshops sought to protect their time and workload, typically hard to negotiate within the app. To do so, they initially explored the process of accepting tasks, and suggested options to reject assignments. But, later, they changed course when reviewing the resulting prototypes. Even in unionized workplaces, GRAs explained that they did



**Figure 6: Prototype showing how an AM may limit a supervisor's ability to assign a room beyond the GRA's credit limit.**

not have the power of refusal for supervisor requests, especially when their employment may be at stake. As such, they recognized that even if refusal was an option in the technology, using it may incur significant personal cost.

Participants were also sensitive to how increasing the self-efficacy of some users may unintentionally increase the labor of other workers. GRAs acknowledged the breakneck pace and sheer volume of assignments under which they all labored. We learned that while workers value the ability to set boundaries around tasks they consider "not their job," they also value helping their peers through this demanding workload. One participant hesitated to document problems that would be offloaded onto housemen or other GRAs, who would have to "run around like crazy." GRAs were all too familiar with the stress of rush assignments handed down through the app by supervisors. While previous scholarship has considered how AMs transfer power from workers to managers [40], we note that workers are aware of how these same algorithmic affordances can facilitate hierarchical power dynamics between peers.

Our participants expressed a deep sense of shared responsibility and a hesitance to saddle others with additional work. The dynamic of teamwork GRAs maintained is duly emphasized in the workplace wellbeing literature [68]. Trust, shared responsibility, and solidarity were important to our participants; what would it mean for an AM to reflect those same values? To better understand these dynamics from a management perspective, future research could employ a participatory process with supervisors to learn how they negotiate competing priorities around managing a labor shortage, and supporting staff who have stayed on.

**5.1.2 Transparency vs. self-efficacy.** Participants also explored how the technological affordances of AMs could decrease the intensity of work and account for job structures as mandated by the union. Fuller documentation via an AM could be used as evidence in a union grievance hearing, or it could be used in future contract negotiations to argue for a decrease in credits. However, while workers wish to receive recognition for the nuances of their labor, making their work more visible could create significant trade-offs. On one hand, making visible the (currently) invisible labor that GRAs do could be a first step in re-evaluating work expectations similar to a time and motion study. If the goal is to create an environment that is conducive to the long-term tenure of GRAs in order to address staffing problems, workers, their union and management will need to work together to transform jobs — not only to be more lucrative, but also more fulfilling and less physically demanding. A holistic picture of the GRAs' workload is a necessary component of transforming the work.

On the other hand, increased transparency into every aspect of a job opens up opportunities for surveillance (e.g., tracking where in a hotel one has traveled). Though some GRAs noted feelings of enhanced safety knowing their supervisors might be able to locate them in a hotel property at any given time, these same methods could be used to monitor “idle time” [25, 42]. Scholars note how additional transparency may counterintuitively reduce workers' performance by inducing workers to hide unsanctioned activities through other costly means [13]. Previous scholarship on truck drivers also notes how increased surveillance due to algorithmic management robs workers of not only their autonomy, but also some of the basic pleasures of their work, such as the tips and tricks developed through years of intimate know-how [56, 57]. GRAs have already lost some of these pleasures under UpKeep configurations that limit self-sequencing, a critical component of their work. Careful approaches to transparency would help AMs to lift up the work GRAs most want to be most recognized for.

**5.1.3 Transparency vs. workload.** Our participants were consistently challenged by limitations of time, usability, and legibility of information. The solutions they suggested revealed trade-offs between transparency and workload, particularly around communication with supervisors. For example, adding transparency to communications (e.g., read receipts, status updates) would not alone reduce the technological labor required to use these digital communications [63]. Participants' idea of linking work tickets to supervisor chats may instead introduce the tradeoff of more cognitive labor in creating additional messaging threads.

With this in mind, one might imagine AI interventions that could automate many of the functions that are currently manual. With simple AI, for example, an AM like UpKeep could automatically record GRAs' start and stop times, track guests who remain in checkout rooms, and self-report on maintenance issues [90]. While promising from the perspective of usability, these functions would require sensing infrastructure that exceeds the current capacities of AMs. Instead, there may be more promise in developing mechanisms to adapt AM affordances towards worker assistance, which is more closely associated with higher paid work sectors like information and medicine. Unlike AMs, assistance software seeks to reduce the cognitive load of users by automating preferential scheduling

and routine communications, and helping workers set and track their personal goals [48]. In hospitality, other mechanisms could be used to link housekeeping and operations workflows. For example, room assignments could be vetted to ensure GRAs receive proactive support for extra work, or better account for supplies across the property. Digital interoperability (beyond tracking workers) would be important to achieving these goals. However, while software management tools currently exist in the hospitality industry, many are siloed from the AMs that track day-to-day work.

