Working with Robots in Restaurants: Job Responsibility and Work Motivation Changes

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***Abstract*— Human–robot work collaboration can be complementary where both the robot and employee use their strengths to complete the task at hand. But who is ultimately responsible for the task? Employees may assume more or less responsibility when working with robots, which can have a direct impact on job outcomes. In this paper the authors use the job characteristics model as a framework to investigate changes in job characteristics and their impact on job responsibility and worker outcomes as a result of robot implementation in restaurants. The results identify changes in task significance, job autonomy, and feedback from the job as important predictors of changes in experienced responsibility toward work. The study also found a significant positive relationship between job responsibility and motivation to work.**

I. Introduction

The use of service robots in the workplace is expected to grow substantially with the ongoing advancements in robotic technology [1]. Service robots are designed to assist workers in accomplishing their work tasks [2], [3], [4] and are expected to share the same workspace with employees while performing joint work tasks [5]. Service robots can provide advantages to organizations like increased productivity, dependability, scalability, and improved customer retention while also providing cost savings [6], [7]. According to a recent report, the global market of service robots was estimated at USD 41.5 billion in 2023 and is expected to increase to USD 84.8 billion by 2028 [8].

Employees' job responsibilities, tasks, and obligations associated with their job are expected to change dramatically with the introduction of service robots [9]. Although job responsibility has been associated with employee outcomes such as work motivation, we know very little about how changes in job responsibility are likely to impact employees working with service robots. This is problematic both academically and practically. Scholars must comprehensively integrate the impact of robots into their work theories to advance academic understanding in this domain [10], [4]. Practically, designers and managers should be cognizant of work design changes that may adversely affect job responsibilities to avoid problematic changes [4], [3], [11].

This study addresses significant questions regarding the anticipated shifts in job responsibilities stemming from the introduction of robots in restaurants. Service robots are increasingly being deployed in restaurants to enhance efficiency, improve customer service, and address labor shortages. Furthermore, the global market size for service robots in the hospitality industry, including restaurants, is projected to grow from USD 1.29 billion to USD 3.86 billion by the end of 2030 [12]. The hospitality industry, particularly restaurants, has been known to be quite resistant to technological advancements [13], and the ways different stakeholders interact in this industry has remained largely unchanged for decades [14]. But the emergence of increasingly intelligent technology has afforded hospitality businesses to start automating their processes, which may include the deployment of robots. However, not much is known about the changes in job dynamics and their resulting impact on human–robot collaboration brought about by the growing use of technology such as service robots.

We used the Job Characteristics Model (JCM)—a theoretical framework to understand the relationship between job characteristics and job outcomes [15] —to explore how employees' perceived responsibility in their roles and consequently their work motivation may change with the introduction of robots into the workplace. We also identified factors influencing these changes. By delving into these questions, we seek to enhance our comprehension of job design in the context of human–robot interaction, thereby facilitating a seamless transition and fostering greater acceptance of robots in work environments [5].

The study explored the JCM by surveying 220 service employees regarding their anticipated changes in job dynamics as a result of robot implementation in restaurants. Results, based on a regression analysis, indicate that perceived changes in task significance, job autonomy, and feedback from the job are associated with anticipated changes in job responsibility. Furthermore, the study found that job responsibility has a significant impact on motivation to work.

II. Literature Review

A. Service Robot Adoption

Service robot adoption offers several benefits, including increased productivity, cost savings, and improved service quality [4], [7], [16]. Scholars have found service robots to hold the potential to aid in assistive tasks in under pressure service sectors like hospitals [5], elderly care [16], and ambulatory care [17]. Service robots are also known to attract customers in retail [18], [4] and enhance crucial parts of the business, like communication and data analysis [19].

Despite these advantages, research indicates that user experiences with robots in the service domain often fall short of expectations [11]. Service robots are known to cause

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frustration and perceived loss of job autonomy [11], [20]. Research indicates that robots often require humans to learn how to effectively use and coordinate with them because they can lack the intuitiveness and empathy necessary to operate independently in service environments [21], [22]. The learning curve to work with robots can be hard, leading to confusion, demotivation, miscommunication, and distrust among employees [22]. These concerns are often accompanied by the fear of job displacement [23].

