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Robotic Workforces' Value and Relationships with Human Employees: The Impacts on Human Work Efficacy

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Short Research Paper

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Abstract: As artificial intelligence (AI) and robotic process automation (RPA) develop rapidly, robotic workforces are playing increasingly prominent roles in enterprises as an emerging human resource force. This development is affecting the psychological state of human employees. Drawing upon social comparison perspective, this research examines how human employees perceive the value of robotic workforces and the human-robot relationship. The study also analyzes how these perceptions jointly influence employee work efficacy. The following two unexplored issues are addressed: First, the study focuses on the interactions between the perceived value of robotic workforces and the perceived human-robot relationships by human employees. Those interactions can be divided into four categories. Second, the study examines the social comparison process in human- robot interaction. This research enriches the meaning of social comparison and analyzes the changes of human employees' psychological states. A mixed design is developed to empirically test the proposed model and hypotheses.

Keywords: robotic workforce; value; human-robot relationship; social comparison; work efficacy

1.INTRODUCTION

In the age of the digital economy, companies increasingly deploy advanced digital technologies, including artificial intelligence and robotic process automation, to engage in digital transformation[1]. The term "robotic workforce" essentially refers to robots that are capable of conducting tasks in a human-like way in the workplace. These tasks mainly consist of automatically running software robots and service-oriented robots with physical characteristics [1].

Representing an emerging type of workforce, the robot workforce is bound to greatly influence the existing human resource ecosystem [2] [3]. According to McKinsey's forecast, automation investment in the United States will reach $145 billion by 2030, and the modeled unemployment displacement will be 23 percent [4]. The World Economic Forum report predicts that 42% of workers will be replaced by machines [5]. With high standards in efficiency, competence, controllability and low costs, a robot workforce can play a momentous role, especially in the fields of manufacturing, finance, accounting, healthcare and other industries [1]. This degree of automation in the workplace will arguably change human employees, psychologically speaking, and will eventually transform their behavior. Therefore, exploring how human employees perceive and respond to the presence of their robot colleagues is critical.

Robotic workforces have attracted considerable academic attention. Ljungblad et al. (2012) examines how human workers perceive their robotic peers [6]. Yogeeswaran et al. (2016) focuses on the impact of certain features of robot workforces on human employees [7]. Muthusamy et al. (2020) looks at the contribution of a robot workforce to corporate operations [8]. Prior studies contribute to our understanding of the value of robot workforces. However, little attention has been paid to how a robot workforce influences specific psychological changes among human employees. Because this phenomenon has only appeared over a relatively short time, people are still in the initial stages of figuring out what a robot workforce is, rather than focusing on why and how it is. This study

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highlights two research gaps that deserve further examination.

First, few studies to date have examined how human employees perceive their robot peers; the impacts of these perceptions on the psychological states of human workers have also not been explored. Despite the fact that some studies argue that the features of digital workers can have effects on human workers [7], the underlying mechanism is unclear. Furthermore, various features of digital workers could jointly, rather than separately, influence how human employees perceive and behave in human-robot interactions [7]. These joint effects are far from clear.

Second, prior literature tends to treat robots as a tool or instrument in the workplace. Little research focuses on possible social comparisons during human-robot interaction. With the development of AI and RPA, human employees tend to treat robots with in-built social cues as colleagues, and social comparisons may emerge in human-robot interaction. Therefore, social comparison, which is typically used to understand human-human relationship/interaction, may be a meaningful perspective to understand this issue.

Motivated by these research gaps, this research explores the effects of perceived value and human-robot relationships on human employees' work efficacy from a social comparison perspective. Overall, this study's model proposes to disclose how the perceived features of robots in the workplace influence human employees' psychological states.

2. THEORY AND HYPOTHESES DEVELOPMENT

2.1 Robot value and human-robot relationship

The perceived value of a robot workforce (by human employees) indicates the extent to which robots in the workplace are perceived valuable in terms of performing tasks. Human perception of robot value relies on the functionality of robots and tasks these robots are supposed to fulfill. Robots may be perceived to present high value in performing routine, repetitive, and error-prone tasks [1].