## 5.2 Future work: Looking beyond technology

Our work demonstrates how participatory prototyping may reveal avenues through which an AM can protect hospitality workers' wellbeing, along with tradeoffs that arise in the pursuit. Our findings suggest that an AM may be able to support certain norms which are difficult to enforce on a case-by-case basis, such as respectful assignment requests and staggered checkouts.

However, we learned that many of GRAs' most commonly suggested changes went well beyond current affordances of the technology. Design ideas like self-sequencing did not need to be built from scratch — they existed within UpKeep already, but simply weren't turned on in most properties. These discrepancies suggest that we have more to learn about the implementation of current systems. Further research can work alongside technology vendors and managers to determine whether the features most coveted by GRAs cost more, or whether managers themselves may also benefit from additional training on AM systems. By first understanding the nuances of AM deployment, we may also help unions negotiate how existing features are utilized.

Our future work will also more deeply explore the degree to which an AMs can realistically be adapted to enforce protections. To account for workers' physical and psychological wellbeing more holistically, factors such as institutional oversight, new roles, additional training, other workplace technologies, and even new policies would need to be considered. Though it is unclear how much of this can be done successfully by software, participatory design methods can be used to explore further opportunities for wellbeing.

In the case of UpKeep, the goal of participatory prototyping was not necessarily for researchers to solve workers' problems [83], but to concretize a vision of possible adaptations that continue to live in workers' hands. Because GRAs were largely unfamiliar with the possibilities of AMs before using them at work, participatory methods proved especially helpful in the work of auditing and adapting technologies already deployed. For example, we found that by scaling research from group workshops to participatory prototype engagements, GRAs who were newer to the technology were able to learn the tips and tricks of veteran peers. During workshops, GRAs learned (often for the first time) about helpful features or workarounds discovered by GRAs who had more time to tinker with UpKeep.

As changes in the hospitality industry correspond with changes in work for service workers more generally, we highlight a growing need for increased worker participation in technology design. We believe participatory design can support meaningful steps toward achieving self-efficacy, transparency, and reduced workload for workers. The wellbeing framework shared here, for example,

could help owners and managers make decisions about technology upgrades which would benefit their workforce. Additionally, participatory approaches may also be effective in helping union leaders negotiate for their workers [51] and develop new policies to support the accountable development of AI and automation technologies [5]. These methods can be used to operationalize the existing strategies of unionized workers and supervisors, and potentially extend wellbeing protections for non-unionized workers [79].

### 5.3 Limitations to our work

Due to the challenges of the ongoing pandemic, which limited our access to field work onsite in hotel properties, we conducted remote interviews with unionized GRAs around a specific algorithmic room assignment tool. This means that we could not fully capture aspects of work that exist beyond the app itself. Our proposed interventions focus on UpKeep, but we were unable to understand the full context of work in which UpKeep was used. For instance, we were unable to confirm whether users' challenges were the result of inadequate functionality, or inadequate training in accessing UpKeep's full range of affordances. We were also unable to see how UpKeep was configured in particular properties, and how this differs from property to property. As such, the design ideas presented in this paper represent our best understanding of how worker-generated adaptations may extend the app's current functionality.

We were also working with a limited set of participants; as our interviews were conducted with GRAs only, our understanding of collaboration between GRAs and other staff was incomplete. Another limitation of this study is that our participants represented some of the most competent users of the technology. Part of expanding the pool of participants could first include GRAs who struggle with the basic functionality, as their needs may be quite different from those of more adept users. Lastly, we note that due to the occupational segregation of housekeeping work [64], all of our participants identified as women.

### 5.4 Conclusion

Labor shortages have become a defining anxiety for the hospitality industry since the re-openings of 2022 [7]. While guests are left disappointed by gaps in service, hoteliers are struggling to balance the needs of the operations and staffing issues. Some are experimenting with technology as a solution. The algorithmic management of housekeeping has existed in the industry for several years, but has not generally been utilized toward the aiding hotels in creating more sustainable housekeeping jobs.

In this paper, we suggest instead focusing on wellbeing in the hospitality industry may help with retention efforts where solely relying on wage increases have not sufficed. This paper presents preliminary worker-generated design prototypes that adapt an existing room-assignment AM used by housekeeping. Through our participatory prototyping sessions, we revealed participants' values around three facets of wellbeing: self-efficacy, transparency, and workload. We learned that participants' "ideal" designs required consistent negotiation between rewarding aspects of their jobs, and the pressures of their workload. We suggest places for AMs to support workers' wellbeing and job quality, while also noting that improvements to wellbeing cannot be handled by technology

alone. We conclude by suggesting that future participatory design research can support worker wellbeing in collaboration with hotels, unions, policy makers, and technology vendors.