Researchers in the field of human–robot interaction (HRI) have explored various design aspects aimed at improving the effectiveness of robots as collaborators with humans. For example, researchers have tried to explain collaboration as a determinant of shared identity and common ground based on the robot's appearance [24]. Similarly, researchers have explored anthropomorphism [25] and trust from design [26]. However, most research has failed to acknowledge the perceptions and preferences of the humans in human–robot collaboration [10]. Recognizing and understanding employees' concerns is pivotal to taking advantage of the opportunities offered by human–robot collaboration. With this study, we assess anticipated changes in employees' perceived job responsibility as a result of robot implementation in the workplace and investigate the factors that may cause these changes. We also explore how these changes impact the employees' motivation to work on a task.

B. Job Responsibility

Job responsibility in organizational tasks has been shown to have a positive impact on decision-making quality [27], [28], [29]. However, taking on excessive responsibility can lead to rigidity and unpleasantness at work, while lacking enough responsibility can result in disempowerment and demotivation [27], [28], [29]. Therefore, determining the right balance of job responsibility becomes vital.

When collaborating with robots, employees may vary in the degree of responsibility they assume [24]. Ideally, in collaborative tasks, humans and robots complement each other's skills, enhancing overall productivity [5], [24]. However, some individuals may perceive robots as displacing human workers or find it challenging to keep pace with them, leading to frustration and disempowerment [20], [22], [30]. Consequently, these employees may relinquish responsibility and become less motivated to collaborate with robots [31].

Job design is crucial in shaping individuals' changing responsibility when working with robots [32]. While factors like perceived common ground and shared identity can facilitate collaboration, fear of displacement and cognitive strain may hinder it. In this paper, we propose that JCM can provide theoretical insights into the role of job responsibility in human–robot work collaboration. In the next section, we explain the JCM and how it helps us theoretically understand and investigate the changes in job responsibility on human–robot work collaboration.

III. Hypotheses Development and Research Model

The Job Characteristics Model (JCM) explains how job characteristics affect an individual's psychological state and, in turn, influence job-related outcomes [31], [33]. The JCM asserts that five job characteristics positively influence feelings of job responsibility [31], [34]. The five job characteristics are: (1) task significance, or the extent to which a job has a substantial impact on the lives of other people; (2) task identity, or the extent to which a job involves a whole identifiable outcome; (3) skill variety, or the extent to which a job includes a range of activities that require the use of different skills and talents; (4) job autonomy, or the extent to which a job provides substantial freedom, independence, and discretion to the employee in scheduling the work and in determining the procedures to be used in carrying it out; and (5) feedback from job, or the extent to which carrying out the work activities provides the employee with clear information about his or her performance. The JCM further posits that responsibility can lead to higher employee motivation to work on a task [35].

Given the limited understanding of how working with robots affects employees' sense of job responsibility, we used the JCM to examine workers' anticipated shifts in perceived task responsibility when collaborating with robots. Additionally, we investigate how sense of job responsibility relates to work motivation, which can increase productivity on the job through persistence and performance [31].

Our hypotheses were derived from two overarching theoretical assertions: (1) anticipated changes in job characteristics will result in corresponding changes in experienced job responsibility, and (2) anticipated changes in experienced job responsibility will lead to changes in work motivation. Next, we explain each hypothesis in detail.

A. Skill Variety, Task Identity, Task Significance, and Job Responsibility

Skill variety, task identity, and task significance are three job characteristics that have often been hypothesized as a set rather than individual elements [31], [33]. We propose that these three characteristics can impact experienced job responsibility in the context of human–robot collaboration.

Robots usually excel in doing complex, physically demanding, and mundane tasks [16], [5]. While robots take care of routine and labor-intensive jobs, humans can usually focus newfound time on acquiring more skills and strategic decision-making and creativity [36]. This additional time can also be used to complete various tasks and focus on performance that prioritizes the good of others, thus enhancing task identity and task significance [36].

