



Charting the Automation of Hospitality: An Interdisciplinary Literature Review Examining the Evolution of Frontline Service Work in the Face of Algorithmic Management

FRANCESCA SPEKTOR, Carnegie Mellon University, USA

SARAH E. FOX, Carnegie Mellon University, USA

EZRA AWUMEY, Carnegie Mellon University, USA

BEN BEGLEITER, UNITE HERE, USA

CHINMAY KULKARNI, Emory University, USA

BETSY STRINGAM, New Mexico State University, USA

CHRISTINE A. RIORDAN, University of Illinois at Urbana-Champaign, USA

HYE JIN RHO, Michigan State University, USA

HUNTER AKRIDGE, Emory University, USA

JODI FORLIZZI, Carnegie Mellon University, USA

Recent investments in automation and AI are reshaping the hospitality sector. Driven by social and economic forces affecting service delivery, these new technologies have transformed the labor that acts as the backbone to the industry—namely frontline service work performed by housekeepers, front desk staff, line cooks and others. We describe the context for recent technological adoption, with particular emphasis on algorithmic management applications. Through this work, we identify gaps in existing literature and highlight areas in need of further research in the domains of worker-centered technology development. Our analysis highlights how technologies such as algorithmic management shape roles and tasks in the high-touch service sector. We outline how harms produced through automation are often due to a lack of attention to non-management stakeholders. We then describe an opportunity space for researchers and practitioners to elicit worker participation at all stages of technology adoption, and offer methods for centering workers, increasing transparency, and accounting for the context of use through holistic implementation and training strategies.

CCS Concepts: • Human-centered computing → Human-computer interaction (HCI); Collaborative and social computing

Additional Key Words and Phrases: Algorithmic management, future of work, hospitality, service labor

ACM Reference format:

Francesca Spektor, Sarah E Fox, Ezra Awumey, Ben Begleiter, Chinmay Kulkarni, Betsy Stringam, Christine A. Riordan, Hye Jin Rho, Hunter Akridge, Jodi Forlizzi. 2023. Charting the Automation of Hospitality: An

Author's address: F. Spektor, Carnegie Mellon University, 5000 Forbes Ave, Pittsburgh, PA 15213. USA.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from Permissions@acm.org.

2573-0142/2023/April – Art 33

© Copyright is held by the owner/author(s). Publication rights licensed to ACM.

<https://doi.org/10.1145/3579466>

interdisciplinary literature review examining the evolution of frontline service work in the face of algorithmic management. *Proc. ACM Hum.-Comput. Interact.*, 7, CSCW1, Article 33 (April 2023), 19 pages, <https://doi.org/10.1145/33V7cscw033>

1 INTRODUCTION

Technology is slowly reshaping the hospitality industry. Throughout the last century, hotels and restaurants have explored many forms of technology to improve operations and reduce costs. As early as the 1990s, casinos in Atlantic City tested automated bartending machines to reduce labor and save money on liquor costs [75]. Today, the roles of workers within the hospitality sector are changing in unprecedented ways, moving from traditionally high-touch, face-to-face encounters to technologically-mediated interactions [89]. Labor experts predict technology has the potential to automate more tasks in hospitality than in any other industry. In the next 20-30 years, as many as 70% of tasks performed by hospitality workers are projected to be augmented or replaced by automation [74,23]. This trend has only accelerated amid global lockdowns and social distancing mandates brought about by the Covid-19 pandemic [22,65,78].

This paper examines one aspect of this vast landscape: the effects of algorithmic management (AM) tools, which have begun to transform the hospitality workers' roles in new ways. Technology developers and hoteliers emphasize the benefits of using AMs to improve guest service and streamline operations, thus increasing shareholder value [9,87]. Popularized by gig work platforms, AMs can now remotely supervise workers and enable automated or semi-automated decision-making [69]. In other industries, AMs along with other sensors and surveillance methods track workers' movement speed in warehouses, or rate driver performance through ride-share apps.

To date, the CSCW literature has tended to study algorithmic management in the context of the gig economy and platform workers [50,44,100]. However, there is relatively little research on how algorithmic management techniques have begun to influence the ways traditional service organizations manage their staff. Frontline service workers in sectors like hospitality comprise about a third of the overall workforce, with over 13 million employed in hospitality alone [116]. Understanding the impacts of AMs in traditional service contexts has important, transferable implications for millions of service workers in other sectors.

This literature review analyzes research and media coverage on the use of AMs for frontline hospitality workers. Here, we define frontline workers to mean hotel employees who are directly involved in providing guest services: food servers, front desk agents, bell attendants, housekeepers, and others. Technology adoption in these roles may disproportionately impact women, immigrants, and people of color, who occupy the majority of hospitality and service industry roles [104,112].

In the next sections, we introduce the context and structure of the hospitality industry. We surface concepts of worker voice from labor relations literature, studies from CSCW and hospitality management on technology used in frontline service, and methods for worker-centered participatory design. Using these lenses, we track a variety of perspectives in the literature to highlight valuable exploration areas for worker-centered research and co-developed technology. For example, we highlight how various effects of automation may not be inherent to technology alone, but depend on contextual factors such as management, rollout, and training. The extent and sufficiency of such rollout strategies, including ongoing training, have not been adequately studied.

The increasing speed of technology adoption presents an urgent need to anticipate, strategize around, and co-develop future technology with worker needs in mind. Our goal is to offer multidisciplinary perspectives on engaging hospitality workers throughout all aspects of technology design, development, and rollout. We identify opportunities to engage workers around data transparency, technological literacy, and property-specific factors. Finally, we highlight future research directions for how participatory design can level the playing field for workers as central stakeholders in technology development.

2 METHODOLOGY

We performed an interdisciplinary literature review resulting in 320 total papers, from which we synthesize our findings. Given the emergent and understudied nature of AI and AM in hospitality, there is limited empirical research about on-the-ground effects of these technologies specifically on workers. Drawing on sources across disciplines including CSCW, labor relations, organizational studies, and hospitality management affords a multi-faceted perspective. This literature review brings together these disparate approaches to build a shared empirical understanding. Our set of reviewed papers, cultivated through collaboration with academics and practitioners in various related disciplines, maps perspectives on the projected and realized role of algorithmic management in the hospitality industry [129,135]. This interdisciplinary method can be particularly useful in cases where the topic of study is emergent, and there is a need for triangulation of sources. It also helps to establish common ground among our team of designers, union representatives, and labor experts around the shifting meaning of “job quality” amid the rapidly changing context of hospitality.

We examined a wide range of material, including journal articles, books, conference proceedings, policy documents, trade publications, popular press articles, and industry reports. The primary criterion used for inclusion was if we believed the work engaged questions central to understanding automation in the hospitality industry, the inclusion of worker voice in the deployment and use of automation technology, and the factors influencing the acquisition of automation technology in the hospitality industry.

We initially reviewed 177 articles that reported on robotic automation, algorithmic technologies, and artificial intelligence within hospitality. We identified our corpus of sources through multiple stages. First, we ran a search on journal databases including the ACM Digital Library and Google Scholar for the following keywords: “algorithmic management,” “algorithmic decision making,” “human AI collaboration,” “automation,” “human-in-the-loop,” “robotic process automation,” “AI assistant,” “intelligent virtual assistant,” and “virtual agent.” We next consulted with a hospitality expert for literature that was specifically focused on technology within the hospitality industry, which yielded 60 additional papers. This included material examining automation in hotels and representing the interests and concerns of the hoteliers and technology creators, including academic articles, theories of consumer acceptance and behavior, theories of organizational behavior, reports on technology automation, and industry trade press. We consulted with union research analysts to collect 83 additional sources relating to union bargaining, trade press, and the changing nature of work.

Our search ultimately resulted in 320 papers, from which we completed several additional rounds of omissions as we iteratively discussed them in our research meetings, with a goal of refining our scope. We omitted certain types of technologically-enhanced work, such as papers on=co-robots, and robotic process automation. We retained a focus on algorithmic management in traditional hospitality service. We also omitted sources on gig work and crowdwork, as these

are less relevant to the employment structures in hospitality. This allowed us to collect papers that addressed automation for workers who are classified as employees. We also excluded research on virtual assistants and chatbots, as the interface of these technologies with algorithmic managers is in initial stages and was therefore not a part of this study.

