

STARA Awareness: Work Stressors in the Age of Industry 4.0

Ping Jiang

Chongqing University of Technology, Chongqing 400054, China

Abstract: STARA awareness characterizes employees' perception of the extent to which the use of emerging information technologies such as STARA (Smart Technology, Artificial Intelligence, Robotics, and Algorithms) in the workplace affects their personal career development in the context of the Fourth Industrial Revolution. On the basis of combing domestic and international literature, scholars systematically organize the concept of STARA awareness, measurement scales, and elaborate the current research status of antecedent and outcome studies as well as mediating and moderating mechanisms of STARA awareness. Finally, we further prospect the future research direction of STARA awareness. Future research should further explore the specific factors that influence the emergence of STARA awareness and expand the mediating mechanisms and outcome effects of STARA awareness.

Keywords: STARA awareness; stressors; antecedent studies; outcome mechanisms.

1. Introduction

In the era of new technological revolution driven by information technology, Smart Technology, Artificial Intelligence, Robotics and Algorithms are gradually being applied to various industrial fields and have acquired extensive attention from scholars. Taking Artificial Intelligence and Intelligent Technology as the research background, scholars point out that STARA applied to work will affect all aspects of society, life and even business (Salas et al., 2017, Makridakis, 2017). It is estimated that approximately one-third of jobs will be replaced by smart technologies by 2050 (Frey & Osborne, 2013). This substitution will not only occur in simple and basic operative tasks, but may also gradually replace highly skilled jobs. In a study aimed at determining the impact of automation on employment and wages in different industries, Frey and Osborne (2017) noted that transportation, logistics, office, and administrative jobs are at a high risk of automation and will lead to job loss. As a result, more and more people are worried about their jobs being replaced by smart technology and their career development being hindered, thus perceiving STARA awareness stressors. STARA awareness refers to an individual's perception of the extent to which information technology will replace his or her job (Brougham & Haar, 2018), reflecting an individual's insecurity about career stability and career development. However, some scholars have also suggested that emerging information technology not only has an inhibitory effect, but also a creative effect, which can bring more opportunities and challenges and create new jobs (Schumpeter, 2002). Therefore, it is of great significance to systematically analyze the specific causes and results of STARA awareness and its mediating and moderating mechanisms.

Recently, there are fewer studies on STARA awareness, and previous studies have shown that STARA awareness can bring negative outcomes to employees, leading to increased turnover intentions (Li et al., 2019). From a positive perspective, some scholars found that STARA awareness also helps to increase employee creativity and competitive productivity (Ding, 2021; Wang et al., 2022). However,

looking at the existing research, domestic and international studies on STARA awareness are still in the preliminary exploration stage. Most of the studies focus on the negative outcomes of STARA awareness on individual attitude, emotion, and cognition, and seldom explores its effects on individual behaviors. Moreover, the research on the mediating and moderating mechanisms of STARA awareness has just started, and it still needs to be further explored and researched.

In this study, we searched domestic and international related literature through core databases such as Web of Science and China National Knowledge Infrastructure (CNKI) according to the keywords "AI awareness, robot awareness, artificial intelligence, algorithms, STARA awareness, AA", and obtained more than 70 pieces of literature. On this basis, we firstly analyze the conceptual connotation of STARA awareness and further summarize the corresponding measurement scales, then systematically analyze and review the antecedent, outcome, mediating mechanisms, and moderating mechanisms of STARA awareness. Finally, we point out the research limitations and provide an outlook on future research directions to provide theoretical references for future research in this field.