Human employees may perceive robots in the workplace as either competitors or collaborators. Thus, human-robot relationships can be divided into cooperative and competitive categories. Human employees that hold a perception of cooperative human-robot relationships usually view robots as assistants in performing tasks. Srnicek and Williams (2015) argued the positive role of robots by proposing that robots can save people from tedious chores, rather than replacing humans [9]. On the contrary, other human employees may perceive that robots can equally or better deal with the same tasks and that they (the human employees) may be replaced by these superior robots. This pessimism is also supported by Ford (2015), who noted that robots could threaten human employees' job security [10]. Various perceptions of human-robot relationships may generate different emotions among human employees. In contrast to competitive robots, perceived cooperative robots likely bring about positive emotions in human employees [11]. Overall, human employees feel differently when they perceived different human-robot relationships.

Robot value and human-robot relationships can jointly influence human workers' psychological states and behaviors [7]. Based on the levels of perceived robot value and the types of human-robot relationships, this research classifies workplace human-robot interaction into four categories.

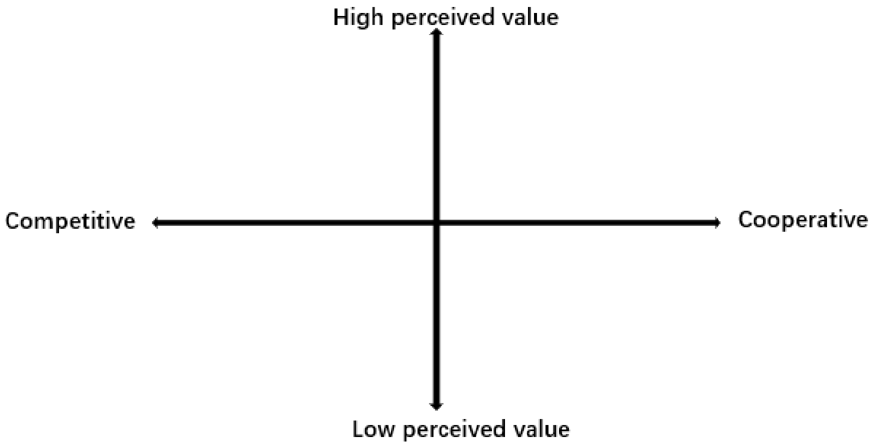

Figure 1. The category of robot workforce interaction

As Figure 1 shows, four corresponding types of robot relationships exist. (1) The high value and cooperative relationship represent a robot that is perceived by human employees to have high value and be cooperative during human-robot interaction. This type of robot can be a great workplace partner and helps reinforce human employees' efficiency. (2) The high value and competitive relationship represent a robot that is perceived by human employees to have high value and be competitive during human-robot interaction. This type of robot is a strong competitor for human employees' jobs and could even replace human beings in the future. (3) The low value and competitive relationship represent a robot that is perceived by human employees to have low value and be competitive. This type of robot is an inferior competitor that actually brings confidence to humans. (4) The low value and cooperative relationship represent a robot that is perceived by human employees to have low value and be cooperative. This type of robot is an inefficient collaborator.

2.2 Social comparison in human-robot interaction

Festinger (1954) proposed the social comparison process among individual situations, status, characters, etc., in order to subjectively realize individual evaluations [12]. Social comparison produces either a contrast effect or an assimilation effect, which engenders diverse perceptions, depending on the specific situation [13]. Social comparison appears so universal that it has been used to explain various social behaviors, such as human self-evaluation, self-improvement, and self-satisfaction.

Social comparisons can be divided into three types: parallel comparison, upward comparison and downward comparison. Parallel comparison means to compare with others who are less divergent from himself [12]. Downward comparison means to compare with others who are inferior; conversely, upward comparison means to compare with others who are superior [14] [15]. Although early studies believed that individuals can achieve a good understanding of themselves through parallel comparison, later studies noted that downward comparison and upward comparison work better in self-evaluation. Thus, this study focuses more on the latter two. In particular, humans tend to choose inferior comparison targets that can induce positive emotions and desirable conclusions. Prior literatures examine how downward comparison is likely to produce positive emotions, whereas upward comparison is likely to produce negative emotions [15] [16]. Conversely, it was noted that self-expectation influences comparison results. In other words, if human expectation is lower than the expectations related to the comparison objects, negative emotions and self-evaluation will emerge. Alternatively, if human expectation is equal to or higher than the expectations related to the comparison objects, positive emotions and self-evaluation emerge [18]. In particular, upward comparison can produce positive assimilation effects when the intimate comparison object becomes an important part of the human's self-concept [17].