An increase in skill variety, task identity, and task significance can contribute to experienced responsibility through the investment of an array of skills and talents at the job to complete the job efficiently and for the overall good. With more skill variety, employees are not only called upon to use more of themselves in the performance of the job, but they can also do that with less cognitive strain owing to the

range of skills they have acquired. Investing in a job with a variety of skills also boosts their confidence in retaining their position and increases their accountability for the task [37]. The lack of cognitive strain about competing with the robot and the gain in understanding of the robot with the help of new skills can help employees achieve common ground with the robot and boost collaboration [24]. An increase in task identity makes the employee responsible for the completion of a task from start to end, thus increasing responsibility and accountability. And an increase in task significance can boost a person's shared identity with the robot because both work together for the wellbeing of others [37], [24].

Robot implementation can also lead to a decrease in skill variety, task identity, and task significance. The introduction of robots can lead to task fragmentation. When robots take over entire tasks or a major part of an employee's work, the employee might be left with little to be accountable for and experience a decreased sense of responsibility toward the job [38]. Similarly, a lack of role identification can decrease the sense of owning a task or completing it from start to finish, reducing task identity. As a result, employees might feel less accountable and responsible. When employees do not have control over task completion and outcomes, the significance of a task decreases for them, and they do not want to be held accountable for it [37]. Therefore, we propose a direct association between skill variety/task identity/task significance and job responsibility in the context of human–robot work collaboration.

H1) Expected increases/decreases in (a) skill variety, (b) task identity, and (c) task significance due to the implementation of robots are associated with corresponding expected increases/decreases in experienced job responsibility.

B. Job Autonomy and Job Responsibility

The JCM proposes a positive association between job autonomy and experienced responsibility such that an increase in freedom to do the job will lead an employee to feel more responsible for completing the job. With the implementation of technology like robots in the workplace, organizations try to push decision-making responsibility and monitoring to lower levels in an organization [39], [40]. In many cases, decision-making is dependent on the working and performance of the robot, leading employees to feel less control over their own work [37]. Extant research also shows employees' frustration with new technology [41] and perceived loss of autonomy in their ser- vice jobs with the implementation of robots [20]. This may result in tensions such as disengagement, dismemberment, and disempowerment [42] and lead to negative feelings of responsibility toward the job.

Contrarily, sometimes employees have the freedom to program, instruct, and monitor the robots, allowing them to have control of the overall task [43]. This feeling of increased job autonomy should be accompanied by an increased sense of responsibility for getting the job done. Hence, consistent with the JCM, we propose that perceived changes to job autonomy as a result of robot implementation will lead to direct changes in perceived job responsibility.

H2) Expected increases/decreases in job autonomy due to the implementation of robots are associated with corresponding expected increases/decreases in perceived job responsibility.

C. Feedback from Job and Job Responsibility

Feedback from the job promotes employees' intimate association with their work [31]. This means that an increase in feedback granted for a job should help employees understand their work better. The implementation of robots can enhance this feedback by providing accurate, timely, and rational insights. Consequently, it can enhance the understanding of the job. An increased understanding of the job leads a person to take ownership of the job and complete it with an increased sense of responsibility [37].

Working with robots can also result in less actionable feedback from the job for the employee. This is because in a collaborative task where the superiority of the robot is needed to complete the task, the feedback may not highlight the competencies or areas of improvement for the employee. It may also be unclear whether the feedback is for the employee or the robot. Using such feedback for job design and process improvement can result in overwhelming and challenging goals for human employees and can negatively impact job outcomes [44], [45]. As a result, an employee does not feel appreciated or useful and can experience a reduced sense of responsibility toward the job. Therefore, we propose that feedback from the job has a direct association with perceived responsibility in the JCM such that anticipated changes in feedback from the job can result in changes in employees' experienced job responsibility.

H3) Expected increases/decreases in feedback from the job due to the implementation of robots are associated with corresponding expected increases/decreases in experienced job responsibility.

D. Job Responsibility and Work Motivation

Extant research emphasizes the negative impact of the lack of feelings of responsibility on job outcomes: employees with a lost sense of responsibility at the job find themselves demotivated to perform or stay at the job [41]. Decreased accountability toward tasks can lead to a decreased interest in pursuing career aspirations, which negatively impacts the motivation to perform, excel, or complete the job [40]. Robot implementation should lead to positive/negative changes in experienced responsibility from positive/negative changes in skill variety, task identity, task significance, job autonomy, and feedback from the job. These changes should be directly associated with changes in work motivation.

H4) Expected increases/decreases in perceived job responsibility due to the implementation of robots are associated with corresponding expected increases/decreases in work motivation.