This process achieved a narrower focus on the intersection of algorithmic management, worker voice, and technology adoption factors in hospitality. We proceeded to examine papers thematically to draw out knowledge along several layers of analysis [16]. We first analyzed our data for whether the technologies discussed were nascent or widespread, and what, if any, adoption processes were reported. Our second stage of analysis focused on how workers' roles, tasks, and relationships were affected by AMs. Here, we strove to classify the unique impacts of algorithmic management on frontline workers, as opposed to guest services or business outcomes. Lastly, we refined our analysis towards understanding the extent to which worker voice is represented in adoption.

3 THE CONTEXT OF THE HOSPITALITY INDUSTRY

3.1 Structure of the hotel industry

The structure of the hotel industry is complex. Once an industry composed of all independent organizations, the hotel industry now has many formats of ownership, management and chain affiliation. Generally, hotels and hotel companies fall into the following categories (or combinations thereof) [97]: 1) Independently owned and operated hotels; 2) Hotels that are independently owned and operated but have a brand affiliation; 3) Hotels that are independently owned but are managed or operated by a management company which may or may not have a brand affiliation; 4) Chain-owned and managed hotels; and 5) Hotels belonging to referral groups or consortiums. For example, an independently owned hotel may have a management contract with a small regional company in addition to a brand affiliation with an international hotel chain. Many large international hotel chains engage in both management contracts and brand affiliations, further complicating the structure [97]. Research suggests that fragmented, or "fissured" [107], organizational structures can impact work-related outcomes such as wages, job quality, and compliance of labor standards [10,11,26,35,45].

The fragmented nature of hotel structure, coupled with various management contracts and franchise agreements, has proven to be an especially complicating factor for the uniform adoption of technology [24,98]. For instance, while larger companies have more resources to research and test new technologies, decision-making stakeholders like owners and management companies rapidly multiply. In contrast, a smaller company may have more flexibility to implement tech [24,97]. Studies have shown that smaller independently-owned hotels had lower investments in their human resource operations and systems than larger company owned hotels [57].

These examples show how organizational structures change what resources and hurdles surface throughout technology adoption. Technology advances will also facilitate changes in organizational structure [56]. Specifically, hospitality organizations will need to develop new management strategies for technology implementation to be effective and sustainable [7]. Hotels that lack resources for external training, for example, may want to invest more carefully in peer-to-peer training protocols and incentives.

3.2 Technologies currently used in hospitality

Until recently, the adoption of automation technology in the hospitality industry has moved slowly. The current space of automation in hospitality can be classified in terms of a few functional impacts on hospitality workers: physical assistance, collaboration, and management.

Physical assistance takes the form of robots and co-robots that perform functions including human recognition, autonomy, learning, perception, and action. Some hotels are testing robots to meet and greet guests, perform cleaning tasks, assist in security surveillance, and transport and deliver products and services. The use of food delivery robots in particular is expanding food service in hotels, on college and business campuses, and throughout communities. One food delivery robot used in hotel restaurants makes use of LiDAR technology developed in autonomous vehicles to carry food and drinks from the kitchen to the table [30,77]. During the pandemic, hotels also adopted cleaning robots for repetitive cleaning of high contact surfaces [115].

Collaboration technologies include chatbots and remote ambulatory devices equipped with displays to enable video chat and conferencing. They can also include mobile ordering and mobile check-in, which are becoming ubiquitous across hotel properties [63]. These tools offer new ways to serve customers, and offer better coordination across facilities and contexts such as expansive hotel and casino properties.

In this literature review, we focus our findings on algorithmic management technologies, which are widely used in hotel properties. They are used to forecast and keep track of demand, inventory, employee tasks, and hotel-wide operations; to manage reservation and revenue management, and to manage inventory [97]. Other AMs track foods, linens, and other goods throughout the hotel property with the goal of streamlining operations [97]. These management technologies apply simple artificial intelligence, including monitoring, predictive analytics, advanced decision-support, next-best action recommendations, and CRM systems to automate portions of business processes. Because they require little technical overhead, they have achieved a strong foothold across the hotel industry. AMs are also in use in retail, health care, transportation, and logistics work [69,50,64]. Given the cost cutting pressures of the pandemic and subsequent rise in labor costs, AMs will likely feature even more prominently across industries. In this paper, we focus on AMs in the hospitality industry, with the understanding that our results will be generalizable to other high-touch service sectors.

3.3 Impacts of the pandemic

COVID-19 quarantine and social distancing mandates have had widespread impacts on hospitality. Most hotels and restaurants were closed during the initial stages of the pandemic. When they opened once more, it was under limited occupancy, resulting in layoffs for the majority of workers. This rapid reconfiguration created an opportunity to reorganize basic hospitality operations. For example, in March of 2020, a number of hoteliers began making structural changes in their workforce, implementing new data tracking protocols and rapidly deploying automation technology [87]. In the hospitality industry, the pandemic created the opportunity for contactless service, which accelerated mobile check-in and online ordering while reducing human contact. The varied impacts of the pandemic resulted in staff reductions and redeployment of the remaining workers and management across the property. This trend continues even as the effects of the pandemic on hospitality are waning [46]. Hotel chains such as Marriott, Hyatt, and Hilton, which opted for contactless check-in during the pandemic, have now replaced some front desk staff with “ambassadors” to help guests with digital kiosks [63]. At

the beginning of the pandemic, guests often requested no housekeeping service to minimize exposure to the virus. Hotels moved to on-demand digital requests for room cleaning which dramatically reduced both daily cleanings and housekeeping staff hours [79,83]. These changes to cleaning schedules led to an increased use of algorithmic management software in housekeeping, which hotels are continuing to adopt [38,63].

According to US Labor Department data, the hospitality industry has additionally been one of the industries most impacted by the great resignation [118,103]. Some hospitality workers used the period of business closures to transition to other industries [3,90]. Hotels and restaurants report that they are now unable to find enough employees to operate their business at full capacity. In response to increasing labor shortages, many hotels are exploring how technology can help them to fill the gap [82,117,117]. Some hospitality businesses that had planned to implement automation in the near future also utilized these periods of low occupancy and closure to implement and test new systems.

4 IMPACT OF TECHNOLOGY ON HOSPITALITY WORK

A vast literature within the CSCW and adjacent communities attempts to study and assess the impacts of technology on the future of work. Research has explored how the advent of new technologies are changing workers' roles, tasks, and workflows in domains ranging from call centers to snow removal [8,12,29,34,88,96,101]. Various interpretations of automation technology and its development generally fit into three different categories: optimistic, pessimistic, and more nuanced views [9]. What differentiates optimistic and pessimistic approaches from more nuanced ones is their flavor of technological determinism, where technology is considered a dominant force in structuring social change [111,67]. While they share a belief in the capacity of technologies to automate jobs, they differ in the potential for human agency to impact the speed of change.

Optimistic approaches tend to assert that human and machine capabilities are most productively harnessed by designing systems in which humans and machines function collaboratively based on their individual strengths and limitations [36]. Optimistic perspectives tend to focus on employer benefits, highlighting the successes of technology development towards better resource utilization, an increase in efficiency, and labor savings [28,43,42]. This line of thinking predicts that while automating work will reduce the human workforce, remaining jobs will increase in efficiency with the introduction of new technologies and some new jobs will be created [17]. The general thesis is that automation presents employees with exciting new opportunities to upgrade relevant skills for their future employment viability [66,31,108].

A pessimistic perspective, on the other hand, points to the negative impacts of technology and the threat of a "jobless future" [32]. These impacts may include worker displacement and job elimination in the face of automation, as well as historical inequalities for workers along axes of race, gender, education, and geography [1]. In this line of thinking, it is not always possible to optimize worker-technology collaboration toward mutually beneficial ends. For example, reports of algorithmically-enforced work intensification for Amazon warehouse workers and call center representatives paint a sobering picture of the often antagonistic relationship workers have with automation technology [27,4].

