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Working with service robots in the dining room: Employees' perspectives and realities

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Abstract

Purpose – The purpose of this study was to investigate restaurant and foodservice workers' perceptions of working with a service robot and the extent to which the workers' well-being was impacted by a mandated service robot adoption.

Design/methodology/approach – This study used a qualitative methodology where 42 US restaurant and foodservice workers from two organizations were interviewed. The data analyzed generated 1,302 coded segments that clustered into six overarching themes.

Findings – The findings from this research revealed that restaurant and foodservice workers who regularly use service robots in the dining room experience a complex set of issues and challenges related to robot reliability, management training and support, leveraging the robot to entertain the customer, feelings of dread, anger and frustration, and indications of decreased physical exertion as a proxy for well-being.

Research limitations/implications – As an initial qualitative investigation, the results of this study can be used as a starting point for quantitative investigations, as well as informing restaurant and foodservice industry stakeholders as to the best practices for a comprehensive and successful service robot adoption and integration.

Originality/value – This research presents an intersection between service robot technology acceptance with worker well-being using a broad range of frameworks including National Institute for Occupational Safety and Health's Future of Work, SERVQUAL and technology acceptance models to gain a deep and rich set of service worker perspectives.

Keywords SERVQUAL, Technology acceptance, Future of work, Employee well-being, Service robot, Qualitative methodology

Paper type Research paper

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在餐厅与服务机器人合作：员工的观点与现实

摘要

研究目的 – 本研究旨在调查餐厅和餐饮服务工作人员对与服务机器人合作的感知，以及服务机器人采用对工作人员福祉的影响程度。

研究方法 – 本研究采用定性方法，对来自两家机构的42名美国餐厅和餐饮服务工作人员进行了访谈。分析的数据生成了1,302个编码段，分为六个总体主题。

研究发现 – 本研究的发现显示，餐厅和餐饮服务工作人员在餐厅使用服务机器人时经历了一系列与机器人可靠性、管理培训和支持、利用机器人娱乐顾客、恐惧、愤怒和挫折感、以及作为福祉代理的身体活动减少相关的复杂问题和挑战。

研究局限性/意义 – 作为初步的定性调查，本研究的结果可作为定量调查的起点，并向餐饮服务行业的利益相关者提供有关全面和成功采用和整合服务机器人的最佳实践。

研究创新 – 本研究将服务机器人技术接受与工作人员福祉相结合，利用包括NIOSH的未来工作、SERVQUAL和技术接受模型在内的广泛框架，获得了丰富多样的服务工作者观点。

关键词 SERVQUAL、技术接受度、工作的未来、员工福祉、服务机器人、定性方法

文章类型 研究型论文

1. Introduction

Prior to the global pandemic, the adoption of service robots in the US restaurant industry was virtually nonexistent despite widespread adoption and use in other countries such as China (Karabegović, 2017), Japan (Bhimasta and Kuo, 2019) and South Korea (Atkinson, 2019; Tuomi *et al.*, 2020). Due to an exodus of service workers following the pandemic and as pent-up consumer demand returned, restaurateurs and foodservice organizations worldwide have faced a decision as to whether they close their businesses or remain open by adopting service robot technology to fill a labor gap (Liu-Lastres *et al.*, 2023; McCartney and McCartney, 2020). Service robot manufacturers are enjoying a notable rise in demand in the USA and elsewhere, as robot adoption was predicted to quadruple globally from 2020 to 2025 as a result of the pandemic and the economic crisis in its aftermath (Brown, 2020). Moreover, the USA is forecasted to overtake the global service robotics market, estimated earnings at US$7.1bn in 2023 (Statista, 2023).

Given the breadth and rapidity of service robot adoption in the USA, the National Institute for Occupational Safety and Health (NIOSH) has prioritized the role of technology in its Future of Work initiative with a particular focus on understanding the impacts on the well-being and work experiences of disproportionately affected workers including women, younger workers and immigrants (Chang *et al.*, 2022). Although US restaurant and foodservice employment has returned to near pre-pandemic levels, the majority of its frontline workers are still minorities from marginalized populations (Connell, 2022). Therefore, a research gap is identified which must address issues of not only technological job displacement and workforce productivity, but also frontline worker well-being in the US restaurant and foodservice industry with respect to prolific service robot adoption.

A 2019 content analysis study of service robot adoption papers in the hospitality and tourism discipline found this to be an emerging topic of inquiry. At the time of the study, a majority of papers published on service robots in the hospitality industry employed conceptual rather than empirical investigations (Ivanov *et al.*, 2019). The purpose of this study was to conduct empirical research on a relatively emergent phenomenon of service robot adoption and perceptions among frontline workers in the US restaurant and foodservice industry. Pairing questions inspired by NIOSH's Future of Work Framework (Tamers *et al.*, 2020) with adapted measures from SERVQUAL (Parasuraman *et al.*, 1988), technology acceptance (Venkatesh and Davis, 2000; Venkatesh *et al.*, 2003) to inform a

qualitative protocol on service robot adoption, the objectives of this study were to (1) determine the ways in which workers, robots and customers collaborated and engaged in a dining room environment; and (2) determine the extent to which restaurant and foodservice workers' well-being was impacted by a mandated service robot adoption and the subsequent perceptions of technology job displacement.