Humans evaluate themselves not only by comparing themselves with others, but also by comparing themselves [18]. Social comparison with others represents an inter-person comparison, which includes parallel comparison, upward comparison and downward comparison. Social comparison with selves represents an intra-person comparison, which includes comparisons with selves in the past, present and future. This type of comparison can also be called temporal comparison [19]. The purpose of intra-person social comparison is to obtain satisfied emotions, rather than to perform an accurate self-evaluation [18].

According to Reeves et al. (1996) and Yi Mou (2020), if technologies present social cues, humans may unconsciously treat technologies as humans [20] [21]. This implies that the understanding of social interactions among humans can be applied to human-robot contexts. Ljungblad et al. (2012) argued that human employees regard robots as workplace partners [6]. Particularly, physical robots are given certain human features, such as human-like figures, specific genders and human names [12] [21]. Besides, there exist three basic conditions for the formation of social comparison: (1) Humans are motivated to evaluate their own value and capabilities [22]; (2) Comparisons with others enhance self-understanding [22]; (3) A comparison is useful for evaluating individual value and capabilities [22]. These assumptions of social comparison also apply to the human-robot interaction. Overall, workplace robots could be the targets of social comparison for human employees.

When human workers perceive that a robotic workforce presents high value and cooperativeness, they may experience upward comparison. Since no substitution relationship exists, human employees treat robots as workplace partners, and they can collaborate with robots more efficiently. This situation reinforces human employees' self-awareness and positive emotions. Moreover, human employees can achieve self-improvement by observing and learning from their robotic peers. Therefore, this robotic workforce can create a sense of support [13]. Additionally, human employees feel more confident when they conduct an intra-person comparison and find that they can perform tasks better with the help of robots than they can in situations with no robots. Thus, we propose:

Hypothesis 1a: When human employees perceive that robotic workforce has high value and is cooperative, they perceive supports from robots.

When human employees perceive a high value of robots and a competitive human-robot relationship, they experience an upward comparison. Competition between humans and robots implies that robots can replace human employees and therefore decrease the benefits of human employees. The competition between humans and robots becomes fierce when robots are believed to have high value. In this circumstance, human employees may interpret robots as a highly-competitive substitute and as a source of threats to the humans' employment [15]. Thus, we propose:

Hypothesis 1b: When human employees perceive that a robotic workforce has high value and is competitive, they perceive threats from robots.

When perceiving low value robots and a competitive human-robot relationship, human employees may go through a downward comparison. Comparing themselves with inferior competitors, human employees may generate positive emotions and enhanced self-evaluation. Therefore, this comparison brings about a sense of support [15].

Hypothesis 1c: When human employees perceive that a robotic workforce has low value and is competitive, they perceive support from the robots.

When perceiving low value robots and a cooperative human-robot relationship, human employees may go through a downward comparison. A cooperative human-robot relationship may cause the development of positive feelings toward human-robot interaction. However, the perceived low value of robots may mitigate this feeling. Thus, we posit:

Hypothesis 1d: When human employees perceive that a robotic workforce has low value and is cooperative, they have neutral feelings toward the robots.

2.3 Work efficacy

Work efficacy refers to the subjective evaluation of confidence in human ability as related to performance [23]. Work efficacy is most important for motivation, attitude, and performance in the workplace. Self-judgment and social comparison can form work efficacy. When humans conduct various types of social comparisons, they develop a clearer evaluation of themselves and further influence how they evaluate their capacity in the workplace. Therefore, we propose:

Hypothesis 2a: If human employees perceive supports, their work efficiency would be high.

Hypothesis 2b: If human employees perceive threats, their work efficiency would be low.

Hypothesis 3: Human employees' perceptions (i.e., perceived supports/threats) mediate the integrative effect of robot value and the human-robot relationship on work efficacy.