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### REFERENCES

- [1] [n.d.]. Hotel Guest Experience Measurement and Strategy | Deloitte US. <https://www2.deloitte.com/us/en/pages/consumer-business/articles/hotel-guest-experience-strategy.html>
- [2] [n.d.]. [Webinar Replay] The New Rules of Operational Efficiency & Profitability Webinar - Amadeus Hospitality. <https://www.amadeus-hospitality.com/resources/webinar-replay-the-new-rules-of-operational-efficiency-profitability-webinar/>, <https://www.amadeus-hospitality.com/resources/webinar-replay-the-new-rules-of-operational-efficiency-profitability-webinar/>
- [3] 2009. Workplace well-being. [https://www.ilo.org/global/topics/safety-and-health-at-work/areasofwork/workplace-health-promotion-and-well-being/WCMS\\_118396/lang--en/index.htm](https://www.ilo.org/global/topics/safety-and-health-at-work/areasofwork/workplace-health-promotion-and-well-being/WCMS_118396/lang--en/index.htm)
- [4] 2022. *Bearing the Cost: How Overrepresentation in Undervalued Jobs Disadvantaged Women During the Pandemic*. Technical Report. U.S Department of Labor. 48 pages. <https://www.dol.gov/sites/dolgov/files/WB/media/BearingTheCostReport.pdf>
- [5] 2022. NLRB General Counsel Issues Memo on Unlawful Electronic Surveillance and Automated Management Practices. <https://www.nlr.gov/news-outreach/news-story/nlr-general-counsel-issues-memo-on-unlawful-electronic-surveillance-and>
- [6] 2022. *The Year of the "New" Traveler: The American Hotel & Lodging Association 2022 State of the Hotel Industry Report in Collaboration with Accenture*. Technical Report. AHLA. 21 pages. <https://www.ahla.com/sites/default/files/AHLA%20SOTI%20Report%202022%201.24.22.pdf>
- [7] 2023. *A New Era for U.S. Hotels: The American Hotel & Lodging Association 2023 State of the Hotel Industry Report*. Technical Report. AHLA. [https://www.ahla.com/sites/default/files/AHLA\\_SOTI\\_Report.2023.final\\_002.pdf](https://www.ahla.com/sites/default/files/AHLA_SOTI_Report.2023.final_002.pdf)
- [8] David Autor. 2022. The Labor Market Impacts of Technological Change: From Unbridled Enthusiasm to Qualified Optimism to Vast Uncertainty. <https://doi.org/10.3386/w30074>
- [9] Katie Bach. 2022. New data shows long Covid is keeping as many as 4 million people out of work. <https://www.brookings.edu/research/new-data-shows-long-covid-is-keeping-as-many-as-4-million-people-out-of-work/>
- [10] Diane E. Bailey. 2022. Emerging Technologies at Work: Policy Ideas to Address Negative Consequences for Work, Workers, and Society. *ILR Review* 75, 3 (May 2022), 527–551. <https://doi.org/10.1177/001979392211076747> Publisher: SAGE Publications Inc.
- [11] Thomas R. Bailey and Annette D. Bernhardt. 1997. In Search of the High Road in a Low-Wage Industry. *Politics & Society* 25, 2 (June 1997), 179–201. <https://doi.org/10.1177/0032329297025002003> Publisher: SAGE Publications Inc.
- [12] Annette Bernhardt, Lisa Kresge, and Reem Suleiman. 2023. The Data-Driven Workplace and the Case for Worker Technology Rights. *ILR Review* 76, 1 (Jan. 2023), 3–29. <https://doi.org/10.1177/00197939221131558> Publisher: SAGE Publications Inc.
- [13] Ethan Bernstein. 2022. The Transparency Paradox: A Role for Privacy in Organizational Learning and Operational Control - Article - Faculty & Research - Harvard Business School. <https://www.hbs.edu/faculty/Pages/item.aspx?num=43639>
- [14] Abha Bhattarai and Maggie Penman. 2023. Restaurants can't find workers because they've found better jobs. <https://www.washingtonpost.com/business/2023/02/03/worker-shortage-restaurants-hotels-economy/> Section: Economy.
- [15] Claus Bossen, Christian Dindler, and Ole Sejer Iversen. 2010. User gains and PD aims: assessment from a participatory design project. In *Proceedings of the 11th Biennial Participatory Design Conference (PDC '10)*. Association for Computing Machinery, New York, NY, USA, 141–150. <https://doi.org/10.1145/1900441.1900461>
- [16] Heather Boushey and Rinz Kevin. [n.d.]. Blocking the Low Road and Paving the High Road: Management Practices to Improve Productivity | CEA. <https://www.whitehouse.gov/cea/written-materials/2022/04/06/blocking-the-low-road-and-paving-the-high-road-management-practices-to-improve-productivity/>
- [17] Tone Bratteteig and Ina Wagner. 2016. Unpacking the Notion of Participation in Participatory Design. *Computer Supported Cooperative Work (CSCW)* 25, 6 (Dec. 2016), 425–475. <https://doi.org/10.1007/s10606-016-9259-4>
- [18] David Brody. 2016. *Housekeeping by Design: Hotels and Labor*. University of Chicago Press, Chicago, IL. <https://press.uchicago.edu/ucp/books/book/chicago/H/bo24312927.html>