2. Literature review

2.1 Service robot adoption

There are psychological and sociotechnical aspects to service robot adoption as it pertains to workers. Prior research has indicated that workers might be ambivalent in their feelings toward service robots by recognizing workload reduction as a possible benefit, but also fearing that robots will cause job redundancy (Ivanov *et al.*, 2020). However, the hospitality industry will still require human competencies such as nuanced communication, empathy and creative problem-solving. Job impacts are expected, but so too are increased efficiencies (Ivanov and Webster, 2017). The conceptual literature has proposed that the dehumanization of service might pose threats to worker dynamics within organizations (Tung and Law, 2017); thus, smooth workforce transition is important for long-term use. Prior research on the sociotechnical factors for service robot adoption advances the importance of training and thoughtful task allocation that would balance service robot capabilities with human competency requirements in the services industries (Tussyadiah and Park, 2018). Conceptual papers on sociotechnical factors stress the importance of worker participation in robot design and use, transparent and inclusive implementation and careful consideration of ethical protocol regarding human–robot collaboration (Ivanov and Webster, 2017).

2.2 National Institute for Occupational Safety and Health Future of Work Framework

The NIOSH operates under the umbrella of the U.S. Centers for Disease Control with a mission to foster research that can support a healthy, safe and productive workforce. Given the changing landscape of work, the NIOSH Future of Work Framework presents a topical research agenda to address the new opportunities and risks ushered in by interconnected changes in work, workplaces and in the workforce (NIOSH, 2021). *Changes in work* increasingly involve emerging technologies, such as service robots, that impact the nature of jobs and work to be done. *Changes in the workplace* capture concomitant changes in job characteristics and organizational design, including both the quality and quantity of jobs, as well as organizational factors such as leadership and work arrangements. *Changes in the workforce* capture issues of vulnerable segments of the labor force, increasing precarity created through technological and workplace change, as well as labor force readiness issues of skilling and up-skilling. The Future of Work Framework views these issues as nonmutually exclusive (NIOSH, 2021). For example, while technologies such as service robots are a driving force in creating change, the implications for worker well-being and productivity are shaped by the impact of service robot adoption on the quantity and quality of jobs. These changes occur in the context of the differential vulnerabilities and readiness experienced across workers (Schulte *et al.*, 2020). Simultaneously, worker acceptance of technologies will shape the process of technology adoption and use in the workplace.

Because of its integrated focus on work, workplace and worker issues, the NIOSH Future of Work Framework provides a useful foundation for the current research. Our research examines the intersection of service robot implementation (work), the restaurant and foodservice workforce with members from vulnerable populations (workforce) and issues of work design (workplace). We adopt the perspective of technology articulated in the Future

of Work Framework that service robots offer many opportunities, as well as many threats, for worker well-being and workplace productivity (NIOSH, 2021). Whether these opportunities or threats are realized depend not only on (a) the technology itself, but also on (b) how it is incorporated into the workplace, (c) the resulting impacts for work quality and quantity and (d) the needs, readiness and experiences of workers and management. Such dynamics underscore issues of utilization, trust and other psychological reactions directed both at the robot (e.g. excitement, frustration) and at the industry/occupation more broadly (e.g. fears of technological job displacement) (Schulte *et al.*, 2020).

2.3 Service quality and technology adoption

Service robots are technological tools built and sold by robot manufacturers to hospitality and other service organizations. In that vein, a service organization is the customer of the robot manufacturer, and by extension, so too are the workers who use service robots. From this logic, SERVQUAL (Parasuraman *et al.*, 1988) dimensions (reliability, assurance, tangibles, empathy and responsiveness) can be used to measure the gap that workers as customers experience regarding robot service quality expectation and perception. Prior research has borrowed SERVQUAL measures to develop a robot service quality scale in a hospitality setting (Prentice and Nguyen, 2021) and SERVBOT, a SERVQUAL-based model to include the entertainment value of a service robot (Kharub *et al.*, 2021), among others. SERVQUAL might possess limitations for service robots in that assurance and empathy may not translate directly to robots, especially within an anthropomorphic framework (Lu *et al.*, 2019). Moreover, service robots are tangible and visible, but co-production between the worker, robot and the guest could be missed by the SERVQUAL dimensions (Ivanov *et al.*, 2019).

Technology acceptance model (TAM) (Venkatesh and Davis, 2000) and unified theory of acceptance and use of technology (UTAUT) (Venkatesh *et al.*, 2003) are technology adoption models based on an individual user's assessment of the perceived ease of use and usefulness of a technology that predicts an intention to use. Despite the criticism of technology adoption study saturation using TAM and UTAUT over a decade ago (Benbasat and Barki, 2007), as new technologies have come to market, researchers have continued to investigate "intention to use" across a multitude of contexts and conditions. With service robot adoption, there is an intersectional phenomenon emerging that includes components of service quality, and worker well-being frameworks with technology adoption (Meyer *et al.*, 2020) that few studies have connected. Given the complexity of tasks and competencies required of frontline workers who use service robot technology in a hospitality environment to serve customers, a more comprehensive understanding is needed to prepare and train a workforce where technology displacement may otherwise be immanent (Horan *et al.*, 2021).