A third, more nuanced perspective identifies opportunities to better understand how technology will come to effect social change. This perspective illuminates a future in which technology may either fully automate some jobs, augment jobs to shore up human inefficiencies, or else fail to deliver on its promised functionality entirely [9,68,73,81]. For example, Acemoglu

& Restrepo's concept of "so-so" automation describes technology that is not sufficient enough to help workers in their jobs or customers in their service experience, but is adopted nonetheless to save on labor expenditures [1]. This perspective makes clear that not enough is known to predict whether labor-replacing automation technology may create new opportunities for improved service or job quality [27,4,50].

Current literature lags behind the implementation of automation technologies and how they have transformed the workforce [50]. Our exploration of these themes is particularly motivated by Kellogg et al., which highlights the lack of empirical data in the future of work literature, especially from existing versus experimental technologies; and a need for nuanced evaluations of technology that yield richer data on the experiences of workers as crucial stakeholders [50]. Even existing empirical results from service automation studies differ significantly between sectors, revealing little consensus on the potential long-term success of new technologies [86]. This suggests the importance of further research sensitive to specific context-dependent social, economic, and technological factors.

4.1 Engaging workers in technology development

There is a rich literature on worker participation as an essential component to maintaining job quality in CSCW. While the labor economics literature originally focused on wages and benefits in evaluating job quality, recent definitions of job quality are more expansive. Job quality entails both tangible and intangible characteristics, including health and safety standards, work-life balance, and access to meaning, purpose, and dignity at work [75].

A central opportunity for increasing pride, dignity, and meaning-making at work rests on incorporating greater employee participation [40]. Participation can be understood as workers having input, whether formally through management practices or unions, or informally through conversations with supervisors, into decisions [18]. Such input has traditionally governed improved job quality and organizational performance [64]. In practice, however, workers' participation in technological change is often hampered by lack of access to mechanisms for input [52]. This leads to situations in which workers must accommodate technologies that are poorly suited to their needs, leading to decreased job quality [18,53,64].

To increase worker participation in the design and deployment of workplace technologies, CSCW scholars have drawn on participatory design (PD) methods—the process of enlisting users in the development of technologies to better support their interests. Participatory design originated in the Scandinavian workplace democracy movement during the 1960s and 70s. Rooted in democratic ideals, PD held that workers should have a meaningful stake in designing the tools and processes of their everyday working conditions [49,110]. Early approaches explicitly centered workers and were directly sought out by labor unions to co-design worker-centered technologies. As these methods migrated to the US, they were refocused on questions of usability, workplace efficiency, and customer-facing success. The Scandinavian model emphatically rejected efficiency as a goal, recognizing that it often translates to the intensification of work and deskilling [93]. The evolution of PD in the US may be attributed to a political and economic context of relatively low unionization rates in comparison with other industrialized countries [119].

The PD process allows multiple stakeholders to weigh in on the decision-making process around technology design, rollout, and implementation. Scholars emphasize that decision-making in the design process necessitates more than surface participation—it means having a real say in design outcomes [15] [6]. This participation can take many forms such as workshops to capture day-to-day accounts of work [47]; or working with advocacy groups and unions [120]. Similarly,

Calacci calls for “co-research,” which involves mutual agenda-setting and data sharing agreements to elevate workers from research subjects to fellow researchers and designers [19]. These practices help to level the playing field between workers and other stakeholders and developers who contribute to technology adoption. We continue to draw on these methods in our discussion to offer nuanced approaches towards worker-centered technology adoption in hospitality.

5 ALGORITHMIC MANAGEMENT AND SERVICE WORK

Early research on service encounters focused on face-to-face interactions between a customer and a service provider guided by specific behaviors and responses [92,98]. In contrast, hospitality service has become increasingly technology-mediated; workers now interact with a wide range of interrelated platforms delivered by various in-house and external providers [89,58]. AMs are shifting service roles, affecting both workers and managers. In high-touch service delivery, it is typically not the case that jobs are entirely eradicated or created from scratch. The ebb and flow of tasks between workers and AMs is reshaping job design [9].

Human Computer Interaction (HCI) and CSCW scholars studying technology deployment for service delivery note the fluid creation and adoption of new tasks, new workflows, and new job titles [60] [7,6,91]. Some frontline service roles are being eliminated as AMs are put in place, while others are created or redesigned. Other research identifies how workers respond to technology adoption by taking on emergent roles as technology advocates or enablers, supporting coworkers through points of tension and facilitating acceptance of AMs in their workplaces [58]. These emergent positions show that frontline workers are intimately familiar with the articulation work required to interface across systems, roles, and expectations to deliver guest satisfaction [94]. Making guests feel properly taken care of and at ease is a core part of this service work [37]. The sociology of work identifies this nexus of tasks and service skills as emotional labor, which is also frequently used as a heuristic in the hospitality management literature [59,39]. Emotional labor is a form of critical but invisible work that involves making the guest welcome, important, and at ease. Frontline workers may even help guests recover from frustration during points of stress or friction [95,80]. Interacting with guests can be a source of dignity and pride for housekeepers; smiling, chatting, and taking care of the guests they serve is often cited as the most meaningful part of the job [75].

To be successful, AMs must take the social and emotional aspects of service work into account. A housekeeping algorithmic manager optimized for efficiency may reduce the time housekeepers can spend on meaningful service tasks. By rationalizing their work as a series of cleaning tasks on a digital checklist, for instance, AMs undermine their capacity to deliver personalized service. As housekeepers service the rooms of long-term guests, they learn the preferences of the guest to deliver more personalized service, increasing the value of the hotel to the guest. An AM which assigns this room to different housekeepers each day may negate the personalized service and value of this service to the guest, while also reducing job satisfaction to the housekeeper. This may render their work more invisible, regardless of the intent. In contrast, an AM which is well designed and implemented could match long term or repeat guests with the same service worker, helping to deliver a more personalized service, thereby increasing both guest and employee satisfaction. This example illustrates how technological transformations are being layered upon existing service roles that are by definition unpredictable and ambiguous [14]. More empirical research is needed to understand how technology can best account for the important emotional work performed by workers.

Many scholars agree that the current literature on the use of AMs in service is still in its infancy [50,55,102,109]. As a result of this gap, the literature may not adequately capture the ways in which this form of automation is impacting workers' wellbeing. In the next section, we examine AMs effect on invisible work and effect on relationships between workers and managers. Many of the impacts of automation are not necessarily inherent to technology itself, but instead stem from a combination of the technology, deployment, training, economic pressures, and lack of worker involvement during all of these stages.

5.1 Ensuring worker wellbeing in the face of algorithmic management

In a comprehensive 2020 literature review on algorithmic forms of control in the workplace, Kellogg et al. detail unique affordances of algorithmic management technologies [50]. The authors track six main mechanisms through which employers can direct workers by "restricting and recommending," evaluate workers by "recording and rating," and discipline workers by "replacing and rewarding" [ibid]. In light of Kellogg et al's critical assessment, we draw on the framework of the "6 Rs" to consider how the current and projected impacts of algorithms can best support hospitality employee's work and wellbeing.

Restricting and recommending. Through clear and configurable recommendations, algorithmic managers can help workers document tasks and decrease confusion. However, algorithmic recommendations may also be unintelligible to workers who lack technology literacy or comprehensive training [42]. In informal observations, housekeepers at some properties report benefiting from being able to see all their room assignments on one dynamic screen, as opposed to a shuffle of papers. In other properties, housekeepers felt that the software instead presented a more complicated view, which they were not able to match as closely to their preferred workflow. Additional training would have allowed housekeepers and housekeeping managers to work together to re-configure this algorithm's settings, which are capable of accommodating various workflows. In this instance, further exploration of the user experience (UX) and design may also recommend a simpler screen or the use of a different device to benefit non-technical users. This case shows that even for configurable technologies, the success of an algorithm is highly dependent on its implementation, configuration within a property, and ease of use.

