Construction employees' appraisals of new technology implementation and team innovation behaviour: The mediating role of collective coping strategies

Mohamed Nasaj[1], Sulafa Badi[2] , Niamh Murtagh[3*] & Mohammad Alghababsheh[4]

[1] College of Business, Abu Dhabi University, United Arab Emirates, Email: mohamed.nasaj@adu.ac.ae.
[2] Faculty of Business & Law, The British University in Dubai, United Arab Emirates, Email: sulafa.badi@buid.ac.ae.
[3]The Bartlett School of Sustainable Construction, University College London, United Kingdom, Email: n.murtagh@ucl.ac.uk.
[4]Department of Business Management, School of Business, Mutah University, Jordan, Email: m.alghababsheh@mutah.edu.jo.

* Corresponding author.

Abstract

Purpose: The implementation of smart technology, artificial intelligence, robotics, and algorithms (STARA) is recognised as a driver of innovation in the construction industry. However, STARA implementation has also been found to present psychological challenges to employees that may affect their innovation performance. Adopting a transactional model of stress and coping, this study examined the effect of construction employees' appraisals of STARA implementation as either a challenge or a hindrance to team innovation behaviour. Additionally, it explored the mediating role of collective coping strategies on this relationship.

Design/Methodology/Approach: Data were collected from 487 employees in the European construction industry through an online questionnaire and analysed using structural equation modelling.

Findings: Construction employees' appraisal of STARA implementation as a challenge positively influenced team innovation behaviour. Contrary to expectation, employees' appraisal of STARA implementation as a hindrance was not significantly related to team innovation behaviour. Both collective problem- and emotion-focused coping strategies mediated the relationship between appraisals and team innovation behaviour.

Originality: The study is the first to our knowledge to apply an established psychological theory of stress and coping in relation to STARA implementation and team innovation behaviour. The findings advance understanding of how psychological appraisals and coping mechanisms shape team innovation in technological disruptions such as STARA.

Practical Implications: To bolster team innovation, construction firms should foster a challenge appraisal mindset and facilitate both problem- and emotion-focused coping strategies as part of pursuing STARA implementation.

Keywords: challenge appraisal, collective emotion-focused coping, collective problem-focused coping, hindrance appraisal, STARA implementation, team innovation behaviour.

Introduction

Traditionally, the construction industry is known for its slow technological advancement (Dorée and Holmen, 2004). However, recent developments in smart technology, artificial intelligence, robotics, and algorithms (STARA) have driven a significant shift towards more efficient and sustainable construction practices (Silva *et al.,* 2018). STARA refers to a suite of advanced technologies designed to enhance productivity, safety, and sustainability (Brougham and Haar, 2018). In construction, these technologies include the use of drones for site surveying and inspection (Rakha and Gorodetsky, 2018), Artificial Intelligence (AI) algorithms to optimise processes (Pan and Zhang, 2021), robotics for automated tasks (Melenbrink *et al.,* 2020), and virtual and augmented reality for designing and visualising projects (Alkan and Basaga, 2023). By integrating these STARA technologies, construction companies can improve their productivity, reduce costs, minimise waste, and enhance overall project efficiency (Baduge *et al.,* 2022).

However, several studies highlight the adverse effects of STARA implementation on employees across different sectors, including job insecurity (Brougham and Haar, 2018; Ding, 2022), performance pressure (Kang *et al.,* 2023) and job stress (Lestari *et al.,* 2023). The implementation of STARA places different or additional demands on employees, such as adapting to new technologies, learning unfamiliar tasks, or adjusting to altered workflows (Brougham and Haar, 2018). In STARA implementation, these stressors reflect the complexities of integrating advanced technologies into organisational contexts and the resultant changes in work processes, roles, and team dynamics (Lestari *et al.,* 2023). Stress can also arise from disruptions to established routines, pressure to acquire new skills quickly, anxiety about being monitored or evaluated by automated systems, and fear of job displacement or reduced job security due to automation (Hur and Shin, 2024). Additionally, the cognitive load associated with continuous learning and the emotional strain of adapting to a rapidly changing work environment are key stressors associated with STARA implementation (Oosthuizen, 2022). These demands can be particularly challenging when unpredictable, such as sudden updates to the system, or uncontrollable, such as mandatory shifts in job roles or increased surveillance (Lestari *et al.,* 2023; Oosthuizen, 2019).