3. Methodology

This qualitative field study used a semi-structured interview protocol to collect data from 42 restaurant servers who regularly worked with service robots in their respective dining room locations. Due to the novelty of the study and the emergence of the phenomenon under investigation (i.e. service robot use among frontline employees in US-based restaurants), a qualitative methodology was deemed appropriate to engage a large sample yielding in-depth and robust results (Bansal and Corley, 2012). A description of the protocol development, participant selection, data collection and qualitative data analytic procedures are detailed in the following sections.

3.1 Interview protocol development

The interview questions were based on prior worker well-being, service quality and technology adoption literature and written in a generalized format to elicit rich descriptions from the participants, thus generating more nuanced data typically not accessible through technology adoption quantitative methodologies (Venkatesh *et al.*, 2013). Aside from asking questions about the general demographics of participants, the protocol was divided into three sections (see Appendix) with questions adapted for the worker-service robot context under investigation and pertaining to:

(1) NIOSH's Future of Work Framework (NIOSH, 2021);

(2) the five dimensions of SERVQUAL which included reliability, assurance, tangibles, empathy and responsiveness (Parasuraman *et al.*, 1988); and

(3) technology acceptance and adoption using TAM (Venkatesh and Davis, 2000) and UTAUT (Venkatesh *et al.*, 2003) measures.

The interview protocol was assessed for face validity by established researchers in hospitality technology adoption and in industrial-organizational psychology, in addition to experts from the restaurant industry and in service robot manufacturing.

3.2 Selection of participants and data collection procedures

The target population for this study consisted of restaurant workers who utilized service robots in the dining room as part of their job. The researchers established a point of contact with a lead deployment manager for a service robot manufacturer in the USA who then contacted several restaurant and foodservice organizations who at the time used their proprietary robot technology. Two organizations located in the Southeastern USA agreed to participate in the research. One organization was a medium-size independently owned restaurant chain with 14 locations, two of which were selected for data collection. The other organization was a large continuing care senior living community with two full-service restaurants on premises. The justification to include two different foodservice business types was based on attaining wider generalizability of the study's findings (Canziani *et al.*, 2016). To enhance the external validity of the study, the criteria for participant selection included a wide range of frontline restaurant workers with varying levels of experience, types of roles and levels of service robot interaction (Maxwell, 2021) (see Table 1). In total, 42 restaurant workers agreed to participate, 25 from the restaurant chains' two locations and 17 from the senior living community's restaurant dining rooms. Participants were incentivized with US$20 Amazon gift cards upon completion of a full interview. Potential respondent bias was mitigated by including a wide range of participants at different levels within their organizations and who interacted with a service robot on a regular basis, including 2 busser/servers (4.8%), 23 working in a full or partial server capacity (54.8%), 3 server/bartenders (7.1%), 9 working in curbside/pick-up (21.4%), 2 cooks (4.8%) and 3 managers (7.1%) (see Table 1). The interviews were conducted in person at each of the locations, using the same protocol and asking questions in the exact order across all interviews to ensure generalizability of the study (Maxwell, 2021).

The duration of the interviews ranged from 15 to 60 min and was dependent on the participants' availability to conduct the interviews during or after their scheduled shifts. Historically, qualitative interview length has served as a proxy for quality of data (Creswell and Poth, 2016), but more recent literature has challenged this notion (Rivera *et al.*, 2023). For example, cultural considerations, linguistics and differences between white- and blue-collar communication has revealed an inferiority of data bias among qualitative researchers (Gist-

Participant #	Organization type	Position	Years in position	Years in industry	Years w/Robot
1	Retirement community	Server (F)	4.5	6.0	0.5
2	Retirement community	Server (F)	0.8	0.8	0.5
3	Retirement community	Server/host (F)	16.0	22.0	0.5
4	Retirement community	Server (F)	14.0	14.0	0.5
5	Retirement community	Server (F)	1.0	1.0	0.5
6	Retirement community	Bartender (M)	0.3	22.0	0.3
7	Retirement community	Server (F)	1.0	1.0	0.5
8	Retirement community	Server (F)	1.0	15.0	0.5
9	Retirement community	Busser/server (M)	0.4	0.4	0.4
10	Retirement community	Server (M)	0.8	9.0	0.4
11	Retirement community	Cook (M)	0.1	10.0	0.1
12	Retirement community	Server (F)	8.5	47.0	0.5
13	Retirement community	Kitchen manager (M)	9.0	17.0	0.5
14	Retirement community	Server (F)	1.0	5.0	0.5
15	Retirement community	Server (F)	1.0	10.0	0.5
16	Retirement community	Server (F)	0.1	15.0	0.1
17	Retirement community	General manager (F)	9.0	25.0	0.5
18	Restaurant	Server (M)	3.0	4.0	0.5
19	Restaurant	Server/bartender (M)	0.2	3.0	0.2
20	Restaurant	Server (M)	1.0	1.0	1.0
21	Restaurant	Cook (M)	1.0	4.0	0.7
22	Restaurant	Busser/server (M)	7.0	31.0	1.0
23	Restaurant	Server (M)	8.0	9.0	0.3
24	Restaurant	Curbside/pick-up (M)	10.0	15.0	2.0
25	Restaurant	Server (F)	1.5	10.0	1.0
26	Restaurant	Server (M)	9.0	25.0	1.0
27	Restaurant	Curbside/pick-up (F)	0.6	5.0	1.0
28	Restaurant	Pick-up/prep cook (F)	8.0	8.0	2.0
29	Restaurant	Server/cashier (F)	4.0	4.0	2.0
30	Restaurant	Server (F)	2.0	2.0	2.0
31	Restaurant	Server/bartender (F)	4.0	4.0	1.0
32	Restaurant	Manager (F)	1.0	6.0	1.0
33	Restaurant	Delivery driver (M)	0.5	0.5	0.5
34	Restaurant	Server (F)	10.0	10.0	2.0
35	Restaurant	Pick-up/driver (F)	1.3	2.0	0.8
36	Restaurant	Server (F)	8.0	10.0	2.0
37	Restaurant	Server (F)	13.0	30.0	2.0
38	Restaurant	Phone orders (F)	0.6	0.6	0.6
39	Restaurant	Delivery supervisor (F)	3.0	5.0	2.0
40	Restaurant	Curbside/Pick-up (M)	11.0	12.0	1.5
41	Restaurant	Server (M)	0.3	0.3	0.3
42	Restaurant	Pick-up/driver (M)	0.8	0.8	0.8
		Average	*4.2 yrs In position*	*10.1 yrs In industry*	*0.9 yrs w/Robot*