2. STARA Awareness: Conceptualization and Measurement

2.1. Conceptualization of STARA Awareness

STARA awareness stems from the exploration of Smart Technology, Artificial Intelligence, Robotics, and Algorithms. While most previous studies have focused on the macro context of AI, Smart Technology, and Algorithms, scholars have suggested that Artificial Intelligence (AI) is challenging the foundations of businesses and changing the way people work globally (Salas, 2017). It not only affects jobs and tasks, but also potentially improves organizational efficiency. STARA has been widely used in various industry sectors, including logistics, services, and tourism (Almada-Lobo, 2016; Ivanov & Webster, 2017). Some scholars argue that the impact of technological change on employment has not only an inhibitory effect, but also a creative effect (Schumpeter, 2002). The inhibitory effect means that emerging

technological change can enhance economic productivity and lead to the displacement of some labor forces, resulting in mass unemployment. The creation effect refers to the fact that emerging technological change generates new factors that lead to the creation of new occupations and brand new jobs. Different scholars hold different views on the effects of STARA awareness. Some scholars believe that STARA will lead to a gradual decline demand for skilled personnel, creating an over-saturated job market (Beaudry et al., 2016). Another scholars, however, believes that the negative impact of technological shock is only temporary and transient, and that the changes brought about by smart technologies such as artificial intelligence will do more good than harm in the long run. Overall, previous research on STARA mainly focused on macro-level impacts such as society and employment, but there was a lack of empirical studies on the impact of STARA awareness on individual thoughts, attitudes and behaviors.

In recent years, scholars have focused on exploring the impact of the impact of emerging technologies on individuals' thoughts and perceptions at the micro level to further understand how employees perceive technologies such as STARA and how they will respond to emerging technological changes. Brougham and Haar (2018) summarized smart technologies, artificial intelligence, robotics, and algorithms as STARA and firstly proposed STARA awareness to characterize the perceived stress of the degree to which employees anticipate that emerging information technologies will impact careers and displace human jobs.

Subsequently, other scholars expanded and extended the concept of STARA awareness according to different research perspectives and themes, further deriving concepts such as AIRA, AA, AI awareness (Li et al., 2019; Shin et al., 2022). They both reflect employees' stressful perceptions of how the use of emerging technologies affects their future career development as well as their career sustainability.

2.2. Measurement of STARA Awareness

It was found that the empirical research on STARA awareness is still in the preliminary exploration stage and there are fewer scales for its measurement. After some scholars developed or adapted, the measurement scale of STARA awareness was formed.

Based on the Armstrong-Stassen measure of job insecurity, Brougham and Haar (2018) developed and designed a four-item scale for measuring STARA awareness through exploratory factor analysis. Sample question items included "I think my job can be replaced by STARA" and so on. The scale achieved good reliability and validity and has been widely used in domestic and international studies.

3. Researches on STARA Awareness

3.1. Research on the Antecedent of STARA Awareness

There is less research on the antecedents of STARA awareness. Research suggests that technological upheavals caused by emerging technologies such as artificial intelligence and robotics cause employees to realize that AI and robots pose a threat to their jobs, creating AI and robot awareness (Arias-Pérez & Vélez-Jaramillo, 2022). In this context of great technological upheaval, employees are increasingly aware of the high risk of losing their jobs if they are replaced by intelligent robots (Lingmont & Alexiou, 2020; Rampersad, 2020).

3.2. Research on the Outcome of STARA Awareness

Current research on the impact of STARA awareness focuses on its negative impact on employees' attitudes, emotions, and perceptions, but less on its positive impact.

Focusing on the negative outcomes of STARA awareness, Lingmont and Alexiou (2020) showed that STARA awareness increases employees' job insecurity. Li et al. (2019) preliminarily demonstrated that AI and robot awareness affects employees' turnover intentions. Khaliq et al. (2022), using hotel employees as their survey respondents, also found that employee turnover intentions increased when faced with AI and robot threats. As the research progresses, scholars continue to expand the impact of STARA awareness on individual work attitudes. Brougham and Haar (2018) argued that STARA threatens a person's overall career development, making it more challenging to meet individual needs, and thus proposed that STARA awareness negatively affects employees' organizational commitment and career satisfaction, and positively affects employees' turnover intention, cynicism, and depression. Kong et al. (2021) also found that there is a positive correlation between AI awareness and burnout and career competency. Meanwhile, some other scholars have noted the role of STARA awareness on individual behavioral outcomes. For example, Arias-Pérez and Vélez-Jaramillo (2022) found that when employees realize that AI poses a threat to their jobs, they are willing to hide their knowledge in every possible way. Liang et al. (2022) confirmed from the perspective of innovative behavior that AI awareness has a double-edged effect on employees' service innovation behavior through the paths of emotional exhaustion and intrinsic motivation, respectively.