The uncertainty, role ambiguity, and perceived job insecurity associated with STARA implementation align with the established definition of stress as a response to demands perceived as unpredictable or uncontrollable (Koolhaas et al., 2011). Stress is conceptualised as the psychological impact on an individual in circumstances that have significant personal implications and challenge or surpass the individual's abilities or available resources (Lazarus and Folkman, 1984). Factors that trigger a stress response, known as 'stressors', affect individual well-being, behaviour, and performance (Searle and Auton, 2015).

Research remains scarce on the stress associated with STARA implementation in the construction industry, although empirical studies are emerging in the context of the hospitality and tourism industry. These studies explored how STARA affects individual well-being, job satisfaction, and overall performance as employees navigate the complexities introduced by the integration of STARA into their work processes (Ding, 2022; Kang *et al.,* 2023; Lestari *et al.,* 2023). The heightened levels of stress induced by STARA implementation are associated with increased knowledge hiding (Arias-Pérez and Vélez-Jaramillo, 2022), decreased job satisfaction (Yam *et al.,* 2023), and increased intention to quit one's job (Li *et al.,* 2019). While recent research has begun exploring the psychological and social impacts of AI in construction, including the role of collective coping (Nasaj et al., 2025), little is known about how construction teams appraise broader technological disruptions such as STARA and how these appraisals influence innovation outcomes. This study extends prior work by applying the transactional model of stress and coping to team-level appraisals and coping strategies in response to STARA implementation — offering a novel lens on the psychological mechanisms underpinning innovation in Construction 4.0.

At the team level, studies have highlighted the detrimental effects of stress on goal-directed functioning and overall team performance (Nasaj et al., 2025; Savelsbergh *et al.,* 2012). However, the distinct stressors introduced by the implementation of STARA pose unique challenges to team dynamics. These stressors can undermine collaborative processes, limit the open exchange of ideas, and suppress the creative thinking necessary to foster innovation (Arias-Pérez and Vélez-Jaramillo, 2022). Moreover, heightened stress levels may intensify team conflicts, further disrupting the innovation process (Dackert, 2010). Given the increasing reliance on STARA within the construction sector, the scarcity of research addressing the specific relationship between STARA-induced stress and team innovation behaviour represents a significant gap in the literature. Understanding this link is critical because innovation is often a key objective of STARA integration, potentially enhancing operational efficiency and competitiveness. Therefore, this study aimed to investigate how stressors associated with STARA implementation in construction influence team innovation behaviour, defined as the collective capability of a team to generate, develop, and implement new ideas (Brougham and Haar, 2018; Kang *et al.,* 2023).

To better understand how teams respond to the stressors posed by STARA implementation, it is essential to consider the role of coping strategies. Coping refers to the cognitive and behavioural efforts individuals or groups use to manage stressful demands (Lazarus and Folkman, 1984). While individual coping has been widely studied, recent research highlights the importance of collective coping at the team level, particularly in organisational settings where stressors are shared (Nasaj et al., 2025; Badi, 2024; Leprince et al., 2019). However, few studies have investigated how construction teams cope collectively with technological disruptions such as STARA. By examining collective problem-focused and emotion-focused coping strategies, this study addresses this gap and offers insight into how teams can buffer the negative impact of STARA-induced stress and maintain innovative performance.

Guided by this rationale, the present study seeks to explore the following objectives:

- To examine how construction employees' appraisals of STARA implementation—as a challenge or a hindrance—affect team innovation behaviour.
- To investigate the mediating role of collective problem-focused coping strategies in the relationship between STARA appraisals and team innovation.
- To investigate the mediating role of collective emotion-focused coping strategies in the relationship between STARA appraisals and team innovation.