- [19] Marion Buchenau and Jane Suri. 2000. Experience Prototyping. 424–433. <https://doi.org/10.1145/347642.347802>
- [20] Rafael Buckner. [n. d.]. The Outcome: From Launch to #1 Hotel Housekeeping Software in 3 Years. <https://www.aliceplatform.com/blog/housekeeping-software-launch-to-winner-in-3-years>
- [21] Susanne Bødker and Kaj Grønbaek. 1991. Cooperative prototyping: Users and designers in mutual activity. *International Journal of Man-Machine Studies* 34 (1991), 453–478. [https://doi.org/10.1016/0020-7373\(91\)90030-B](https://doi.org/10.1016/0020-7373(91)90030-B) Place: Netherlands Publisher: Elsevier Science.
- [22] Dan Calacci. 2022. Organizing in the End of Employment: Information Sharing, Data Stewardship, and Digital Workerism. In *2022 Symposium on Human-Computer Interaction for Work*. ACM, Durham NH USA, 1–9. <https://doi.org/10.1145/3533406.3533424>
- [23] Kathy Charmaz. 2006. *Constructing grounded theory*. Sage Publications, London ; Thousand Oaks, Calif.
- [24] Nadav Cornberg. 2021. Use digital check-in to enhance, not replace, guest engagement. <https://hotelbusiness.com/use-digital-check-in-to-enhance-not-replace-guest-engagement/>
- [25] Valerio De Stefano and Simon Taes. 2022. Algorithmic management and collective bargaining. *Transfer: European Review of Labour and Research* (Dec. 2022), 10242589221141055. <https://doi.org/10.1177/10242589221141055> Publisher: SAGE Publications Ltd.
- [26] Dunja Demirović Bajrami, Aleksandra Terzić, Marko D. Petrović, Milan Radovanović, Tatiana N. Tretiakova, and Abosa Hadoud. 2021. Will we have the same employees in hospitality after all? The impact of COVID-19 on employees' work attitudes and turnover intentions. *International Journal of Hospitality Management* 94 (April 2021), 102754. <https://doi.org/10.1016/j.ijhm.2020.102754>
- [27] Deborah M. Figart and Ellen Mutari. 2022. Preparing Hospitality Workers and Workplaces for the Future of Automation.
- [28] Amanda Fins. 2020. Women in Leisure and Hospitality Are Among the Hardest Hit by Job Losses and Most at Risk of Covid-19 Infection. *National Women's Law Center* (Nov. 2020), 6. <https://nwlc.org/wp-content/uploads/2020/11/LeisureFS.pdf>
- [29] Michael Gibbs and Sergei Bazylik. 2022. How is new technology changing job design? *IZA World of Labor* (2022), 344–344. <https://ideas.repec.org/a/iza/izaworl/journl2022n344.html> Publisher: Institute of Labor Economics (IZA).
- [30] Joan Greenbaum. 1996. Back to labor: returning to labor process discussions in the study of work. In *Proceedings of the 1996 ACM conference on Computer supported cooperative work - CSCW '96*. ACM Press, Boston, Massachusetts, United States, 229–237. <https://doi.org/10.1145/240080.240259>
- [31] Joan Greenbaum and Morten Kyng. 2020. *Design at Work: Cooperative Design of Computer Systems*. CRC Press. Google-Books-ID: KAOHEAAAQBAJ.
- [32] Bob Habeeb. 2022. It's Time for Hoteliers to Be Honest About Labor Concerns. <https://www.costar.com/article/522582010/its-time-for-hoteliers-to-be-honest-about-labor-concerns>
- [33] Christina Harrington, Sheena Erete, and Anne Marie Piper. 2019. Deconstructing Community-Based Collaborative Design: Towards More Equitable Participatory Design Engagements. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (Nov. 2019), 1–25. <https://doi.org/10.1145/3359318>
- [34] Christina N. Harrington, Radhika Garg, Amanda Woodward, and Dimitri Williams. 2022. "It's Kind of Like Code-Switching": Black Older Adults' Experiences with a Voice Assistant for Health Information Seeking. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3491102.3501995>