Source: Created by the authors

Table 1. Profile of participants in the study

Mackey and Kingsford, 2020), thus shorter interviews of greater quantity were deemed acceptable in this study (deMarrais and Lapan, 2003; Martinez, 2018). Following approval by the researchers' University Institutional Review Board (IRB), the protocol was professionally translated to Spanish and verified by a third party in compliance with IRB procedures. Native Spanish speakers on the research team conducted the 14 interviews in

Themes	Codes	Freq.	%
1. Service Robot Collaboration [Customer and Employee]	Reliability of the robot	68	18.7
	Level of technology experience	46	12.7
	Reason for robot adoption	45	12.4
	Type of technology for employee personal use	43	11.9
	Safety improvements	40	11.0
	Past experience with new technology on the job	30	8.3
	Additional technology on the job	27	7.4
	Openness to new ideas/suggestions about robot use	23	6.3
	Customer [guest] contact	21	5.8
	Needs of guests/best interest of guests	11	3.0
	Caring attention provided to guests	9	2.5
	Total	363	100.0
2. Service Robot Optimization [Employee]	Recommendations for process improvement	91	33.7
	Challenge(s) with technology on the job	74	27.4
	Efficiency of robot in the physical space	68	25.2
	Physical obstructions	37	13.7
	Total	270	100.0
3. Service Robot Integration [Employee]	Impacts on worker productivity	121	49.4
	Training	55	22.5
	Management support	55	22.5
	Inhibited service	14	5.7
	Total	245	100.0
4. Service Robot Engagement [Customer and Employee]	Most helpful robot functions	81	42.6
	Customer reactions	64	33.7
	Feelings of enjoyment	45	23.7
	Total	190	100.0
5. Service Robot Workforce Effects [Employee]	Impact of robot on job	65	55.6
	Impact of robot on employee well-being	52	44.4
	Total	117	100.0
6. Service Robot Resentment [Employee]	Employees' feelings of dread, anger, frustration	62	53.0
	Changes in coworkers	55	47.0
	Total	117	100.0

Table 2.
Emergent themes and code frequencies

Source: Created by the authors

Spanish, and the voice data were professionally transcribed to English with third-party validation in accordance with the IRB. The majority of interviews in the study were conducted in English ($n = 28$; 66.7%), while 14 (33.3%) were conducted in Spanish.

3.3 Data analysis and coding

The qualitative data were coded using MAXQDA v.22 qualitative data analysis software. The researchers organized a codebook as a starting point that was prescribed by the Total Worker Health (NIOSH, 2021), SERVQUAL (Parasuraman *et al.*, 1988), TAM (Venkatesh and Davis, 2000) and UTAUT (Venkatesh *et al.*, 2003) constructs under investigation. One researcher on the team coded all 42 transcripts, while two other researchers on the team

coded partial data sets through random selection. In addition to the codes provided in the codebook, the researchers added a few additional grounded codes as needed to identify emergent phenomena more accurately. The findings were triangulated to ensure consistency, and in the final thematic output (see Figure 1), the researchers independently assessed the interpretations of the coded clusters into six overarching themes. Based on a matrix of code frequency and proximity to other codes, the MAXQDA v.22 software produced cluster maps for each researcher independently (Kuckartz and Radiker, 2019).