These objectives contribute to extending the transactional model of stress and coping to the team level in technology-driven environments, offering new insights into how construction teams psychologically adapt to STARA-induced disruption.

Literature Review

We now outline the evidence on the uses and challenges of STARA in construction and review current knowledge on team innovation before setting out the theoretical basis for the study, the Transactional Model of Coping. The study focused on the European construction industry, which presents a compelling setting for examining the implementation of STARA. Despite Europe's industrial strength, the construction sector has been slower in adopting AI and digital innovation due to market fragmentation, talent shortages, and competitiveness issues (Brattberg *et al.,* 2020). However, recent initiatives, including EU-wide AI strategies and increased investment in digital transformation, have signalled a growing commitment to STARA technologies. This shift has positioned Europe as an increasingly relevant context for investigating the impact of these technologies on industrial practices and innovation.

STARA in the construction industry

As part of Industry 4.0, also known as the Fourth Industrial Revolution, STARA is transforming the construction industry (Shahruddin and Husain, 2024). Smart Technologies, such as cloud computing, have enabled collaborative work through document sharing and virtual meetings, enhancing team coordination (Bello *et al.,* 2021). AI has significantly improved construction safety by offering hazard-avoidance systems, real-time risk maps, and automated safety robotics (Martinez-Rojas *et al.,* 2020). Additionally, AI-driven drones and robots now monitor construction progress, replacing inefficient and error-prone manual inspections (Emaminejad and Akhavian, 2022). Robotics plays a crucial role in automating repetitive tasks, thereby increasing productivity and precision in construction operations (Goel and Gupta, 2020). Algorithms powered by AI enhance quality control by using machine learning to detect defects and errors in construction materials or structures, enabling early intervention and preventing potential safety hazards

(Baduge *et al.,* 2022). AI's ability to analyse large datasets helps optimise resource allocation and improve productivity by identifying inefficiencies and suggesting operational improvements (Niederman, 2021; Rane, 2023). This data-driven approach reduces costs and ensures timely project delivery (Pan and Zhang, 2021).

While construction companies are presented with considerable opportunities owing to the implementation of STARA, these potentials are accompanied by significant obstacles that encompass financial, sociological, technological, ecological, political, and legal aspects (Oosthuizen, 2019). Numerous studies have highlighted the negative consequences of STARA on workers, including workplace stress (Lestari *et al.,* 2023), performance pressure (Kang *et al.,* 2023), AI anxiety (Nasaj et al., 2025) and job instability (Brougham and Haar, 2018; Ding, 2022). The introduction of STARA has resulted in considerable stress among individuals and teams as they strive to meet the demands of adaptation to imposed changes in changing environments (Ogbeibu *et al.,* 2021). Although STARA technologies and AI-driven systems have gained prominence in research for their role in improving organisational sustainability and performance (Al Masud et al., 2024), the focus has largely remained on macro-level capabilities such as green human resource management (GHRM) and green supply chain management (GSCM). Recent work by Veiga et al. (2024) explores the relationships between digital ambidexterity, employee resilience, and behavioural innovation, highlighting that individual and team-level psychological traits significantly influence innovation outcomes in digitally transforming environments. However, these studies often overlook the cognitive-emotional mechanisms involved in adapting to technological disruption.

Mirzaei (2024) contributes further by illustrating how AI adoption initiates different sensemaking responses and workplace learning trajectories, depending on whether AI is perceived abstractly or concretely. Still, this work does not extend to specific team-level outcomes such as innovation behaviour or stress-coping dynamics. Sharma and Gupta (2025) also highlight the importance of cognitive framing and collective sensemaking in navigating workplace disruptions caused by AI. Their findings underscore the need to understand how teams reinterpret and adapt to AI-driven change, yet do not empirically examine downstream consequences like innovation behaviour.