There are also occasions when system recommendations may be at odds with a worker's goals and performance. Due to the nature of high touch service work, workers may require the capacity to override a management system in order to achieve the highest guest satisfaction. For instance, if workers are evaluated on the speed of a task, such as guest check-in, this may be at odds with their ability to provide a personalized guest experience for a guest who needs a little more time and attention. Service is a complex process which does not always follow parameters of AM recommendations. Fluid integration of human and algorithmic decision making requires alignment between optimization conditions and worker goals. Where this is not possible, workers may create workarounds to provide the best service for their guests [54].

Recording and rating. Algorithmic recording utilizes computational procedures to aggregate an enormous amount of real-time data from employees and customers. Though surveillance can often be detrimental for workers, the hospitality industry has succeeded in developing several tools which help keep workers safe and extend opportunities for support. Among these are panic buttons for housekeepers, GPS-enabled devices which a housekeeper activates if they are feeling unsafe. The button emits a beacon which alerts security to the housekeeper's whereabouts. Panic

buttons are a widely celebrated safety tool for housekeepers, and represent a hard-won success of union / hotel partnerships [71]. Traditionally, housekeeping managers are motivated to expedite their staff's work, help with difficulties, and be present in hotel corridors to anticipate needs. Tracking worker assignments and locations remotely extends these opportunities for collaboration and support between housekeepers and housekeeping managers. As an example, a housekeeper who is taking more time than expected to clean a room may have additional training needs, be short of necessary supplies, or have encountered a room that was trashed by the previous guests. Tracking worker time in location would alert management or supervisory attention to more quickly decipher needs and to assist this housekeeper. Both panic buttons and management tools depend on consensual relationships with workers, and both represent instances where humans, not algorithms, control how data is used.

When paired with surveillance practices, algorithms can also be used to provide ratings of hospitality workers in customer-facing roles. Increased visibility in the hospitality sector allows managers to more readily recognize and reward high performing staff [70]. However, evidence from gig workers suggests potential harms from recording and ratings that may translate to hospitality workers. Many gig workers depend on maintaining near perfect ratings to maintain revenue streams, increasing their precarity [85]. Hotels as a whole are often under similar guest rating expectations. Dependence on customer ratings may also amplify customer racial and gender bias [84]. To ensure that numerical ratings alone cannot discipline and replace workers, or else cause workers with high ratings to legitimize unfair conditions for others, human oversight remains essential [27,61,50].

Replacing and rewarding. Algorithmic replacing has been used in other industries to automatically fire workers who have failed to meet an algorithmically enforced benchmark [50]. There is little precedent of algorithmic firing in the hospitality industry to date, which consists mostly of human-managed hourly labor. However, combined with incentives to decrease employment liability through outsourcing, the “gig-ification” of the workplace is accelerating [51,99,105,106].

Under pressures from the labor shortage, there are opportunities for the hospitality industry to instead retain their regular workers by recognizing and rewarding staff. Kellogg et al note that algorithmically structured, gamified rewards may stretch workers past their capacity. In hospitality, merit bonuses could be similarly abused. For this reason, “reward structures” could instead be employed on a daily basis to make workers’ jobs safer and more sustainable. Housekeeping is a physically taxing job with one of the highest injury rates in hospitality [114,62]. There are several ways algorithmic managers could ensure that the tasks that housekeepers are assigned are balanced so that their work is not as physically onerous. By alternating the more strenuous check-out rooms with the less strenuous stayover rooms, it seems possible that algorithmic managers could make the job safer and more sustainable. Housekeeper’s carts may weigh over 200lbs and require significant effort to push. Algorithmic room assignments could reduce travel between rooms, or schedule the last room before lunch to be closest to the break room in order to optimize time while reducing fatigue and injury. This functionality could be developed alongside workers to account for their voice and wellbeing.

6 DISCUSSION

In this paper, we have explored technological change in high touch, face-to-face service work, and specifically AMs used in hospitality work. The hospitality industry is composed largely of

women of lower socioeconomic status, and in some cases, immigrant workers. It is these service workers who are on the frontlines of increasingly widespread technological changes. We surface a number of factors that have influenced technology adoption in this sector: changes to labor and work which were brought on by the pandemic, the rise of contactless service, and complex franchising structures have all played a role in how automation technologies have come to affect hospitality frontline workers [21,38]. Allowing workers to participate in the design, deployment and continuous refinement of these systems will help maintain role autonomy and workplace protections; create new, meaningful roles for hospitality workers; and make work safer and more sustainable for workers.

We identify opportunity areas for new participatory design, research and development in the hospitality industry. We believe that these concepts are not only applicable to hospitality, but could also inform shifts in parallel industries such as retail, caregiving, and other high touch services.

6.1 Participatory approaches for design, deployment, and iteration

The interests of frontline workers, managers, guests, hoteliers, vendors, and developers should all be considered when new technologies are developed for the workplace. Further complicated by franchising structures, these new technologies may advantage different stakeholders unevenly; amidst these various actors, considerations for how frontline staff like housekeepers engage with systems are often left for last. One idea to engage the needs of stakeholders evenly is to leverage PD methods to take into account new and evolving work shaped by emergent technology [2,6,13]. Beyond attuning or tweaking new systems, this shift would mean assuming a radically different process of technology development: one first focused on the needs and aspirations of frontline staff.

Taking a worker-centered approach to design would hinge upon the ability of designers and technologists to shift their practical focus away from valuing efficiency or cost reduction as a design goal, to instead supporting the requirements articulated by frontline service workers themselves [33]. Additional research can determine whether focusing on the needs of workers leads to better outcomes for other stakeholders in the complex ecology of hotel ownership, management, and branding.

One key method for ensuring equitable participation is to open channels for worker feedback at all points in the technology adoption timeline. Research has noted that implications of technology are shaped top down by designers' and promulgators' own visions of work. While the input of operations managers may be a part of the design process, it rarely includes insight from actual workers [5]. To ensure we build toward a more equitable future of work, we argue for leveraging participatory methods not only during the design and development stages, but also throughout the rollout and iteration of new technologies.

6.1.1 Using participatory techniques before deployment

Participatory design methods can be used to understand the needs of stakeholders early on in the design and development process. They can be used to prototype visions of the future that allow workers to make sense of technologies that may not yet exist, or for which there are no social norms. For example, speed dating and user enactments are PD methods that allow stakeholders to sample the future in the form of demonstrational prototypes, before any resources are committed to actually building the technology [113]. After generating concepts for different

futures, these methodologies offer workers a series of samples that allow them to imaginatively experience possible futures, one after the other. By offering a landscape of possibilities, this method can surface norms and social boundaries, and help to bring participants' latent needs or desires to the surface.

PD methods could also help workers express concrete preferences around existing technologies before they are rolled out. The elicitation of pairwise scenarios is another participatory method that enables workers to build on their own wellbeing models [72]. In an applied case study with algorithmic scheduling, pairwise elicitation reportedly helped participants discover their own schedule preferences for the very first time [ibid]. PD methods could help to consider workers preferences in technology configurations, such as allowing algorithmic housekeeping managers to assign housekeepers to consistent stations. Expanding these concepts to include the frontline worker could bring valuable insight early in the development process, while also accounting for worker wellbeing.

6.1.2 Building participatory tools to support transparent deployment procedures

By drawing on these tactics, researchers can develop participatory methods that improve increase data transparency and help workers understand what kind of data is being collected about them [25]. Tools that leverage data toward new models of self-tracking include WeClock, a worker-cooperative led product that helps account for invisible labor, skipped breaks, and overtime [19]. Similarly, the Shipt Calculator was designed with co-workers and advocates to help increase wage transparency in platform work [20]. Exemplified by tools like WeClock and Shipt, participatory methods offer large promise for involving workers in shaping the ideologies behind workplace technologies.

Co-developed tools could serve as an important first step towards training and technological literacy for workers and managers. Participatory methods can help identify training needs, bridge gaps in expertise, and develop appropriate training procedures with workers—and particularly with managers. Participatory design methods might additionally offer scenarios with basic information about current and future technologies to ensure that workers are not blindsighted by technology rollout. This is particularly helpful for independent hoteliers who comprise more than half of hotels worldwide.

We also consider how and if PD approaches may help increase the power of workers as research stakeholders. As we have previously shared, examples of these strategies could include organizing data sharing agreements with workers as co-researchers and partnering directly with labor unions and existing advocacy groups to gain meaningful insights into worker needs [19] [20].