- [35] Debra Howcroft and Phil Taylor. [n. d.]. Automation and the future of work: A social shaping of technology approach. *New Technology, Work and Employment* n/a, n/a ([n. d.]). <https://doi.org/10.1111/ntwe.12240> \_eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/ntwe.12240>
- [36] Yu-Chin Hsieh, Yorghos Apostolopoulos, and Sevil Sönmez. 2016. Work Conditions and Health and Well-Being of Latina Hotel Housekeepers. *Journal of Immigrant and Minority Health* 18, 3 (June 2016), 568–581. <https://doi.org/10.1007/s10903-015-0224-y>
- [37] Gallup Inc. 2020. The Characteristics of Good Jobs for Low-Income Workers. <https://www.gallup.com/education/309911/characteristics-good-jobs-low-income-workers.aspx>
- [38] Stanislav Ivanov. 2020. The impact of automation on tourism and hospitality jobs. *Information Technology & Tourism* 22, 2 (June 2020), 205–215. <https://doi.org/10.1007/s40558-020-00175-1>
- [39] Fauzia Jabeen, Sameera Al Zaidi, and Maryam Hamad Al Dhaheer. 2021. Automation and artificial intelligence in hospitality and tourism. *Tourism Review* 77, 4 (Jan. 2021), 1043–1061. <https://doi.org/10.1108/TR-09-2019-0360> Publisher: Emerald Publishing Limited.
- [40] Mohammad Hossein Jarrahi, Gemma Newlands, Min Kyung Lee, Christine T. Wolf, Eliscia Kinder, and Will Sutherland. 2021. Algorithmic management in a work context. *Big Data & Society* 8, 2 (July 2021), 20539517211020332. <https://doi.org/10.1177/20539517211020332> Publisher: SAGE Publications Ltd.
- [41] Robert Jungk and Norbert Müllert. 1987. *Future workshops: how to create desirable futures*. Institute for Social Inventions, London. OCLC: 26307687.
- [42] Jodi Kantor, Arya Sundaram, Aliza Aufrechtig, and Rumsey Taylor. 2022. The Rise of the Worker Productivity Score. *The New York Times* (Aug. 2022). <https://www.nytimes.com/interactive/2022/08/14/business/worker-productivity-tracking.html>
- [43] Anna Kawakami, Venkatesh Sivaraman, Hao-Fei Cheng, Logan Stapleton, Yanghui Cheng, Diana Qing, Adam Perer, Zhiwei Steven Wu, Haiyi Zhu, and Kenneth Holstein. 2022. Improving Human-AI Partnerships in Child Welfare: Understanding Worker Practices, Challenges, and Desires for Algorithmic Decision Support. In *CHI Conference on Human Factors in Computing Systems*. ACM, New Orleans LA USA, 1–18. <https://doi.org/10.1145/3491102.3517439>
- [44] Katherine C. Kellogg, Melissa A. Valentine, and Angèle Christin. 2020. Algorithms at Work: The New Contested Terrain of Control. *Academy of Management Annals* 14, 1 (Jan. 2020), 366–410. <https://doi.org/10.5465/annals.2018.0174>
- [45] Finn Kensing and Jeanette Blomberg. 1998. Participatory Design: Issues and Concerns. *Computer Supported Cooperative Work (CSCW)* 7, 3 (Sept. 1998), 167–185. <https://doi.org/10.1023/A:1008689307411>
- [46] Finn Kensing, Jesper Simonsen, and Keld Bødker. 2004. Participatory IT Design – an exemplary case. *Journal of the Center for Information Studies* 5 (01 2004), 58–68.
- [47] Vera Khovanskaya and Phoebe Sengers. 2019. Data Rhetoric and Uneasy Alliances: Data Advocacy in US Labor History. In *Proceedings of the 2019 on Designing Interactive Systems Conference (San Diego, CA, USA) (DIS '19)*. Association for Computing Machinery, New York, NY, USA, 1391–1403. <https://doi.org/10.1145/3322276.3323691>