IV. METHOD

We conducted a survey to test the proposed relationships in the JCM with data from 220 restaurant employees. Participants were 18 to 67 years in age, with an average age of 36.8 years. The majority of participants identified as female (64.5%), followed by male (34.5%), with one transgender male (0.5%) and one participant who chose not to specify their gender (0.5%). On average, restaurant em- ployees worked 8.8 hours per day, with a standard deviation of 2.5 hours. Their average employment duration in the restaurant industry was 9.5 years.

Data were collected using an online survey through the Qualtrics platform. The survey depicted four pictures of robots (cook, greeter, server, cashier) currently being deployed in restaurants (Appendix 1). Participants were told that such robots are expected to be part of the workforce and working side-by-side with the employees in the next five years. Participants were also provided with a description of the robot with its respective picture (for example: robots as counter cashiers).

Participants were then asked about their perceptions of expected changes in the JCM constructs on a 7-point scale. Items for all constructs including skill variety, task identity, task significance, job autonomy, feedback from the job, job responsibility, and work motivation were adapted from Hackman and Oldham [31] (Appendix 2). Reliability was assessed by calculating Cronbach's alpha and all values comfortably surpassed 0.70, affirming high reliability of scales. Four control variables were considered: age, gender, work hours per day, and years in the profession. However, none of the control variables was significant.

A. Analysis and Results

The study used regression analysis to evaluate the hypotheses. H1 posited that expected changes in (a) skill variety, (b) task identity, and (c) task significance due to the implementation of robots are associated with changes in experienced responsibility toward the job. Expected changes in skill variety (β = 0.015, p $>$ 0.05) and task identity (β = 0.018, p $>$ 0.05) were not significantly related to changes in experienced responsibility on the job. However, there was a significant positive relationship between task significance and experienced job responsibility (β = 0.167, p $<$ 0.05) which indicates that only H1c was supported. H2 and H3 posited that expected changes in job autonomy and feedback from the job due to the implementation of robots are associated with changes in experienced job responsibility. Results confirmed that both job autonomy (β = 0.167, p $<$ 0.01) and feedback from the job (β = 0.313, p $<$ 0.00) were positively related to changes in experienced job responsibility. As such, both H2 and H3 were fully supported. As hypothesized in H4, expected changes in job responsibility due to the implementation of robots were positively associated with changes in work motivation (β = 0.62, p $<$ 0.000), which fully supports H4. The model explained over 35 percent of the variance associated with job responsibility and 48 percent of the variance associated with work motivation. The research model and results are illustrated in Figure 1.

V. DISCUSSION

The study utilized the JCM to reveal job characteristics that can influence employees' changes in feelings of work responsibility and highlighted the importance of felt responsibility in determining work motivation. This section outlines the study's contributions and limitations.

First, this study emphasizes the importance of utilizing established work theories such as the JCM to identify employees' anticipated changes associated with working with a robot in the service sector. The JCM framework allows HRI researchers to identify significant job characteristics for work redesign and allows researchers to apply novel and interesting findings to the larger JCM literature. This holds immense potential because it facilitates smooth integration with and utilization of the existing work redesign literature and enhances our understanding of the various implications of robots in the workplace [38].

Second, our study identified the most relevant factors to changing employees' perceived work responsibility: task significance, job autonomy, and feedback from the job. In doing so, the study highlights that not all job characteristics are relevant to understanding feelings of job responsibility in the context of working with robots. Consequently, our findings support a nuanced approach to applying existing work theories, such as the JCM, within robotic work environments. By contextualizing these theories, we can unveil novel insights that are crucial for researchers in the HRI field.

Third, this study demonstrated the importance of changes in task significance, job autonomy, and feedback from the job in determining changes in employees' feelings of responsibility toward the job, emphasizing that a job that is high in these characteristics is likely to boost employees' sense of responsibility and lead to higher work motivation. While our results support the hypothesized relationship between job autonomy and experienced responsibility in the JCM, they also highlight task significance and feedback from the job as novel predictors of employees' experienced responsibility. An emphasis on task significance underscores the effectiveness of service robots in industries that emphasize the well-being of others, for example restaurants, hospitals, and security. The significance of job feedback highlights the importance of employees understanding the job [37] and robot-employee roles [10], [5] to achieve better human-robot collaboration. Finally, the study reinforces extant literature in supporting the role of job responsibility in increasing work motivation by increasing the employees' ownership of the job, their sense of purpose, and their desire for clear expectations and feedback.