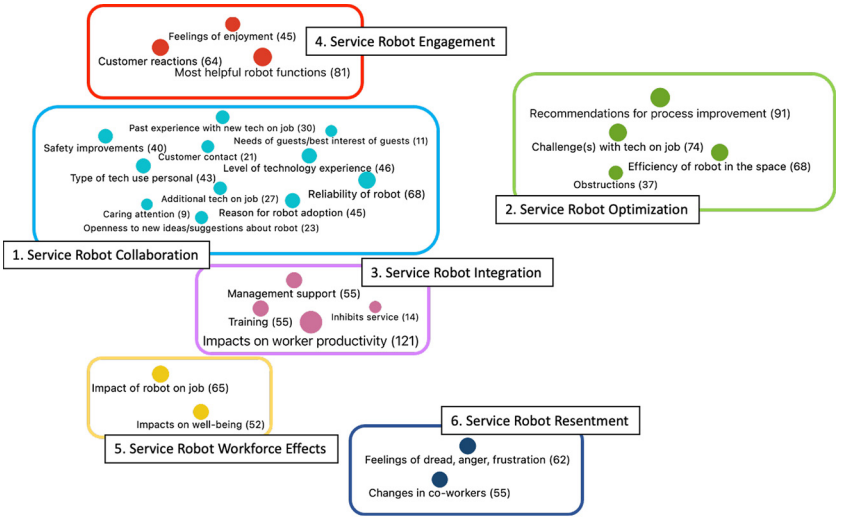
4. Results and discussion

Among the 42 participants who agreed to participate in the study, 17 (40%) were male and 25 (60%) were female. Participants worked 4.2 years on average at their respective organizations, with a range of one month to 16 years. Participants worked on average 10.1 years in the hospitality industry with a range of 1 month to 47 years. Finally, participants in the study worked 11 months on average with a service robot, with a range of one month to two years (see Table 1).

The results returned 1,302 coded segments which clustered into six themes (see Figure 1):

(1) Service Robot Collaboration (363);
(2) Service Robot Optimization (270);
(3) Service Robot Integration (245);
(4) Service Robot Engagement (190);
(5) Service Robot Workforce Effects (117); and
(6) Service Robot Resentment (117) (see Table 2).

In the following sections, we provide an interpretation of the results citing participant numbers anonymously [in brackets] (see Table 1) in addition to including sample narratives for the purpose of establishing credibility and validity of the findings (Creswell and Miller, 2000).



Source: Created by the authors

Figure 1. Six emergent themes from the qualitative analysis of 42 interviews with restaurant servers working with service robots

4.1 Service robot collaboration

Service Robot Collaboration was the dominant theme in the analysis which clustered 11 codes (see Table 2 for frequencies): *Reliability of the robot, level of technology experience, reason for robot adoption, type of technology for employee personal use, safety improvements, past experience with new technology on the job, additional technology on the job, openness to new ideas/suggestions about robot use, customer [guest] contact, needs of guests/best interest of guests* and *caring attention provided to guests*. The narratives coded under Service Robot Collaboration were characteristic of joint customer and employee interactions with the robot and revealed efficiencies and processes related to restaurant operations. For example, characteristics identified as collaborative between the employee and the robot included its dependability to arrive at a table [19], independence to carry food trays [2], maneuverability around static objects [3], assurance of operation [8] and reliability [15]. Characteristics associated with customer and robot collaboration included guests serving themselves from the robot (deemed as both positive and negative) [42], the robot stopping or saying, "excuse me" when in customer contact in the walkways [35] and the entertainment value of "robot-watching" [2].

Also included in this theme was the level of technological experience that participants possessed prior to using the robot, and their comfort level with new technologies at work. Participants' responses when asked their level of experience with technology in general (beginner, intermediate and advanced) ranged from those who "cannot use a laptop" and "still wrote paper checks" [12] to those who were legitimately expert, as one participant held an undergraduate degree in Computer Science [2]. In their personal lives, regardless of their level of comfort or expertise with new technology, all participants owned a cell phone, and most could use a desktop or laptop computer and wore a smartwatch or physical fitness tracker. As it pertained to new technologies at work, participants had experiences learning how to place food orders using iPads [4] [10] [12] [13] or other point of sales (POS) systems [1] [15] [18]. Finally, a singular code that clustered along with customer and employee Service Robot Collaboration was *safety improvements*. It appears this code pertained to operations, where participants discussed how the robot alleviated stress and strain because it could carry heavy trays to and from the tables, thus eliminating the physical burden during working hours [1] [13] [20] [28] [37].

4.2 Service robot optimization

Service Robot Optimization was the second highest frequency theme and represented codes specific to employees' *recommendations for process improvement*, *challenges with technology on the job, the efficiency of the robot in the physical space* and *obstructions* (see Table 2). Participants offered numerous recommendations to improve processes when working with the robot to deliver food to customers, including more accurate mapping of the robot "landing" points [2], the ability of the robot to move faster and easier over uneven thresholds across the flooring [5], the use of headphones among the waitstaff to be notified when the robot was leaving the kitchen [8], the unlikely ability of the robot to clean dirty tables by itself [4], rearranging tables and widening walkways in the restaurant [7] and using trays on the robot with higher edges to keep plates and food from falling [9].

Regarding *challenges with technology on the job*, some participants reported frustration with the slow pace of the robot and felt they were competing with the robot technology, often opting to deliver the food to the tables manually [4] [14] [41]. Several participants who witnessed the same technology failure (the robot roaming out of the dining room on its own) felt uncertain with how to work with the robot technology in bringing the robot back to its charging station [12] [17] or how to handle a problematic Wi-Fi connection [1] [25].

Participants voiced several ways to optimize the robot for employees with respect to *efficiencies in the physical space* and *obstructions*. In high-traffic or areas where customers tended to socialize or congregate, participants suggested having the ability to temporarily re-map the physical space [5] or re-program the robot to move slower during busy service [14]. Conversely, participants explained that sometimes they would like to temporarily program the robot to move faster [5]. Participants reported that re-mapping and/or re-programming would be particularly helpful when tables were joined together for large parties, thus allowing for greater service flexibility [41][42].