6.1.3 Cultivating methods for on-going evaluation and iteration

Finally, PD methods could be used after technology has been deployed in the workplace. Workers could be given mechanisms to provide meaningful feedback and recommendations without fear of penalty when evaluating new technology, and the accompanying implementation and ongoing training processes. It is likely that an ideal solution won't arise on the first try, but could instead be reached through continual iteration with workers. The success of automation technologies is not solitary, but depends on its interface with the technologies, resources, and social arrangements already in place. Participatory design mechanisms could surface these various infrastructural practices, such as contracts, tacit conversations, and cultural codes [48].

In hospitality settings, this would be an excellent mechanism to account for the contextual variation between properties. For example, PD sessions post-deployment could help explain the workarounds developed by housekeepers in response to unconfigurable algorithms. In addition to increasing productivity on workers' terms, these methods can catch instances of "everyday breakdown," repair, and adaptation, helping workers keep up with malfunction or attend to a property's unique requirements [41]. In turn, understanding property-specific requirements helps develop technology and institutional policy that are not only better-suited to a hotel context, but also reduce worker turnover. We argue for continuing research on how to recuperate accounts of workers' hidden labor in these areas, which includes valuable time and attention spent devising workarounds for guest service needs and mismatched technology [47,100].

Future PD efforts in this space will explore if these methods might be extended to address different views of frontline workers, managers, and other stakeholders. More research is needed to understand how and if PD approaches may prioritize workers as critical partners in technology design, development, and adoption. These nuances are particularly critical in low-wage work contexts with multiple stakeholders, such as the hospitality industry. In the face of unprecedented technological change, developing methods to attend equitably to worker voice will improve worker wellbeing in service roles across industries.

7 CONCLUSION

This paper presented a literature review focusing on algorithmic managers in the hospitality industry. Our goal is to understand the current research landscape, and to deepen the community's understanding of how these innovations might transform, shift, add, or eliminate worker roles. Our review revealed that this is an underexplored area, and in particular, that opportunities exist to more deeply involve workers in the design and implementation of algorithmic management systems in hospitality settings. We identify opportunities to increase worker participation in all stages of design and use of these future technologies. Additionally, we hope that future research will explore participatory design methods to increase worker wellbeing and decrease turnover. Finally, we want to assert the importance of design in developing particular ecologies around automation in the hospitality industry. Solutions will differ based on context, organization, worker, task and workflow; this difference will only be magnified in hospitality contexts with varied ownership, management, and branding. Research and development in this area will carry the intent to first develop the 'ultimate particular' [76], then to move towards the general and the universal.

ACKNOWLEDGMENTS

This work was partially funded by NSF 2128954, NSF 2208835, and CMU's Block Center.

REFERENCES

- [1] Daron Acemoglu and Pascual Restrepo. 2019. Automation and New Tasks: How Technology Displaces and Reinstates Labor. *Journal of Economic Perspectives* 33, 2: 3–30. <https://doi.org/10.1257/jep.33.2.3>
- [2] Peter M. Asaro. 2000. Transforming society by transforming technology: the science and politics of participatory design. *Accounting, Management and Information Technologies* 10, 4: 257–290. [https://doi.org/10.1016/S0959-8022\(00\)00004-7](https://doi.org/10.1016/S0959-8022(00)00004-7)
- [3] Katie Bach and Bach Kinder. 2021. Is your business struggling with the labor shortage? Consider a union. *Brookings*. Retrieved June 27, 2022 from <https://www.brookings.edu/blog/the-avenue/2021/12/14/is-your-business-struggling-with-the-labor-shortage-consider-a-union/>

[4] Verena Bader and Stephan Kaiser. 2019. Algorithmic decision-making? The user interface and its role for human involvement in decisions supported by artificial intelligence. *Organization* 26, 5: 655–672. <https://doi.org/10.1177/1350508419855714>

[6] Diane E. Bailey and Stephen R. Barley. 2020. Beyond design and use: How scholars should study intelligent technologies. *Information and Organization* 30, 2: 100286. <https://doi.org/10.1016/j.infoandorg.2019.100286>

[7] Sergio Barile, Mara Grimaldi, Francesca Loia, and Carlo Alessandro Sirianni. 2020. Technology, Value Co-Creation and Innovation in Service Ecosystems: Toward Sustainable Co-Innovation. *Sustainability* 12, 7: 2759. <https://doi.org/10.3390/su12072759>

[8] Stephen R. Barley. 1990. Images of Imaging: Notes on Doing Longitudinal Field Work. *Organization Science* 1, 3: 220–247. <https://doi.org/10.1287/orsc.1.3.220>

[9] Stephen R. Barley. 2020. Work and technological change. Oxford University Press, Oxford.

[10] Rosemary Batt and Hiroatsu Nohara. 2009. How Institutions and Business Strategies Affect Wages: A Cross-National Study of Call Centers. *ILR Review* 62, 4: 533–552. <https://doi.org/10.1177/001979390906200404>

[11] Annette Bernhardt, Susan Houseman, Rosemary Batt, and Eileen Appelbaum. 2016. Domestic Outsourcing in the United States: A Research Agenda to Assess Trends and Effects on Job Quality. W.E. Upjohn Institute. <https://doi.org/10.17848/wp16-253>

[12] Michele Bettinelli, Yuxiu Lei, Matt Beane, Caleb Mackey, and Timothy N. Liesching. 2015. Does Robotic Telerounding Enhance Nurse–Physician Collaboration Satisfaction About Care Decisions? *Telemedicine and e-Health* 21, 8: 637–643. <https://doi.org/10.1089/tmj.2014.0162>

[13] Susanne Bødker and Morten Kyng. 2018. Participatory Design that Matters—Facing the Big Issues. *ACM Transactions on Computer-Human Interaction* 25, 1: 1–31. <https://doi.org/10.1145/3152421>

[14] Bronwyn Boon. 2007. Working within the front-of-house/back-of-house boundary: Room attendants in the hotel guest room space. *Journal of Management & Organization* 13, 2: 160–174. <https://doi.org/10.5172/jmo.2007.13.2.160>

[15] Tone Bratteteig, Keld Bødker, Yvonne Dittrich, and Jesper Simonsen. 2013. Methods: Organising principles and general guidelines for Participatory Design projects. In *Routledge international handbook of participatory design*, Jesper Simonsen and Toni Robertson (eds.). Routledge, New York.

[16] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 2: 77–101. <https://doi.org/10.1191/1478088706qp063oa>

[17] Erik Brynjolfsson and Andrew McAfee. 2016. *The second machine age: work, progress, and prosperity in a time of brilliant technologies*. W. W. Norton & Company, New York London.

[18] John W. Budd. 2004. Employment with a human face: balancing efficiency, equity, and voice. ILR Press, Ithaca, NY.

[19] 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 (CHIWORK 2022), 1–9.

[20] Dan Calacci, Willy Solis, Drew Ambrogi, Venessa Bain, and Danny Spitzberg. 2022. Bargaining With The Black-Box: Designing and Deploying Worker-Centric Tools to Audit Algorithmic Management. In Association for Computing Machinery.