Additionally, Skibniewski (2025) offers a macro-level overview of smart construction technologies—such as BIM, IoT, robotics, and digital twins—highlighting the strategic imperative of digital transformation in the construction sector. Crucially, he argues for a human-centric approach involving organisational learning, reskilling, and adaptability, reinforcing the need to understand not just what technologies are used, but how people respond to them.

Taken together, these studies reveal a strong emphasis on technological capabilities, structural change, and system-wide adaptation, but a relative neglect of team-level psychological processes—particularly challenge vs. hindrance appraisals and coping strategies—that shape innovative behaviour under STARA-induced stress.

Team innovation behaviour in Construction Organisations

Within the construction industry, a team is a cohesive group of employees with diverse but complementary skills who collaborate to achieve organisational goals and objectives (Spatz, 2000). These teams typically consist of professionals from various departments, such as engineering, procurement, and management, who work together to enhance operational efficiency, improve decision-making, and drive innovation within the organisation (Wipulanusat *et al.,* 2021). The effectiveness of these internal teams is often evaluated based on their ability to contribute to the organisation's overall performance, adapt to changing demands, and maintain high levels of productivity and morale (Zhang and Hao, 2022).

Among the key outcomes of effective teams is innovative behaviour. Innovation is the introduction of nontrivial and unique ideas, practices, or products that significantly improve or change existing behaviours, processes, or markets (Nasaj, 2020; Rogers, 2003). This concept encompasses the creation of new ideas and their application and realisation into tangible changes (Anderson *et al.,* 2014; Hülsheger *et al.,* 2009). Innovative behaviour often unfolds during deliberate change processes with specific objectives in focus. It includes activities such as actively pursuing novel concepts, advocating for new initiatives, and obtaining the necessary planning and financial support to execute these ideas (Nasaj 2021; Nasaj et al., 2022). In the construction industry, innovation encompasses a wide range of activities aimed at improving processes, products, services, and organisational practices, such as the introduction of sustainable construction practices (Badi, 2017), collaborative project management techniques (Lindblad and Guerrero, 2020), and advancements in building materials (Dadakhanov *et al.,* 2022).

The synergy between STARA technologies fosters enhanced operational efficiency and innovation, driving continuous improvement and collaborative creativity within construction teams (Melenbrink *et al.,* 2020; Pan *et al.,* 2021; Wang and Kim, 2019). By integrating STARA, construction teams are equipped with advanced tools to streamline processes, optimise resource allocation, and foster innovation. Team-level innovation has received less attention than innovation at the individual and organisational levels in the construction industry (Statsenko *et al.,* 2023)

The Transactional Model of Coping

The Transactional Model of Coping (Lazarus and Folkman, 1984) provides a theoretical basis for the foundational process for evaluating stress and the subsequent strategies used to manage stress. The theory posits that the coping process is initiated by an individual's cognitive evaluation of a stressor (i.e. its meaning as a threat or opportunity), which is termed 'appraisal'. The theory differentiates between two types of appraisals: challenge and hindrance.

- Challenge appraisal occurs when individuals perceive a situation as offering prospects for personal development, knowledge acquisition, or success. A situation is perceived as a challenge that can be overcome through exertion and expertise.
- Hindrance appraisal refers to the perception of a situation as presenting obstacles or threats to one's goals, well-being, or resources.

The initial cognitive appraisals directly influence the selected coping strategies which are categorised as problem-focused or emotion-focused:

- Problem-focused coping involves directly addressing or altering stress sources. The goal is to eliminate or reduce the impact of stressors by solving the problem causing the stress. Problem-focused coping includes seeking information, planning, changing one's environment, and taking steps to resolve issues.

- Emotion-focused coping strategy aims to manage or reduce emotional distress caused by the stressor rather than address the stressor itself. Examples of emotion-focused coping include engaging in activities that provide comfort or distraction, seeking emotional support from others and using relaxation techniques.