The study also has important practical implications. Organizations could use job characteristics like task significance, job autonomy, and feedback from the job to improve human–robot collaboration. For example, organizations could emphasize the overall good achieved by a job and the critical and complementary role of the employee in achieving it. This

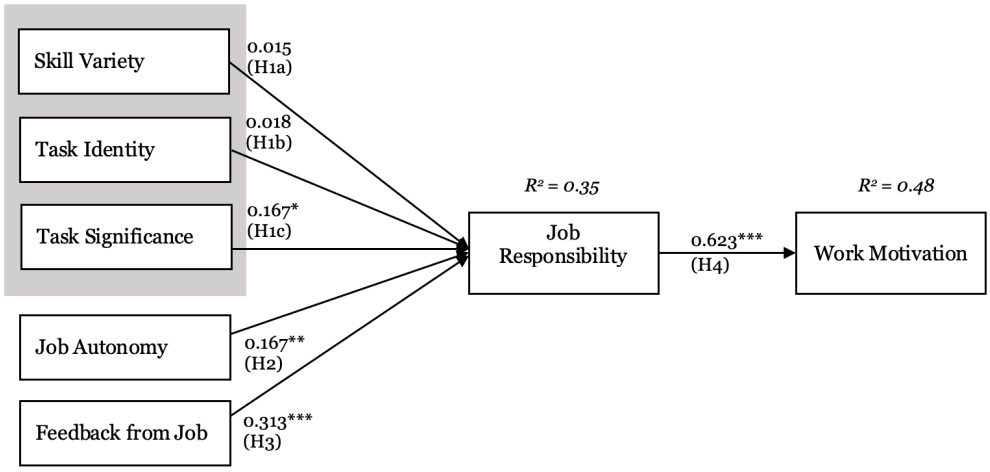

Fig. 1. Quantitative Results

would promote job responsibility and collaboration with the robot. Organizations could also focus on determining clear task roles and division in responsibility so that employees do not feel dependent on the robot in achieving their task goals. One way designers could facilitate this while promoting job autonomy is to design work arrangements that allow employees to determine the role of the robot and human in a given task [46], [47]. This would also help with promoting a culture of synergy rather than dependency. Last, creating appropriate mechanisms to provide constructive feedback about work tasks to employees who are working alongside a robot could help increase the employees' feelings of responsibility toward the job and their motivation to improve.

VI. Limitations

The study is not without limitations. While we attempted to prime participants using pictures, we conducted the study online, relying on participants' perceptions rather than actual work-related changes from interacting with robots. Thus, studying anticipated changes is just the first step in exploring robot integration and job design. Field experiments with experienced employees or a longitudinal study tracking real changes would help to validate our conclusions.

Our research provides a starting point for HRI researchers to study the Job Characteristics Model (JCM) within the context of robot implementation. While the JCM has been used effectively for work redesign, it lacks technology-specific constructs relevant to technology implementation outcomes. This presents an opportunity to explore new technology-related constructs that could enhance the existing model. Additionally, future research could investigate the mediating role of psychological states and the moderating role of factors like shared identity in robot implementation.

Finally, we acknowledge the unique setting of our study. While we recognize the limitations related to generalizability, we believe our findings provide valuable insights that can be applied and adapted in diverse contexts. Future research could further test and expand upon our results in settings relevant to robot implementation in the workplace.

VII. Conclusion

Work arrangements involving human–robot collaborations are on the rise. Robots have the potential to greatly influence the dynamics of work, positively or negatively. This study investigated changes in job characteristics and their impact on employees' sense of job responsibility and consequent motivation to work. Our findings highlight the role of task significance, job autonomy, and feedback from the job in determining when the employee takes or cedes responsibility in a human–robot collaborative task. They also underscore the importance of job responsibility in motivating the employee toward achieving relevant job outcomes. Most important, the study findings emphasize the need to study human–robot interaction in the workplace and highlight the importance of job redesign in the successful implementation of robots.

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Appendix 1 and 2: Online Repository