In addition, some scholars have also explored the influence mechanism of STARA awareness from a positive dimension. For example, Wang et al. (2022) explored how and when hotel employees adopt proactive behaviors to further stimulate creativity in the face of the threat of AI and robots. The results suggest that artificial intelligence and robot awareness (AIRA) can positively stimulate employee creativity. Ding (2021) also focuses on the positive effects of STARA awareness, and found that STARA awareness positively promotes employees' increased engagement and organizational commitment, and enhances individual competitive productivity.

3.3. Research on the Mediating Mechanisms of STARA Awareness

By combing through the relevant literature, it was found that scholars used different theories to explore the mediating mechanism of STARA awareness, further expanding the theoretical study of STARA awareness.

3.3.1. Career theory.

Career theory suggests that organizational commitment is related to individual occupational outcomes, and that employees with high organizational commitment have high occupational competence, high job satisfaction, and low burnout. Based on this theory, Kong et al. (2021) showed that AI awareness reduces employees' organizational commitment and thus has a negative effect on career competence.

3.3.2. Work adjustment theory .

Work adjustment theory suggests that individuals will actively seek and maintain personal-environmental fit, and employees with AIRA will adopt proactive behaviors to achieve person-environment fit. Therefore, Wang et al. (2022)

proposed that the relationship between AI and robot awareness and creativity is mediated by active learning and task crafting, meaning that employees will proactively learn knowledge and skills to better cope with the challenges of AI and robotics.

3.3.3. Job Demand-Resource Theory.

The job demand-resource (JD-R) theory proposes that job demands, job resources together determine an individual's resource gain or loss, which in turn determines an employee's work. Based on it, Liang et al. (2022) found that emotional exhaustion and intrinsic motivation play a significant mediating role in AI awareness and innovative service behavior. Specifically, when AI awareness is perceived as a hindrance, employees consume a great deal of resources and energy to cope with this stressor, leading to emotional exhaustion, which inhibits innovative service behaviors. On the contrary, when employees perceive the application of AI as a challenge, they may compete with AI to demonstrate their abilities, stimulating intrinsic motivation and further promoting innovative service behaviors.

3.3.4. Cognitive appraisal theory of stress.

The stress cognitive appraisal theory suggests that individuals' responses to a particular stressor depend on how they interpret or evaluate it. Based on the stress cognitive appraisal theory, Ding (2021) systematically explored the effects of restaurant employees' challenge-hindrance appraisals of STARA awareness on individual competitive productivity (ICP) and found that employee work engagement and organizational commitment mediated the relationship between challenge-hindrance appraisals and ICP.

3.4. Research on the moderating mechanisms of STARA awareness

By combing through the relevant literature, it was found that scholars mainly analyze the factors affecting the outcome of STARA awareness from two perspectives, including individual characteristics and organizational context.

3.4.1. Individual characteristic

Brougham and Haar (2018) proposed that age moderates the adverse outcomes caused by STARA awareness, with younger employees being significantly more aware of STARA than older employees, and thus more susceptible to the negative effects of STARA awareness. Based on the locus of control theory, Wang et al. (2022) proposed that the relationship between AIRA and creativity is moderated by locus of control. Specifically, employees with internal locus of control believe they are capable of overcoming threats, take more proactive actions in response to AIRA, and show more creativity, whereas employees with external locus of control perceive themselves as incapable of performing proactive behaviors and blame external circumstances beyond their control for success or failure. Based on the job demand-resource model, Liang et al. (2022) showed that individual future orientation can mitigate the negative impact of AI awareness on employees' emotion and enhance its positive impact on employees' intrinsic motivation. The stronger the employee's future orientation, the weaker the role of AI awareness in inhibiting innovative service behaviors through emotional exhaustion and the stronger the role of promoting innovative service behaviors through intrinsic motivation.