Problem-focused coping directly targets the problem, whereas emotion-focused coping addresses emotional reactions to the problem. Either strategy can be effective at reducing stress depending on the nature of the stressor and an individual's circumstances.

The Transactional Model of Coping at the team level

Research on stress and coping has tended to focus on the individual-level, while recent studies have focused on team-level dynamics (Savelsbergh *et al.,* 2012). Lansisalmi *et al.,* (2000) described collective coping as a consistent repertoire of responses developed within a group and employed to manage stressors. These responses involved eliminating the stressor, comprehending it, or mitigating its shared negative emotional impact. The shared appraisal of stressors plays a critical role in collective coping. As teams share responsibility for outcomes, they collectively appraise stressors and evaluate their significance to the team's goals. This shared appraisal process helps align team members' perceptions, and fosters coordinated coping responses as team members develop common interpretations of task demands through group socialisation (Nordbäck et al., 2024).

Extending the Transactional Model of Coping (Lazarus and Folkman, 1984) to teams, the literature posits that teams may follow two main types of collective coping strategies: problem-focused and emotion-focused.

- Collective problem-focused coping: Teams may utilise collective problem-focused efforts as a coping mechanism, concentrating on dissecting issues associated with the stressor, exchanging information, and resolving problems (Kamphuis et al., 2021; Nasaj et al., 2025) Such a coping strategy in a team setting can span various activities, including identifying problems, brainstorming diverse solutions, and evaluating these solutions based on factors such as costs and benefits, decision-making, and acting (Badi, 2024). Problem-focused coping has been characterised by a shared sense of accountability for all tasks, efficient communication, and information and knowledge management (Lansisalmi *et al.,* 2000). Consequently, problem-focused collective coping strategies indicate a team's inclination to act to reduce perceived stressful situations, and this applies whether the stressor is appraised as a challenge or a hindrance.

- Collective emotion-focused coping: This strategy involves maintaining a positive attitude and sharing emotions openly within a team. Collective positive emotions facilitate the development of lasting resources, such as social support and resilience (Meneghel *et al.,* 2016) and these resources are crucial to thriving in challenging situations. However, positive emotions are not the sole contributors to favourable team outcomes. Stephens and Carmeli (2016) highlight the beneficial effects of expressing negative emotions in project teams, noting that such expressions, when performed constructively and respectfully, can foster knowledge creation and enhance team performance. This constructive expression of emotions, including fear, anxiety, and distress, allows team members to collaboratively address vital issues, provide mutual support, and build the capabilities essential for knowledge creation.

Researchers in the construction industry have acknowledged the crucial role of coping mechanisms in construction teams (Pinto *et al.,* 2014; Senaratne and Rasagopalasingam, 2017). However, previous studies have focused on stress and coping at the individual level, with Nasaj and colleagues (2025) being one of the few to point to stress as a collective phenomenon in teams. Nasaj's study identified problem-focused and emotion-focused coping as key coping strategies within project teams in the construction industry.

While prior research has contributed to understanding the effects of technological disruption on individual-level outcomes such as job satisfaction, turnover intentions, and psychological strain (Ding, 2022; Lestari et al., 2023), these studies often lack a team-level perspective and rarely consider how shared cognitive and emotional processes shape collective outcomes like innovation. Moreover, the application of coping theory in these contexts remains limited, with most studies focusing on individual strategies without accounting for the interactive and socially constructed nature of team responses. This limits our understanding of how teams collectively make sense of and adapt to complex, disruptive technologies such as STARA. Addressing these gaps, our study draws on the transactional model of stress and coping (Lazarus and Folkman, 1984) to explore how team-level appraisals and coping strategies influence innovation outcomes in construction — a sector where such psychological mechanisms have rarely been examined. Additionally, there is limited research on how these coping strategies interact with cognitive appraisals, particularly in STARA implementation, and how they ultimately influence team innovation behaviour.