4.3 Service robot integration

The theme identified as Service Robot Integration centered on employees and *impacts on worker productivity, training, management support* and *inhibited service* (see Table 2). In general, this theme referred to the ways in which the service robot was first introduced to the organization and how, together with management, the robot was normalized into existing standard operating service procedures. Participants were divided on their thoughts about robot productivity which viewed the robot as a help or as a hindrance to operations. Those who envisioned the robot as helping their service believed the robot was a tool, rather than person-like [1] [17]. Those participants who felt the robot was a nuisance, felt that it adversely affected their productivity [8][10][15].

The majority of participants felt they had not received adequate *training* when the robot first arrived at their location, although those participants who did feel well-trained explained that using the robot was intuitive and that it was pre-programmed to do its job [4] [22]. Some participants explained that they had no prior notice that the robot would be delivered for use to their restaurant location, and some were completely unaware the organization planned to purchase the robot for dining room use. Responses regarding the absence of robot training also seemed to split into two perceptions: a minority of participants felt both inadequately trained and unsupported by management, while most participants felt that although not trained, they did feel supported by their supervisors in learning to integrate the robot into service operations.

One participant shared that the robot integration was stalled due to how its use inhibited their ability to deliver efficient service to their customers [1]. Another participant appreciated the ability of the robot to lower stress, but with the unintended consequences of delivering the food slower to the table [14]: "[The robot] definitely helps physically and mentally when it comes to stress. But it does take a big toll on time and freshness guaranteed when it comes to getting food out to the tables." A participant expressed an inability to multitask on the way to their tables when the robot was rapidly approaching a table and needed to be attended to [18].

4.4 Service robot engagement

Similar to the Service Robot Collaboration theme, the Service Robot Engagement theme included perceptions on how employees worked with the robot to serve customers, and included the *most helpful robot functions, customer reactions* and *feelings of enjoyment* (see Table 2). Among the most helpful service engagement functions, the robot was most valued among participants for its ability to carry heavy trays of food. Participants voiced that positive customer reactions were a motivator to engage in service with the robot. Examples of participants engaging with customers by leveraging the robot included selfie-taking [40], the robot singing "Happy Birthday" [2], children especially entranced by the robot [35] and customers travelling long distances to be served by the robot [9]. Some participants relayed their excitement in being among the first in the industry to use a service robot [1]. One participant shared their delight with being among the first in the industry to use a service

robot: "I think it's still new to me so I cannot help but chuckle sometimes, because I'm still laughing that hey, there's a robot taking out food for me. That's nice" [16]. Finally, one participant enjoyed how the robot said "excuse me" when encountering customers in its path [6].

4.5 Service robot workforce effects

Service Robot Workforce Effects was an employee-related theme that included the codes: *impact of the robot on the job* and *impact of the robot on employee well-being* (see Table 2). Participants discussed the wide age range of workers in their organizations, and in which younger workers felt the robot helped them do their jobs, while older workers felt the robot was "stealing jobs" [1] [17] [36] [38]. Some participants were ambivalent as to the impact of the robot on their job [10]. For example, one participant said they "had good days and bad days" working with the robot [5]. Another participant said about their job: "we still have to walk the same distance to the table [to unload the robot], so it doesn't [make a difference] if we use it or not" [22]. Regarding the impact of the robot on employee well-being, a majority of participants conceded (even the ones who did not like the robot) that the robot relieved stress and physical exertion [5] [7] [14], resulting in less burnout [41].

4.6 Service robot resentment

The final theme emergent from the data was Service Robot Resentment, which was characterized by the codes *employees' feelings of dread, anger, frustration* and *changes in coworkers* (see Table 2). This theme was close in proximity to the Service Workforce Effects theme, indicating that participants held a certain amount of emotion about the robot, its impacts on their well-being, and how they vented frustration (see Figure 1). Feelings of dread and frustration were revealed in several ways. One participant who had worked as a server for decades felt the adoption of the service robot was "the beginning of the end" and that the participant was "feeling insecure and afraid" for the future of work in the industry [26]. When participants of one organization first learned of the robot adoption, workers from an older generational cohort said that the robot adoption "was dumb" and wondered why they "needed a robot" in the restaurant [1]. Participants discussed when there were service failures caused by the robot (i.e. food falling off trays due to the robot's motion or collision with people or physical obstacles), there was frustration shared among the impacted servers in addition to placing undo stress on the kitchen workers who were forced to prioritize the remaking food [15].

Participants shared their observations of coworkers who pushed or kicked the robot [14]. Participants also noticed how their coworkers who had longer tenures at their respective organizations tended to change behaviors and became increasingly disgruntled due to the presence of the robot and the associated pressures of having to use it [1]. Conversely, other participants noticed an increased level of happiness among the staff after the adoption of the robot [28] [34] [41].

5. Conclusion and implications

The purpose of this qualitative study was to investigate US frontline restaurant workers' perceptions of working with a service robot to serve dining room customers. USing questions borrowed from NIOSH's Future of Work, TAM and UTAUT frameworks, the research objectives included (1) the determination of ways in which workers engaged with the robot and customers; and (2) the extent to which restaurant and foodservice workers' well-being was impacted by mandated use of the service robot. After interviewing 42 restaurant and foodservice workers across two organizations in a variety of frontline service

roles, the key findings of this study indicated a high level of collaboration between the worker, the robot and the customer, in which prior research suggested that good training and purposeful onboarding would precipitate such outcomes (Tung and Law, 2017; Tussyadiah, 2020). When asked, participants voiced many recommendations for process and physical space improvements, which revealed that frontline workers possessed advantageous and constructive feedback to optimize a complex set of circumstances when working with a service robot.