- [48] Everlyne Kimani, Kael Rowan, Daniel McDuff, Mary Czerwinski, and Gloria Mark. 2019. A Conversational Agent in Support of Productivity and Wellbeing at Work. In *2019 8th International Conference on Affective Computing and Intelligent Interaction (ACII)*. 1–7. <https://doi.org/10.1109/ACII.2019.8925488> ISSN: 2156-8111.
- [49] Thomas A. Kochan. 2006. Taking the High Road. *MIT Sloan Management Review* 47, 4 (2006), 16–19. <https://www.proquest.com/docview/224964914/abstract/794978628D584490PQ/1> Num Pages: 16-19 Place: Cambridge, United States Publisher: Massachusetts Institute of Technology, Cambridge, MA.
- [50] Thomas A. Kochan and William T. Kimball. 2019. Unions, Worker Voice, and Management Practices: Implications for a High-Productivity, High-Wage Economy. *RSF: The Russell Sage Foundation Journal of the Social Sciences* 5, 5 (Dec. 2019), 88–108. <https://doi.org/10.7758/RSF.2019.5.5.05> Publisher: RSF: The Russell Sage Foundation Journal of the Social Sciences.
- [51] Lisa Kresge. 2020. Union Collective Bargaining Agreement Strategies in Response to Technology. *UC Berkeley Labor Center* (Nov. 2020), 23.
- [52] Krishna B. Kumar. 2021. The Great Resignation: American Workers Suffering a Crisis of Meaning. <https://www.rand.org/blog/2021/10/the-great-resignation-american-workers-suffering-a.html>
- [53] Laura Lamers, Jeroen Meijerink, Giedo Jansen, and Mieke Boon. 2022. A Capability Approach to worker dignity under Algorithmic Management. *Ethics and information technology* 24, 1 (March 2022), 10. <https://doi.org/10.1007/s10676-022-09637-y> Publisher: Springer.
- [54] Min Kyung Lee, Daniel Kusbit, Anson Kahng, Ji Tae Kim, Xinran Yuan, Alissa Chan, Daniel See, Ritesh Noothigattu, Sihoon Lee, Alexandros Psomas, and Ariel D. Procaccia. 2019. WeBuildAI: Participatory Framework for Algorithmic Governance. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW (Nov. 2019), 181:1–181:35. <https://doi.org/10.1145/3359283>
- [55] Min Kyung Lee, Ishan Nigam, Angie Zhang, Joel Afriyie, Zhizhen Qin, and Sicun Gao. 2021. Participatory Algorithmic Management: Elicitation Methods for Worker Well-Being Models. In *Proceedings of the 2021 AAAI/ACM Conference on AI, Ethics, and Society (AI/ES '21)*. Association for Computing Machinery, New York, NY, USA, 715–726. <https://doi.org/10.1145/3461702.3462628>
- [56] Karen Levy. 2022. *Data Driven: Truckers, Technology, and the New Workplace Surveillance*. Princeton University Press. Google-Books-ID: 41R0EAAAQBAJ.
- [57] Karen E C Levy. [n. d.]. The Contexts of Control: Information, Power, and Truck-Driving Work. ([n. d.]).
- [58] Mingyu Li and T. Bradford Bitterly. 2022. How Perceived Lack of Benevolence Harms Trust of Algorithmic Management. <https://doi.org/10.2139/ssrn.4256486>
- [59] Sirena Liladrie. 2010. 'Do not disturb/please clean room': hotel housekeepers in Greater Toronto. *Race & Class* 52, 1 (July 2010), 57–69. <https://doi.org/10.1177/0306396809354177> Publisher: SAGE Publications Ltd.
- [60] Adam Seth Litwin, Jessie HF Hammerling, Françoise Carré, Chris Tilly, Chris Benner, Sarah Mason, Steve Viscelli, Beth Gutelius, and Nik Theodore. 2022. A Forum on Emerging Technologies. *ILR Review* 75, 4 (Aug. 2022), 807–856. <https://doi.org/10.1177/00197939221095527> Publisher: SAGE Publications Inc.
- [61] Bingjie Liu-Lastres, Han Wen, and Wei-Jue Huang. 2022. A reflection on the Great Resignation in the hospitality and tourism industry. *International Journal of Contemporary Hospitality Management* ahead-of-print, ahead-of-print (Jan. 2022). <https://doi.org/10.1108/IJCHM-05-2022-0551>