3.4.2. Organizational context

Considering the effects of STARA awareness from organizational context factors, Li et al. (2019) found that

perceived organizational support and competitive psychological climate played different moderating roles in the relationship between artificial intelligence and robot awareness and turnover intention. Specifically, high organizational support can mitigate the negative outcomes of AI and robot adoption in the workplace by improving employees' overall well-being and job satisfaction. The high competitive psychological climate will increase the work pressure of employees and have a negative impact on their work attitude and performance, thus enhancing the positive impact of artificial intelligence and robot awareness on turnover intention.

Lingmont and Alexiou (2020) proposed and validated that authoritarian organizational culture may strengthen the relationship between STARA awareness and job insecurity. Specifically, the high authoritarian organizational culture can not only lead to a decreased sense of control over work continuity, but also lead to a high sense of power distance, making STARA awareness lead to more job insecurity.

4. Limitations and Future Prospects

First of all, from the existing research, there are few studies on the antecedents of STARA awareness. Most scholars assume that technology impact will affect the formation of STARA awareness among employees, and few scholars systematically analyze the formation mechanism of STARA awareness. However, the reasons that affect the formation of individual stress awareness are complex. Analyzing the causes of STARA awareness from the source is helpful for enterprise managers to take measures to avoid or reduce the negative effects of STARA awareness. Future studies may consider enriching the antecedents of STARA awareness from aspects such as organizational environment.

Secondly, looking at previous studies, the results of STARA awareness mainly focus on the negative results, and it is believed that STARA awareness is positively correlated with job burnout, turnover intention, insecurity and other negative consequences. Only a few scholars have discussed the positive results of STARA awareness from a positive perspective. Future research could focus more on the positive effects of STARA awareness and expand the mechanisms by which STARA awareness influences individual employee behavior. In addition, current research on STARA awareness is limited to the individual employee level. Some studies have shown that group environment may also have a unique impact on group behavior (Choi & Sy, 2010; Therefore, future research should also explore more applicability of STARA awareness and consider exploring whether STARA awareness affects team behavior and team performance.

Third, most studies focus on the moderating effect of organizational context on the effects of STARA awareness, but few scholars have considered the influence of individual trait on the effects of STARA awareness, which often fails to explain why different individuals experiencing the same stressor will produce different behaviors. Future studies should focus more on individual traits, consider whether traits such as self-enhancing humor and servant leadership affect the effect of STARA awareness, further enrich the boundary conditions of STARA awareness.

Acknowledgment

The influence effect of employees' STARA awareness on job crafting based on cognitive appraisal theory,