Conceptual Framework and Hypotheses

Based on the literature reviewed above, two types of appraisals are important in the stress management process for STARA implementation stressors: challenge appraisal and hindrance appraisal. A challenge appraisal strategy may foster more positive appraisals in which teams perceive innovation challenges as opportunities for skill development and learning (Lazarus and Folkman, 1984). When teams assess STARA as a challenge, they are more likely to actively seek opportunities for learning and improvement through problem-solving. Such appraisals can motivate teams to embrace change and engage in activities that promote creative thinking, collaboration, and experimentation (Bandura, 1997), all essential for innovation. Research suggests that viewing stressors as challenges encourages team members to participate in strategic risk-taking and idea-sharing, which are fundamental to generating innovative solutions in response to organisational demands (Nasaj et al., 2025; Kamphuis et al., 2021). Furthermore, this positive appraisal can lead to agile adaptation, whereby teams become more flexible in adjusting to the dynamic demands of technological change (Schwarzer and Knoll, 2003). Consequently, we propose that challenge appraisals of STARA implementation foster an environment conducive to innovation, driving teams to engage in innovative behaviour.

H1: Challenge appraisal towards STARA implementation positively influences team innovation behaviour.

In contrast, hindrance appraisal occurs when team members perceive that STARA poses constraints, barriers, or risks to their work, leading to a sense of threat or loss. This appraisal can foster a risk-averse mindset in which team members adopt a cautious approach towards innovation, fearing that the changes introduced by STARA may disrupt their established practices or diminish their capacity to achieve the desired outcomes (Pindek et al., 2024) Hindrance stressors are linked to negative emotional responses, such as frustration or anxiety, which can decrease motivation and impair cognitive functioning, inhibiting creative thinking and innovation (Cavanaugh *et al.,* 2000). When team members perceive the implementation of STARA as a hindrance, they are more likely to resist change, resulting in scepticism towards new ideas and a reluctance to experiment with novel practices (Pindek et al., 2024) Resistance to change can manifest in behaviours such as avoiding strategic risks, rejecting innovative solutions, and exhibiting low enthusiasm for collaborative innovation efforts (Brockner *et al.,* 2004). Consequently, hindrance appraisals stifle a team's ability to engage in innovative behaviours, undermining its potential for creativity and adaptability in the face of organisational challenges (Podsakoff *et al.,* 2007). Thus, we propose the following hypothesis:

H2: Hindrance appraisal towards STARA implementation negatively influences team innovation behaviour.

We propose that collective coping strategies, both problem- and emotion-focused, mediate the relationships between the challenge and hindrance appraisals of STARA implementation stressors and team innovation behaviour. Problem-focused coping facilitates task-oriented approaches, enhances communication efficiency, and improves information and knowledge management within teams (Länsisalmi *et al.,* 2000). Länsisalmi *et al.,* (2000) emphasised that problem-focused coping is characterised by a collective sense of accountability and seamless communication, allowing teams to manage knowledge and information effectively. In the case of STARA implementation, collective problem-focused coping enables teams to manage stressors regardless of whether they are appraised as challenges or hindrances, thus supporting innovative behaviours within the team. Based on this reasoning, the following hypothesis is proposed:

H3a: Collective problem-focused coping mediates the relationship between challenge appraisal towards STARA implementation and team innovation behaviours.

H3b: Collective problem-focused coping mediates the relationship between hindrance appraisal towards STARA implementation and team innovation behaviours.

Teams can also employ a collective emotion-focused coping strategy to manage stressors related to STARA implementation, which involves fostering a positive outlook and open sharing of emotions. Emotion-focused strategies enable teams to build and maintain social resources, such as support and resilience, which are critical for adaptation in times of change (Meneghel *et al.,* 2016). Constructively expressing negative emotions enhances knowledge creation and improves team performance (Stephens and Carmeli, 2016). This collective approach to managing emotions fosters an environment of psychological safety in which team members feel empowered to navigate complex and potentially overwhelming situations, such as STARA implementation.