[21] Chun-Chu (Bamboo) Chen and Ming-Hsiang Chen. 2021. Well-being and career change intention: COVID-19's impact on unemployed and furloughed hospitality workers. *International Journal of Contemporary Hospitality Management* 33, 8: 2500–2520. <https://doi.org/10.1108/IJCHM-07-2020-0759>

[22] Alex Chernoff and Casey Warman. 2020. COVID-19 and Implications for Automation. National Bureau of Economic Research, Cambridge, MA. <https://doi.org/10.3386/w27249>

[23] Michael Chui, James Manyika, and Mehdi Miremadi. 2016. Where machines could replace humans—and where they can't (yet). *McKinsey Quarterly*. Retrieved July 12, 2022 from <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet>

[24] Liza M. Cobos, Cynthia Mejia, Ahmet Bulent Ozturk, and Youcheng Wang. 2016. A technology adoption and implementation process in an independent hotel chain. *International Journal of Hospitality Management* 57: 93–105. <https://doi.org/10.1016/j.ijhm.2016.06.005>

[25] Tawanna R. Dillahunt, Xinyi Wang, Earnest Wheeler, Hao Fei Cheng, Brent Hecht, and Haiyi Zhu. 2017. The Sharing Economy in Computing: A Systematic Literature Review. *Proceedings of the ACM on Human-Computer Interaction* 1, CSCW: 1–26. <https://doi.org/10.1145/3134673>

[26] Arindrajit Dube and Ethan Kaplan. 2010. Does Outsourcing Reduce Wages in the Low-Wage Service Occupations? Evidence from Janitors and Guards. *ILR Review* 63, 2: 287–306. <https://doi.org/10.1177/001979391006300206>

[27] Josh Dzieza. 2020. Robots aren't taking our jobs — they're becoming our bosses. *The Verge*. Retrieved June 27, 2022 from <https://www.theverge.com/2020/2/27/21155254/automation-robots-unemployment-jobs-vs-human-google-amazon>

[28] Philipp Ebel, Matthias Söllner, Jan Marco Leimeister, Kevin Crowston, and Gert-Jan de Vreede. 2021. Hybrid intelligence in business networks. *Electronic Markets* 31, 2: 313–318. <https://doi.org/10.1007/s12525-021-00481-4>

[29] Nicole B. Ellison, Jennifer L. Gibbs, and Matthew S. Weber. 2015. The Use of Enterprise Social Network Sites for Knowledge Sharing in Distributed Organizations: The Role of Organizational Affordances. *American Behavioral Scientist* 59, 1: 103–123. <https://doi.org/10.1177/0002764214540510>

[30] Lisa Fickenscher. 2022. Short-staffed hotels are hiring robots — and labor unions are pushing back. *New York Post*. Retrieved July 12, 2022 from <https://nypost.com/2022/07/03/short-staffed-hotels-are-hiring-robots-and-unions-are-pushing-back/>

[31] Jenny Fleming and Karsten E. Zegwaard. Methodologies, methods and ethical considerations for conducting research in work-integrated learning. *International Journal of Work-Integrated Learning* 19, Work-integrated learning research methodologies and methods: 205–213.

[32] Martin Ford. 2016. *Rise of the robots: technology and the threat of a jobless future*. Basic Books, New York.

[33] Sarah E. Fox, Vera Khovanskaya, Clara Crivellaro, Niloufar Salehi, Lynn Dombrowski, Chinmay Kulkarni, Lilly Irani, and Jodi Forlizzi. 2020. Worker-Centered Design: Expanding HCI Methods for Supporting Labor. In Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems, 1–8. <https://doi.org/10.1145/3334480.3375157>

[34] Carl Benedikt Frey and Michael A. Osborne. 2017. The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change* 114: 254–280. <https://doi.org/10.1016/j.techfore.2016.08.019>

[35] Fuel Travel Marketing. 2020. Fuel HITEC Showcase: Consumer Sentiment In a COVID-19 World: Why You Need a Mobile App. Retrieved June 27, 2022 from <https://www.youtube.com/watch?v=0j9h9ypM5J4>

[36] Jim Guszcza and Jeff Schwartz. 2019. Superminds: How humans and machines can work together. *Deloitte Review*, 24.

[37] Ian Hampson and Anne Junor. 2005. Invisible work, invisible skills: interactive customer service as articulation work. *New Technology, Work and Employment* 20, 2: 166–181. <https://doi.org/10.1111/j.1468-005X.2005.00151>

[38] Michael Heflin. 2022. Three hospitality trends to prepare for in 2022. *Hotel Business*. Retrieved June 27, 2022 from <https://hotelbusiness.com/three-hospitality-trends-to-prepare-for-in-2022/>

[39] Arlie Russel Hochschild. 2012. *The managed heart: commercialization of human feeling*. University of California Press, Berkeley, Calif. London.

[40] Randy Hodson. 2001. *Dignity at Work*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511499333>

[41] Lara Houston, Steven J. Jackson, Daniela K. Rosner, Syed Ishtiaque Ahmed, Meg Young, and Laewoo Kang. 2016. Values in Repair. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 1403–1414. <https://doi.org/10.1145/2858036.2858470>

[42] Ming-Hui Huang and Roland T. Rust. 2018. Artificial Intelligence in Service. *Journal of Service Research* 21, 2: 155–172. <https://doi.org/10.1177/1094670517752459>

[43] Stanislav Ivanov, Craig Webster, and Katerina Berezina. 2017. Adoption of robots and service automation by tourism and hospitality companies. *Turismo & Desenvolvimento* 27/28: 1501–1517.

[44] 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: 20539517211020332. <https://doi.org/10.1177/20539517211020332>

[45] MinWoong Ji and David Weil. 2015. The Impact of Franchising on Labor Standards Compliance. *ILR Review* 68, 5: 977–1006. <https://doi.org/10.1177/0019793915586384>

[46] Yangyang Jiang and Jun Wen. 2020. Effects of COVID-19 on hotel marketing and management: a perspective article. *International Journal of Contemporary Hospitality Management* 32, 8: 2563–2573. <https://doi.org/10.1108/IJCHM-03-2020-0237>

[47] Esther Y. Kang and Sarah E. Fox. 2022. Stories from the Frontline: Recuperating Essential Worker Accounts of AI Integration. In *Designing Interactive Systems Conference*, 58–70. <https://doi.org/10.1145/3532106.3533564>

[48] Helena Karasti and Jeanette Blomberg. 2018. Studying Infrastructuring Ethnographically. *Computer Supported Cooperative Work (CSCW)* 27, 2: 233–265. <https://doi.org/10.1007/s10606-017-9296-7>

[49] Michael Katell, Meg Young, Dharma Dailey, Bernease Herman, Vivian Guetler, Aaron Tam, Corinne Bintz, Daniella Raz, and P. M. Krafft. 2020. Toward Situated Interventions for Algorithmic Equity: Lessons from the Field. In *Proceedings of the 2020 Conference on Fairness, Accountability, and Transparency*, 45–55. <https://doi.org/10.1145/3351095.3372874>

[50] Katherine C. Kellogg, Melissa A. Valentine, and Angéle Christin. 2020. Algorithms at Work: The New Contested Terrain of Control. *Academy of Management Annals* 14, 1: 366–410. <https://doi.org/10.5465/annals.2018.0174>

[51] Aniket Kittur, Jeffrey V. Nickerson, Michael Bernstein, Elizabeth Gerber, Aaron Shaw, John Zimmerman, Matt Lease, and John Horton. 2013. The future of crowd work. In Proceedings of the 2013 conference on Computer supported cooperative work - CSCW '13, 1301. <https://doi.org/10.1145/2441776.2441923>

[52] Thomas Kochan. 2021. Worker Voice and Corporate Governance: Putting Words into Actions. *Vanderbilt Law Review* 74, 6: 1625–1643.

[53] Thomas A. Kochan, Duanyi Yang, William T. Kimball, and Erin L. Kelly. 2019. Worker Voice in America: Is There a Gap between What Workers Expect and What They Experience? *ILR Review* 72, 1: 3–38. <https://doi.org/10.1177/0019793918806250>

[54] Astrid Krenz, Klaus Prettner, and Holger Strulik. 2021. Robots, reshoring, and the lot of low-skilled workers. *European Economic Review* 136: 103744. <https://doi.org/10.1016/j.eurocorev.2021.103744>

[55] Lisa Kresge. 2020. Data and Algorithms in the Workplace: A Primer on New Technologies. UC Berkeley Labor Center. Retrieved July 12, 2022 from <https://laborcenter.berkeley.edu/working-paper-data-and-algorithms-in-the-workplace-a-primer-on-new-technologies/>

[56] Chun-Min Kuo, Li-Cheng Chen, and Chin-Yao Tseng. 2017. Investigating an innovative service with hospitality robots. *International Journal of Contemporary Hospitality Management* 29, 5: 1305–1321. <https://doi.org/10.1108/IJCHM-08-2015-0414>