- [62] Wanda Martin, Bernie Pauly, and Marjorie MacDonald. 2016. Situational Analysis for Complex Systems: Methodological Development in Public Health Research. *AIMS public health* 3, 1 (March 2016), 94–109. <https://doi.org/10.3934/publichealth.2016.1.94>
- [63] Janis Lena Meissner, Nicolas Pretterhofer, Nadja Bergmann, and Edeltraud Haselsteiner. 2022. The Hidden Technological Labour of Service Workers in Health and Beauty Shops. In *2022 Symposium on Human-Computer Interaction for Work (CHIWORK 2022)*. Association for Computing Machinery, New York, NY, USA, 1–12. <https://doi.org/10.1145/3533406.3533413>
- [64] Shelagh Mooney. 2018. Illuminating intersectionality for tourism researchers. *Annals of Tourism Research* 72 (2018), 175–176. <https://doi.org/10.1016/j.annals.2018.03.003>
- [65] Jo Ellen Moore, Andrea J. Hester, and Susan E. Yager. 2016. Paving the Higher Road: The Role of Voice in the Retention of IT Workers. *SIGMIS Database* 47, 1 (feb 2016), 8–28. <https://doi.org/10.1145/2894216.2894218>
- [66] Cristian Morosan and John T. Bowen. 2022. Labor shortage solution: redefining hospitality through digitization. *International Journal of Contemporary Hospitality Management* 34, 12 (Jan. 2022), 4674–4685. <https://doi.org/10.1108/IJCHM-03-2022-0304> Publisher: Emerald Publishing Limited.
- [67] Michael J Muller and Allison Druin. 2012. Participatory design: The third space in human-computer interaction. In *The Human-Computer Interaction Handbook*. CRC Press, 1125–1153.
- [68] Ellen Mutari and Deborah M. Figart. 2015. *Just One More Hand: Life in the Casino Economy*. Rowman & Littlefield Publishers. <https://rowman.com/ISBN/9781442236677/Just-One-More-Hand-Life-in-the-Casino-Economy>
- [69] NerdWallet. 2022. How the hotel worker shortage could affect your next stay. <https://www.cleveland.com/news/2022/09/how-the-hotel-worker-shortage-could-affect-your-next-stay.html> Section: News.
- [70] Aiha Nguyen and Alexandra Mateescu. 2019. Explainer: Algorithmic Management in the Workplace. <https://datasociety.net/library/explainer-algorithmic-management-in-the-workplace/> Publisher: Data & Society Research Institute.
- [71] Paul Osterman. 2018. In Search of the High Road: Meaning and Evidence. *ILR Review* 71, 1 (Jan. 2018), 3–34. <https://doi.org/10.1177/0019793917738757> Publisher: SAGE Publications Inc.
- [72] Hyanghee Park, Daehwan Ahn, Kartik Hosanagar, and Joonhwan Lee. 2021. Human-AI Interaction in Human Resource Management: Understanding Why Employees Resist Algorithmic Evaluation at Workplaces and How to Mitigate Burdens. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3411764.3445304>
- [73] Hyanghee Park, Daehwan Ahn, Kartik Hosanagar, and Joonhwan Lee. 2022. Designing Fair AI in Human Resource Management: Understanding Tensions Surrounding Algorithmic Evaluation and Envisioning Stakeholder-Centered Solutions. In *CHI Conference on Human Factors in Computing Systems*. ACM, New Orleans LA USA, 1–22. <https://doi.org/10.1145/3491102.3517672>
- [74] Catherine Prentice, Sergio Dominique Lopes, and Xuequn Wang. 2020. Emotional intelligence or artificial intelligence— an employee perspective. *Journal of Hospitality Marketing & Management* 29, 4 (May 2020), 377–403. <https://doi.org/10.1080/19368623.2019.1647124> Publisher: Routledge \_eprint: <https://doi.org/10.1080/19368623.2019.1647124>
- [75] Catherine Prentice and Mai Nguyen. 2020. Engaging and retaining customers with AI and employee service. *Journal of Retailing and Consumer Services* 56 (Sept. 2020), 102186. <https://doi.org/10.1016/j.jretconser.2020.102186>
- [76] Melissa Repko. 2021. The robot work force isn't coming. It's already here. <https://www.cnn.com/2021/12/27/the-robot-work-force-isnt-coming-its-already-here-.html>
- [77] Ana Rosete, Barbara Soares, Juliana Salvadorinho, João Reis, and Marlene Amorim. 2020. Service Robots in the Hospitality Industry: An Exploratory Literature Review. Henriqueta Nóvoa, Monica Drăgoicea, and Niklas Kühl (Eds.), Vol. 377. Springer International Publishing, Cham, 174–186. [https://doi.org/10.1007/978-3-030-38724-2\\_13](https://doi.org/10.1007/978-3-030-38724-2_13) Book Title: Exploring Service Science Series Title: Lecture Notes in Business Information Processing.
- [78] Rachel Sherman. 2011. Beyond interaction: customer influence on housekeeping and room service work in hotels. *Work, Employment and Society* 25, 1 (March 2011), 19–33. <https://doi.org/10.1177/0950017010389240> Publisher: SAGE Publications Ltd.