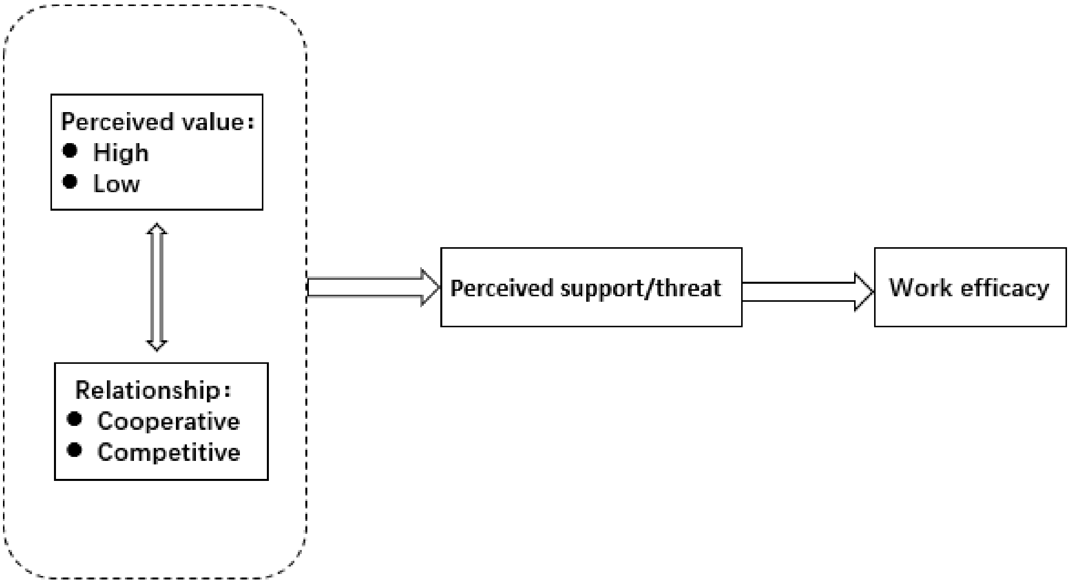

Figure 2. The process of social comparison in human-robot interaction

In summary, the conceptual model is shown in Figure 2.

3. RESEARCH DESIGN

This research intends to use a mixed research design to empirically test the study's propositions. Two studies are planned: Study 1 would conduct a scenario-based experiment to verify specific hypotheses. Study 2 purposes to conduct a survey, in order to further verify the hypotheses.

3.1 Study 1: An experiment

We plan to recruit college students to participate in this experiment. The participants will be invited to take part in a spelling check game. They will be told that robots will be used to work with them to identify and correct misspellings. The time limit for each round will be 15 seconds. If all the misspellings are found and corrected in the given time limit, the round ends automatically. Robots will be designed to have both low-level and high-level performance in terms of speed of spelling check. Human-robot relationships will be manipulated by designing different game rules. Specifically, a game rule is set for a cooperative relationship, in that the total commission for success is shared by participants and robots, with 80 percent for participants and 20 percent for robots. A competitive relationship is manipulated by setting a rule that stipulates that participants who perform better get all the commissions. Participants will be informed that the supervisor expects them to complete more than 50 accurate corrections per round if they are to receive special rewards (to make them participate seriously).

The experiment will be conducted with an inter-group design of 2 (robot value: high vs. low) x 2 (human-robot relationship: cooperative vs. competitive). First, participants will be asked to fill in their demographic information. Second, the task scenario will be introduced to them. Third, the novice task will be completed first. This indicates that the participants who complete tasks alone and receive the full commission represent the benchmark. Fourth, the experiment will formally start. Participants will be randomly divided into four groups that match the four types of robot (high value cooperator, high value competitor, low value competitor and low value cooperator). The participants will be reminded of how to calculate their commission. Then, the respective challenge begins. Finally, participants will be asked to answer the following questions regarding: (1) social comparison results. For example, "Do you think a robotic workforce can help (or threaten) you a lot if the game continues?" (2) They will also be asked about work efficacy. For example, "If you continue to work with the robot, are you more confident in getting a higher commission, compared with the novice task?"

3.2 Study 2: A survey study

The authors further plan to develop a questionnaire combined with existing scales to collect data from employees working with robots. The questionnaire consists of four parts: (1) demographic information; (2) human employees' perception of robot value and human-robot relationships; (3) human employees' perceived support, threat, and neutral feelings, and (4) work efficacy. A structural equation modeling method will be used to analyze data and empirically test the proposed model.

4. SUMMARY

This study's purpose is to make the following theoretical contributions: (1) The study applies social comparison perspective to examine human-robot interaction. (2) The study further explores how various perceptions of robot characteristics jointly affect human employees' psychological states.

We expect this study to contribute to practice by: (1) encouraging managers to assess human employees' psychological changes when introducing robots in the workplace and to take a few measures in advance, and (2) by offering helpful insights regarding how to respond to the coming age of robots.

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