Consistent with prior research on the psychological and socio-technical aspects of working with a service robot (Ivanov *et al.*, 2020; Tussyadiah, 2020; Tussyadiah and Park, 2018), the findings from the research support that while some workers might be reticent about working with a service robot, the majority of participants conceded that service robots help alleviate stress and the physical burden of carrying heavy dish trays to and from their tables throughout a shift. Participants from the study shared that when leveraged, the use of a service robot can be entertaining to customers, yet some participants felt in competition with the service robot as a secondary server when they had historically felt in more command of delivering the totality of the service experience (Kim and Cha, 2024; Ivanov *et al.*, 2020). When asked about impacts on well-being, participants reported that less physical exertion was a prime indicator of well-being and that the ability to go home after a shift feeling less tired was an advantage. Finally, results from this study aligned with prior research on continuous use of service robots where participants revealed self-reported feelings of dread (that robots were taking their jobs), anger (at being forced to use the robot) and frustration (when the robot or Wifi failed), all consistent with research on the technological displacement of service workers (Ivanov *et al.*, 2019; 2020).

The findings from this study support NIOSH's Future of Work Framework by connecting the workplace, worker and work to the nuances of the worker-service robot relationships. In situations where workers had agency to make service standard decisions in the workplace, the worker was more efficient and the work was less burdensome. In the case of the technology acceptance frameworks adopted in this study (TAM, UTAUT), as with any mandated adoption, workers must use the technology. In this study, many of the workers noted that their work was less taxing when using a robot, which they may not have experienced if the robot use was not mandated. Given the complex relationship between the worker, robot and customer, mandated use can be stressful for those workers opposed to the robot, yet with proper training and onboarding, the benefit of decreased physical exertion is a worthwhile aspiration supporting a worker's well-being.

5.1 Theoretical implications

The insights offered by participants present a rich and nuanced perspective on service robot adoption in the US restaurant and foodservice industry. As anticipated by NIOSH's Future of Work Framework, participants expressed a range of reactions to service robots. These responses captured the technology's functionality on the job as well as workers' general fears and concerns about technological displacement. Also reflected in the analyses were issues of leadership, training and support during the service robot implementation and adoption/utilization processes.

These findings support the insights offered by NIOSH's Future of Work Framework. In addition, they advance the framework in several ways. First, our findings illustrate that workers' reactions to robots were shaped by their observations of the effect that the robot had on others, including customers and coworkers. Second, they suggest that worker experiences with technology vary on a day-to-day basis due to factors that go beyond the functioning or malfunctioning of the technology. For example, workers saw service robots

as more of a hindrance during busy rush times in the restaurants. Future research that considers the intersection of work, workplace and worker issues should consider the dynamic fit between work, workplace and worker. In addition, conceptualizations of workplace and workforce issues should be broadened to account for a wider range of contextual elements including temporally dependent demands in the workplace as well as reactions of customers and coworkers.

Another theoretical contribution of this research is the demonstrated convergence of worker well-being and service quality components with technology acceptance as a broad and comprehensive strategy to assess how workers perceive the totality of their interactions, thoughts and feelings when working with a service robot. This qualitative study is a nascent step toward developing a more sophisticated systems approach to understanding better the intersection of technology adoption and worker well-being through a potential circular reasoning of mandated technology use. In the case of workers having to use the service robot, albeit reluctantly, many of them ultimately realized the benefit to decreasing their physical burden. This advances technology acceptance conceptualization as service encounters are complex, and to mandate the use of a service robot in a busy, high-pressured work environment across a diverse group of workers of varying generational cohorts, technology mastery and industry experience is an added layer of burden on a workforce already under technology displacement threat. Theoretical development at the intersection of technology acceptance and worker well-being is warranted as service robot adoption and use become normalized in the hospitality industry.

5.2 Practical implications

The results from this research demonstrate a wide range of perceptions on service robot adoption and use in restaurants and foodservice. Industry practitioners should be advised that workers want to know why, when and how a service robot will be introduced into a hospitality workplace. Even though a majority of workers may be technology savvy, they may still feel apprehensive about the first use of a service robot. Training is critical to the normalization and success of a service robot adoption, so too is inviting regular feedback from workers as to their recommendations for process improvement. Knowing that although some workers will not have favorable feelings toward the mandated use of a service robot, it is important for practitioners to slowly onboard a robot for those workers who may need more convincing and adjustment to their established workflows. Regardless, from the results of this study, practitioners should be confident that the reduction of physical exertion the robot affords will in the long term be a benefit to workers, and more importantly, their sense of well-being.

5.3 Limitations and future research

This research was subject to limitations. Consistent with issues of selection and response bias eliciting socially desirable answers, at times is seemed as though several participants may have felt compelled to say they liked working with the service robot to put on a good "face" which may have buffered the resentment findings to be more peripheral than the other emergent themes in this study. Future research might reorganize the order of the interview questions to ask participants questions about their feelings of working with the robot at the end of the protocol to build trust with the interviewer and to provide more authentic responses.