- [79] Francesca Spektor, Sarah E Fox, Ezra Awumey, Ben Begleiter, Chinmay Kulkarni, Betsy Stringam, Christine A Riordan, Hye Jin Rho, Hunter Akridge, and Jodi Forlizzi. 2023. Charting the Automation of Hospitality: An Interdisciplinary Literature Review Examining the Evolution of Frontline Service Work in the Face of Algorithmic Management. *CSCW* 7 (2023).
- [80] Betsy Stringam and John Gerdes. 2021. Hotel and Guest Room Technology. *University of South Florida (USF) M3 Publishing* 17, 9781732127593 (Sept. 2021). <https://doi.org/10.5038/9781732127593>
- [81] Yngve Sundblad. 2011. UTOPIA: Participatory Design from Scandinavia to the World. In *History of Nordic Computing* 3, John Impagliazzo, Per Lundin, and Benkt Wangler (Eds.). Springer Berlin Heidelberg, Berlin, Heidelberg, 176–186.
- [82] Maria Tomprou and Min Kyung Lee. 2022. Employment relationships in algorithmic management: A psychological contract perspective. *Computers in Human Behavior* 126 (Jan. 2022), 106997. <https://doi.org/10.1016/j.chb.2021.106997>
- [83] Emily Tseng, Fabian Okeke, Madeline Sterling, and Nicola Dell. 2020. "We Can Learn. Why Not?": Designing Technologies to Engender Equity for Home Health Aides. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) (CHI '20). Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3313831.3376633>
- [84] Aarni Tuomi, Mário Passos Ascensão, and Brana Jianu. 2022. Algorithmic management grows more common among service businesses. <https://signals.fi/en/category-en/service/algorithmic-management-grows-more-common-among-service-businesses/>
- [85] Charlotte Franziska Unruh, Charlotte Haid, Fottner Johannes, and Tim Bütte. 2022. Human Autonomy in Algorithmic Management. In *Proceedings of the 2022 AAAI/ACM Conference on AI, Ethics, and Society (AI/ES '22)*. Association for Computing Machinery, New York, NY, USA, 753–762. <https://doi.org/10.1145/3514094.3534168>
- [86] U.S. Bureau of Labor Statistics. 2000. Job Openings: Accommodation and Food Services. <https://fred.stlouisfed.org/series/JTS7200JOL> Publisher: FRED, Federal Reserve Bank of St. Louis.
- [87] Ahmet Vatan and Seden Dogan. 2021. What do hotel employees think about service robots? A qualitative study in Turkey. *Tourism Management Perspectives* 37 (Jan. 2021), 100775. <https://doi.org/10.1016/j.tmp.2020.100775>
- [88] DAVID WEIL. 2014. *The Fissured Workplace*. Harvard University Press. <http://www.jstor.org/stable/j.ctt6wppdw>
- [89] Caitlin Woods, Mark A Griffin, Melinda Hodkiewicz, and Tim French. 2021. Digitisation of maintenance work management - a work design perspective: Lessons Learned in an Industry Study. In *33rd Australian Conference on Human-Computer Interaction*. ACM, Melbourne VIC Australia, 159–164. <https://doi.org/10.1145/3520495.3520526>
- [90] Nur Yildirim, Alex Kass, Teresa Tung, Connor Upton, Donnacha Costello, Robert Giusti, Sinem Lacin, Sara Lovic, James M O'Neill, Rudi O'Reilly Meehan, Eoin Ó Loideáin, Azzurra Pini, Medb Corcoran, Jeremiah Hayes, Diarmuid J Cahalane, Gaurav Shivhare, Luigi Castoro, Giovanni Caruso, Changhoon Oh, James McCann, Jodi Forlizzi, and John Zimmerman. 2022. How Experienced Designers of Enterprise Applications Engage AI as a Design Material. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. Association for Computing Machinery, New York, NY, USA, 1–13. <https://doi.org/10.1145/3491102.3517491>
- [91] Nima Zargham, Michael Bonfert, Robert Porzel, Tanja Doring, and Rainer Malaka. 2022. Multi-Agent Voice Assistants: An Investigation Of User Experience. In *Proceedings of the 20th International Conference on Mobile and Ubiquitous Multimedia (Leuven, Belgium) (MUM '21)*. Association for Computing Machinery, New York, NY, USA, 98–107. <https://doi.org/10.1145/3490632.3490662>
- [92] Angie Zhang, Alexander Boltz, Chun Wei Wang, and Min Kyung Lee. 2022. Algorithmic Management Reimagined For Workers and By Workers: Centering Worker Well-Being in Gig Work. In *CHI Conference on Human Factors in Computing Systems*. ACM, New Orleans LA USA, 1–20. <https://doi.org/10.1145/3491102.3501866>
- [93] Kathryn Zickuhr. [n.d.]. Workplace surveillance is becoming the new normal for U.S. workers. <https://equitablegrowth.org/research-paper/workplace-surveillance-is-becoming-the-new-normal-for-u-s-workers/>

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