[57] Tashlin Lakhani. 2022. How and Why Does Franchise Ownership Affect Human Resource Practices? Evidence from the US Hotel Industry. *ILR Review* 75, 2: 321–347. <https://doi.org/10.1177/0019793920972661>

[58] Bart Larivière, David Bowen, Tor W. Andreassen, Werner Kunz, Nancy J. Sirianni, Chris Voss, Nancy V. Wunderlich, and Arne De Keyser. 2017. “Service Encounter 2.0”: An investigation into the roles of technology, employees and customers. *Journal of Business Research* 79: 238–246. <https://doi.org/10.1016/j.jbusres.2017.03.008>

[59] Lindsey Lee and Juan M. Madera. 2019. A systematic literature review of emotional labor research from the hospitality and tourism literature. *International Journal of Contemporary Hospitality Management* 31, 7: 2808–2826. <https://doi.org/10.1108/IJCHM-05-2018-0395>

[60] Min Kyung Lee, Sara Kiesler, Jodi Forlizzi, and Paul Rybski. 2012. Ripple effects of an embedded social agent: a field study of a social robot in the workplace. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 695–704. <https://doi.org/10.1145/2207676.2207776>

[61] Min Kyung Lee, Daniel Kusbit, Evan Metsky, and Laura Dabbish. 2015. Working with Machines: The Impact of Algorithmic and Data-Driven Management on Human Workers. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 1603–1612. <https://doi.org/10.1145/2702123.2702548>

[62] Sirena Liladrie. 2010. ‘Do not disturb/please clean room’: hotel housekeepers in Greater Toronto. *Race & Class* 52, 1: 57–69. <https://doi.org/10.1177/0306396809354177>

[63] Christine Lin. 2021. Less Hassle, More to Explore: Marriott International Continues to Deliver on Consumer Desire for Enhanced Contactless Technology. *Marriott International Newscenter (US)*. Retrieved June 27, 2022 from <https://news.marriott.com/news/2021/04/05/less-hassle-more-to-explore-marriott-international-continues-to-deliver-on-consumer-desire-for-enhanced-contactless-technology>

[64] Adam Seth Litwin. 2011. Technological Change at Work: The Impact of Employee Involvement on the Effectiveness of Health Information Technology. *ILR Review* 64, 5: 863–888. <https://doi.org/10.1177/001979391106400502>

[65] Angus Loten. 2021. Workplace Automation Bots Gain Clout Amid Covid-19 Pandemic. *The Wall Street Journal*. Retrieved June 27, 2022 from <https://www.wsj.com/articles/workplace-automation-bots-gain-clout-amid-covid-19-pandemic-11632327480>

[66] Vinh Nhat Lu, Jochen Wirtz, Werner H. Kunz, Stefanie Paluch, Thorsten Gruber, Antje Martins, and Paul G. Patterson. 2020. Service robots, customers and service employees: what can we learn from the academic literature and where are the gaps? *Journal of Service Theory and Practice* 30, 3: 361–391. <https://doi.org/10.1108/JSTP-04-2019-0088>

[67] Paul Luff, Jon Hindmarsh, and Christian Heath (eds.). 2000. *Workplace Studies: Recovering Work Practice and Informing System Design*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511628122>

[68] John Markoff. 2016. *Machines of loving grace: the quest for common ground between humans and robots*. Ecco, New York.

[69] Alexandra Mateescu and Aiha Nguyen. 2019. Algorithmic Management in the Workplace. *Data & Society*. Retrieved from <https://datasociety.net/library/explainer-algorithmic-management-in-the-workplace/>

[70] Ben Matthews, Isaac Salisbury, Paul Schlosser, Francine Smith, and Penelope Sanderson. 2020. High Tempo Work: Design Challenges for Head-worn Displays in Quick Service Restaurants. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, 1–12. <https://doi.org/10.1145/3313831.3376200>

[71] Patrick McGeehan. 2012. City Hotel Workers to Be Issued Panic Buttons. The New York Times. Retrieved July 12, 2022 from <https://www.nytimes.com/2012/02/08/nyregion/city-hotel-workers-to-be-issued-panic-buttons.html?module=inline>

[72] 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. Retrieved July 14, 2022 from http://minlee.net/materials/Publication/2021_AIES-WorkerWellBeing.pdf

[73] David A. Mindell. 2015. Our robots, ourselves: robotics and the myths of autonomy. Viking, New York, New York.

[74] Mark Muro, Robert Maxim, and Jacob Whiton. 2019. Automation and Artificial Intelligence: How machines are affecting people and places. Brookings. Retrieved June 27, 2022 from <https://www.brookings.edu/research/automation-and-artificial-intelligence-how-machines-affect-people-and-places/>

[75] Ellen Mutari and Deborah M. Figart. 2015. Just one more hand: life in the casino economy. Rowman & Littlefield, Lanham, Maryland; Boulder; New York; London.

[76] Harold G. Nelson and Erik Stolterman. 2012. The design way: intentional change in an unpredictable world. The MIT Press, Cambridge, Massachusetts; London, England.

[77] Sam Nussey. 2022. SoftBank-backed Bear Robotics raises \$81 mln for waiting robot rollout. Reuters. Retrieved July 12, 2022 from <https://www.reuters.com/world/asia-pacific/softbank-backed-bear-robotics-raises-81-mln-waiting-robot-rollout-2022-03-15/>

[78] Matt O'Brien and Paul Wiseman. 2021. Do we need humans for that job? Automation booms amid COVID-19. Los Angeles Times. Retrieved June 29, 2022 from <https://www.latimes.com/business/story/2021-09-05/automation-job-covid-work-labor>

[79] Xavier Parent-Rocheleau and Sharon K. Parker. 2022. Algorithms as work designers: How algorithmic management influences the design of jobs. *Human Resource Management Review* 32, 3: 100838. <https://doi.org/10.1016/j.hrmr.2021.100838>

[80] Catherine Prentice, Sergio Dominique Lopes, and Xuequn Wang. 2020. Emotional intelligence or artificial intelligence—an employee perspective. *Journal of Hospitality Marketing & Management* 29, 4: 377–403. <https://doi.org/10.1080/19368623.2019.1647124>

[81] Inioluwa Deborah Raji, I. Elizabeth Kumar, Aaron Horowitz, and Andrew Selbst. 2022. The Fallacy of AI Functionality. In 2022 ACM Conference on Fairness, Accountability, and Transparency, 959–972. <https://doi.org/10.1145/3531146.3533158>

[82] Melissa Repko. 2021. The robot work force isn't coming. It's already here. CNBC. Retrieved June 27, 2022 from <https://www.cnbc.com/2021/12/27/the-robot-work-force-isnt-coming-its-already-here-.html>

[83] Juliana Feliciano Reyes. Hotel housekeeping on demand: Marriott cleaners say this app makes their job harder. <https://www.inquirer.com>. Retrieved December 29, 2021 from <https://www.inquirer.com/philly/news/hotel-housekeepers-schedules-app-marriott-union-hotsos-20180702.html>

[84] Alex Rosenblat, Karen Levy, Solon Barocas, and Tim Hwang. 2016. Discriminating Tastes: Customer Ratings as Vehicles for Bias. *Data & Society*. Retrieved July 12, 2022 from https://datasociety.net/wp-content/uploads/2016/10/Discriminating_Tastes_Customer_Ratings_as_Vehicles_for_Bias.pdf

[85] Alex Rosenblat and Luke Stark. 2015. Uber's Drivers: Information Asymmetries and Control in Dynamic Work. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2686227>

[86] Ana Rosete, Barbara Soares, Juliana Salvadorinho, João Reis, and Marlene Amorim. 2020. Service Robots in the Hospitality Industry: An Exploratory Literature Review. In *Exploring Service Science*, Henrique Nôvoa, Monica Drăgoicea and Niklas Kühl (eds.). Springer International Publishing, Cham, 174–186. https://doi.org/10.1007/978-3-030-38724-2_13

[87] Del Ross. 2020. Labor – How Your Largest Operating Expense Can Produce Your Biggest Profits. Retrieved from <https://www.facebook.com/watch/?v=1785410168273313>