The participants interviewed in this study were from two organizations, and although these organizations had different standard operating procedures, future research should reach a wider variety of organizations from multiple geographical areas, including

internationally. As service robots become increasingly normalized in the hospitality industry, and as more workers use them in the service workplace, future research should test behavioral and technology adoption models quantitatively once a large sample can be realized.

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Appendix

Table A1.
Interview protocol and justification

Theoretical framework/measure	Primary interview question(s)	Secondary interview question(s)	Reference
NIOSH Future of Work			
	Have there been any improvements to your well-being since using the service robot? For example, reduced stress or burnout?		Horan, K.A., Shoss, M.K., Mejia, C. and Ciarlante, K., 2021. Industry Context as an Essential Tool for the Future of Healthy and Safe Work: Illustrative Examples for Occupational Health Psychology from the Hospitality Industry. *International Journal of Environmental Research and Public Health, 18*(20), p.10720.
	What types of changes might you recommend to the service process/ standards in your restaurant?	Are you carrying trays to the table when using the robot? Are you bussing dirty dishes and taking those back to the dish station when using the robot?	
	Do you have any feelings of enjoyment when working with the robot? How about dread, or disappointment? When and why do these feelings occur?		Tamers, S.L., Streit, J., Pana-Cryan, R., Ray, T., Syron, L., Flynn, M.A., Castillo, D., Roth, G., Geraci, C., Guerin, R. and Schulte, P., 2020. Envisioning the future of work to safeguard the safety, health, and well-being of the workforce: A perspective from the CDC's National Institute for Occupational Safety and Health. *American journal of industrial medicine, 63*(12), pp.1065–1084.
	Do you ever get angry or frustrated with the robot? How do you feel when you don't want to use the robot and you are expected to?	Have you ever seen any of your coworkers get angry with the robot?	
SERVQUAL			
Reliability	How reliable or dependable is the service robot in your work?		Parasuraman, A., Zeithaml, V.A. and Berry, L.L., 1985. A conceptual model of service quality and its implications for future research. *Journal of Marketing, 49*(4), pp.41 - 50.
Assurance	Have you ever had an idea about how to improve the service with the robot? Did you tell someone? What did or did not happen?		
Tangibles: physical plant	Are there any changes you might recommend for mapping the robot's movements/paths in the restaurant?	Are walls in the way? Are tables in the way? What happens when you have to move tables?	Prentice, C. and Nguyen, M., 2021. Robotic service quality–Scale development and validation. *Journal of Retailing and Consumer Services, 62*, p.102661.
Tangibles: physical plant	Do customers ever run into the robot due to not enough room in the path?	What typically happens and how does management handle any incidents?	

(*continued*)

Table A1.

Theoretical framework/measure	Primary interview question(s)	Secondary interview question(s)	Reference
Tangibles: physical plant	How efficient is the robot in the given space you have to work? What would make the robot more efficient? What would make your workflow more efficient?		
Empathy	How do your customers feel about robots?	How do you think having a service robot impacts the server-customer interaction? Do your customers treat you differently when you are using the robot during service?	
Responsiveness	Does the robot slow down your service to the customer? Does the robot inhibit your ability to deliver good service to your customers?	In what ways could the robot or service standards change in order for you to give better service?	
TAM/UTAUT			
Perceived usefulness (PU)	If your opinion, what, if any, impact has the service robot had on your job?	What might be some possible benefits and challenges to your job since working with the service robot?	Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3) pp.319 - 340.
Perceived usefulness (PU)	What functions do you find most helpful when using the service robot?	What do you wish the service robot could do, or do better? How can the functionalities of the robot be improved?	de Kervenoael, R., Hasan, R., Schwob, A. and Goh, E., 2020. Leveraging human-robot interaction in hospitality services: Incorporating the role of perceived value, empathy, and information sharing into visitors' intentions to use social robots. *Tourism Management, 78,* p.104042.
Perceived usefulness (PU)	What has the service robot done to increase or decrease your productivity, and in what ways?	Increased job satisfaction or engagement? Reduction in sick leave or absenteeism?	
Perceived ease of use (PEU)	Have you experienced any challenges associated with using the service robot at work? If so, what were these challenges?	How did you work to overcome them? What impact has this had on how you feel about your job or how you feel about your organization?	Venkatesh, V. and Davis, F.D., 2000. A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*(2), pp.186–204.

(*continued*)

Table A1.

Theoretical framework/measure	Primary interview question(s)	Secondary interview question(s)	Reference
			Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D., 2003. User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), pp.425–478.
UTAUT			
Facilitating conditions	Have you noticed any improvements in safety while using the service robot?		Lee, Y., Lee, S. and Kim, D.Y., 2021. Exploring hotel guests' perceptions of using robot assistants. *Tourism Management Perspectives, 37*, p.100781. Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D., 2003. User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), pp.425–478.
Facilitating conditions: coworkers	Have you noticed any changes in your coworkers or their behavior since using the service robot?	Have you been able to try new service standards while observing your coworkers using the service robot?	
Facilitating conditions: management	How often do you and the management talk about ways to improve working with the robot? Does your team have any goals in using the robot?	Have you noticed any unintended consequences of using the robot?	
Facilitating conditions: management	What type of training have you received prior to using the service robot? What type of supervisory or managerial support have you received since using the service robot?	To what extent do you feel supported in your organization given the training you have received to work with robots?	

Source: Created by the authors