References

- [1] Almada-Lobo F. The Industry 4.0 revolution and the future of Manufacturing Execution Systems (MES). *Journal of innovation management*. 2015, Vol. 3 (No. 4), p. 16-21.
- [2] Arias-Pérez J, Vélez-Jaramillo J. Understanding knowledge hiding under technological turbulence caused by artificial intelligence and robotics. *Journal of Knowledge Management*. 2022, Vol. 26 (No. 6), p. 1476-1491.
- [3] Armstrong-Stassen M. Reactions of older employees to organizational downsizing: The role of gender, job level, and time. *The journals of Gerontology series B: psychological sciences and social sciences*. 2001, Vol. 56 (No. 4), P. 234-P43.
- [4] Beaudry, P., Green, D. A., & Sand, B. M. The great reversal in the demand for skill and cognitive tasks. *Journal of Labor Economics*. 2016, Vol. 34 (No. 1), p. 199-247.
- [5] Brougham D, Haar J. Smart technology, artificial intelligence, robotics, and algorithms (STARA): Employees' perceptions of our future workplace. *Journal of Management & Organization*. 2018, Vol. 24 (No. 2), p. 239-257.
- [6] Choi J N, Sy T. Group-level organizational citizenship behavior: Effects of demographic faultlines and conflict in small work groups. *Journal of Organizational behavior*. 2010, Vol. 31 (No. 7), p. 1032-1054.
- [7] Cohen J , Azoulay P , Coibion O ,et al. The Medium Is the Measure: Technical Change and Employment, 1909—1949. *The Review of Economics and Statistics*. 2016, Vol. 98 (No. 4), p. 792-810.
- [8] Ding L. Employees' challenge-hindrances appraisals toward STARA awareness and competitive productivity: a micro-level case. *International Journal of Contemporary Hospitality Management*. 2021, Vol. 33 (No. 9), p.2950-2969.
- [9] Frey, C. B., & Osborne, M. A. *Technological Forecasting and Social Change*. Lse American Politics & Policy Blog. 2013.
- [10] Frey, C. B., and Osborne, M. A. The future of employment: how susceptible are jobs to computerisation?. *Technological Forecasting and Social Change*. 2017, Vol. 114, p. 254–280.
- [11] Hidalgo, A., Gabaly, S., Morales-Alonso, G., Uruña, A.. The digital divide in light of sustainable development: an approach through advanced machine learning techniques. *Technological Forecasting and Social Change*. 2020, Vol.150, p. 1–7.
- [12] Ivanov S H, Webster C. Adoption of robots, artificial intelligence and service automation by travel, tourism and hospitality companies—a cost-benefit analysis . *Social Science Electronic Publishing*. 2017, p.19-21.
- [13] Khaliq A, Waqas A, Nisar Q A, et al. Application of AI and robotics in hospitality sector: A resource gain and resource loss perspective. *Technology in Society*. 2022, Vol. 68, p. 101807.
- [14] Kong H, Yuan Y, Baruch Y, et al. Influences of artificial intelligence (AI) awareness on career competency and job burnout. *International Journal of Contemporary Hospitality Management*. 2021, Vol. 33 (No. 2), p. 717-734.
- [15] Liang X, Guo G, Shu L, et al. Investigating the double-edged sword effect of AI awareness on employee's service innovative behavior. *Tourism management*. 2022, Vol. 92.
- [16] Li J J, Bonn M A, Ye B H. Hotel employee's artificial intelligence and robotics awareness and its impact on turnover intention: The moderating roles of perceived organizational support and competitive psychological climate. *Tourism Management*. 2019, Vol. 73, p. 172-181.
- [17] Lingmont D N, Alexiou A. The contingent effect of job automating technology awareness on perceived job insecurity: Exploring the moderating role of organizational culture. *Technological Forecasting and Social Change*. 2020, Vol. 161, p. 120302.
- [18] Makridakis S. The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. *Futures*. 2017, Vol. 90, p. 46-60.
- [19] Mao J, Chang S, Gong Y, et al. Team job-related anxiety and creativity: Investigating team-level and cross-level moderated curvilinear relationships. *Journal of Organizational Behavior*. 2021, Vol. 42 (No.1), p. 34-47.
- [20] Rampersad G. Robot will take your job: Innovation for an era of artificial intelligence. *Journal of Business Research*. 2020, Vol.116,p. 68-74.
- [21] Salas E, Kozlowski S W J, Chen G. A century of progress in industrial and organizational psychology: Discoveries and the next century. *Journal of Applied Psychology*. 2017, Vol. 102 (No. 3), p. 589-598.
- [22] Schumpeter, J. A. New translations from "theorieder wirtschaftlichen entwicklung". *The American Journal of Economics & Sociology*. 2002, Vol. 61 (No. 2), p. 405-437.
- [23] Shin D, Kee K F, Shin E Y. Algorithm awareness: Why user awareness is critical for personal privacy in the adoption of algorithmic platforms?. *International Journal of Information Management*. 2022, Vol. 65, p. 102494.
- [24] Wang H, Zhang H, Chen Z, et al. Influence of artificial intelligence and robotics awareness on employee creativity in the hotel industry. *Frontiers in Psychology*. 2022, Vol. 13, p. 834160.