[88] Ulrike Schultze and Wanda J. Orlikowski. 2004. A Practice Perspective on Technology-Mediated Network Relations: The Use of Internet-Based Self-Serve Technologies. *Information Systems Research* 15, 1: 87–106. <https://doi.org/10.1287/isre.1030.0016>

[89] Jan Schumann, Nancy Keller, and Florian Wangenheim. 2006. Technology-Mediated Services: A Typology and Implications for Research and Management

[90] Justin Schweitzer and Rose Khattar. 2021. It's a Good Jobs Shortage: The Real Reason So Many Workers Are Quitting. Center for American Progress. Retrieved June 27, 2022 from <https://www.americanprogress.org/article/its-a-good-jobs-shortage-the-real-reason-so-many-workers-are-quitting/>

[91] Rosanne M. Siino and Pamela J. Hinds. 2004. Making sense of new technology as a lead-in to structuring: the case of an autonomous mobile robot. *Academy of Management Proceedings* 2004, 1: E1–E6. <https://doi.org/10.5465/ambpp.2004.13862508>

[92] Michael R. Solomon, Carol Surprenant, John A. Czepiel, and Evelyn G. Gutman. 1985. A Role Theory Perspective on Dyadic Interactions: The Service Encounter. *Journal of Marketing* 49, 1: 99. <https://doi.org/10.2307/1251180>

[93] Clay Spinuzzi. 2002. A Scandinavian challenge, a US response: methodological assumptions in Scandinavian and US prototyping approaches. In *Proceedings of the 20th annual international conference on Computer documentation - SIGDOC '02*, 208–215. <https://doi.org/10.1145/584955.584986>

[94] Susan Leigh Star and Anselm Strauss. 1999. Layers of Silence, Arenas of Voice: The Ecology of Visible and Invisible Work. *Computer Supported Cooperative Work (CSCW)* 8, 1: 9–30. <https://doi.org/10.1023/A:1008651105359>

[95] Ronnie J. Steinberg and Deborah M. Figart. 1999. Emotional Labor Since the Managed Heart. *The Annals of the American Academy of Political and Social Science* 561: 8–26.

[96] Aaron Steinfeld and Han-Shue Tan. 2000. Development of a Driver Assist Interface for Snowplows Using Iterative Design. *Transportation Human Factors* 2, 3: 247–264. https://doi.org/10.1207/STHF0203_5

[97] Betsy B Stringam and John H. Gerdes. 2021. Hotel and Guest Room Technology. In *Hospitality & Tourism Information Technology*. USF M3 Publishing, LLC, 1–60. <https://doi.org/10.5038/9781732127593>

[98] Betsy Stringam and John Gerdes. 2018. The Automation of Service in the Hotel Industry. *Conference Proceedings, Global Conference on Services Management*: 259–261.

[99] Arun Sundararajan. 2016. The sharing economy: the end of employment and the rise of crowd-based capitalism. The MIT Press, Cambridge, Massachusetts

[100] Carlos Toxli, Siddharth Suri, and Saiph Savage. 2021. Quantifying the Invisible Labor in Crowd Work. *Proceedings of the ACM on Human-Computer Interaction* 5, CSCW2: 1–26. <https://doi.org/10.1145/3476060>

[101] Jeffrey W. Treem and Paul M. Leonardi. 2013. Social Media Use in Organizations: Exploring the Affordances of Visibility, Editability, Persistence, and Association. *Annals of the International Communication Association* 36, 1: 143–189. <https://doi.org/10.1080/23808985.2013.11679130>

[102] Aarni Tuomi, Iis P. Tussyadiah, and Jason Stienmetz. 2021. Applications and Implications of Service Robots in Hospitality. *Cornell Hospitality Quarterly* 62, 2: 232–247. <https://doi.org/10.1177/1938965520923961>

[103] U.S. Bureau of Labor Statistics. 2000. Job Openings: Accommodation and Food Services. FRED, Federal Reserve Bank of St. Louis. Retrieved July 12, 2022 from <https://fred.stlouisfed.org/series/JTS7200JOL>

[104] U.S. Bureau of Labor Statistics. 2022. Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity. US Bureau of Labor Statistics. Retrieved June 27, 2022 from <https://www.bls.gov/cps/cpsaat18.htm>

[105] Melissa A. Valentine, Daniela Retelny, Alexandra To, Negar Rahmati, Tulsee Doshi, and Michael S. Bernstein. 2017. Flash Organizations: Crowdsourcing Complex Work by Structuring Crowds As Organizations. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 3523–3537. <https://doi.org/10.1145/3025453.3025811>

[106] Alex Veen, Kaine Sarah, Caleb Goods, and Tom Barratt. 2020. The ‘Gigification’ of Work in the 21st Century. In *Contemporary Work and the Future of Employment in Developed Countries*, Peter Holland and Chris Brewster (eds.). Routledge, 15–32. <https://doi.org/10.4324/9781351034906-2>

[107] David Weil. 2014. The fissured workplace: Why work became so bad for so many and what can be done to improve it. Harvard University Press, Cambridge, Massachusetts London.

[108] Leslie Willcocks, Mary Lacity, and Andrew Craig. 2017. Robotic Process Automation: Strategic Transformation Lever for Global Business Services? *Journal of Information Technology Teaching Cases* 7, 1: 17–28. <https://doi.org/10.1057/s41266-016-0016-9>

[109] Jochen Wirtz, Paul G. Patterson, Werner H. Kunz, Thorsten Gruber, Vinh Nhat Lu, Stefanie Paluch, and Antje Martins. 2018. Brave new world: service robots in the frontline. *Journal of Service Management* 29, 5: 907–931. <https://doi.org/10.1108/JOSM-04-2018-0119>

[110] Christine T. Wolf, Mariam Asad, and Lynn S. Dombrowski. 2022. Designing within Capitalism. In *Designing Interactive Systems Conference*, 439–453. <https://doi.org/10.1145/3532106.3533559>

[111] Sally Wyatt. 2008. Technological Determinism is Dead; Long Live Technological Determinism. In *The Handbook of Science and Technology Studies (Third Edition)*, Edward J. Hackett, Olga Amsterdamska and Judy Wajcman (eds.). MIT Press, 165–180.

[112] Mark Young. 2017. How Women Became More Than Half of the Hospitality Workforce. *Lodging Magazine*. Retrieved June 27, 2022 from <https://lodgingmagazine.com/how-women-became-more-than-half-of-the-hospitality-workforce/>

[113] John Zimmerman and Jodi Forlizzi. 2017. Speed Dating: Providing a Menu of Possible Futures. *She Ji: The Journal of Design, Economics, and Innovation* 3, 1: 30–50. <https://doi.org/10.1016/j.sheji.2017.08.003>

- [114] Hotel Workers Rising. 2006. Creating luxury, enduring pain: how hotel work is hurting housekeepers. UNITE HERE!
- [115] Transmitter. 2020. Self-Cleaning Robots Reducing Germs at Hotels. IEEE Transmitter. Retrieved July 14, 2022 from <https://transmitter.ieee.org/3-self-cleaning-robots-helping-reduce-germs-at-hotels/>
- [116] 2021. Employment by major industry sector. U.S. Bureau of Labor Statistics. Retrieved July 12, 2022 from <https://www.bls.gov/emp/tables/employment-by-major-industry-sector.htm>
- [117] 2022. The Year of the “New” Traveler: The American Hotel & Lodging Association 2022 State of the Hotel Industry Report in Collaboration with Accenture. American Hotel & Lodging Association. Retrieved July 12, 2022 from <https://www.ahla.com/sites/default/files/AHLA%20SOTI%20Report%202022%201.24.22.pdf>
- [118] 2022. U.S. Hotels State of the Union. CBRE Hotels Research. Retrieved July 12, 2022 from <https://www.cbrehotels.com/-/media/cbre/countrycbrehotels/documents/february-2022-us-hotels-state-of-the-union.pdf>
- [119] Union membership. ILOSTAT. Retrieved July 12, 2022 from <https://ilostat.ilo.org/topics/union-membership/>
- [120] Our Data Bodies: Data Justice and Human Rights. Retrieved July 12, 2022 from <https://www.odbproject.org/>

Received January 2022; revised July 2022; accepted November 2022.