Cultivating an atmosphere in which emotions—both positive and negative—are acknowledged and constructively addressed enhances team resilience and flexibility, thereby improving the team members' capacity to respond creatively to the challenges posed by new technologies. Thus, emotion-focused coping can mitigate the negative impacts of stress and promote innovative behaviour. Therefore, we propose the following hypothesis:

H4a: Collective emotion-focused coping mediates the relationship between challenge appraisal towards STARA implementation stressors and team innovation behaviours.

H4b: Collective emotion-focused coping mediates the relationship between hindrance appraisal towards STARA implementation stressors and team innovation behaviours.

Based on the theoretical underpinnings, Figure 1 illustrates the conceptual framework adopted in this study.

Figure1: Conceptual framework

*****INSERT FIGURE 1 ABOUT HERE *****

Methodology

Sampling and data collection

The data collection was carried out by CINT.com, a professional survey panel provider. CINT adheres to the ethical standards and guidelines set by ESOMAR (European Society for Opinion and Marketing Research), ensuring that all participants provided informed consent and that data collection upheld strict confidentiality, anonymity, and data protection standards. The survey was distributed to employees of construction companies in the European countries: The selected countries—Spain, Netherlands, Norway, Denmark, Portugal, Sweden, Germany, and the UK—were chosen due to their strategic relevance to the study. These countries represent varying levels of digital maturity and engagement with smart technologies in the construction sector, as indicated by recent EU reports and national digitalisation strategies that highlighted notable differences in the digitalisation maturity levels across the selected countries. Spain has invested significantly in digital transformation, allocating approximately €19.6 billion from its Recovery and Resilience Plan towards digitalisation, with specific attention to the construction sector (European Commission, 2020). The Netherlands is recognised for its advanced digital infrastructure and strong emphasis on sustainable and circular construction practices, supported by the Dutch Digitalisation Strategy (European Construction Sector Observatory, 2020a). Norway's national digitalisation strategy focuses on enhancing public and private sector digital capabilities, fostering innovation across industries including construction (Norwegian Ministry of Local Government and Modernisation, 2019). Denmark is considered a digital frontrunner in Europe, with policies aimed at simplifying digital processes for businesses and promoting digital growth across sectors (Agency for Digitisation, 2022). Portugal, while emerging in this area, is experiencing rapid growth in its construction sector, supported by EU funding and digitalisation initiatives targeting SMEs and infrastructure projects (European Construction Sector Observatory, 2020b). Sweden leads in smart and energy-efficient construction, driven by public-private partnerships and national initiatives promoting digital innovation (US Department of Commerce, 2024). Germany has implemented a national roadmap for digitalisation in construction, with large-scale initiatives like BIM Germany driving sector-wide adoption of Building Information Modelling (European Construction Sector Observatory, 2021). The UK continues to advance its construction digitalisation agenda, with ongoing efforts to improve sector-wide adoption of digital tools and processes (Royal Institution of Chartered Surveyors, 2023).

Including this diverse sample was intended to capture a wide range of organisational experiences with STARA implementation across Europe. This study adopted a cross-sectional survey design, collecting data from construction professionals at a single point in time to examine the relationships between STARA appraisals, collective coping strategies, and team innovation behaviour. To ensure sample relevance, a knockout screening question was included at the beginning of the survey—administered by the data collection company—which asked participants whether they were currently involved in construction projects that implement or utilise STARA technologies (e.g., AI tools, drones, robotics, or digital modelling systems). Only those who answered ‘yes’ were permitted to complete the full questionnaire.

Random sampling technique were employed in addition to several procedures to enhance the representativeness of the data and minimise bias: First, the survey was distributed across multiple countries. It included a diverse range of construction companies, which helped capture a broad spectrum of experiences with STARA implementation. By including respondents from various geographical locations and organisational sizes, we aimed to ensure that the findings were more generalisable to the European construction sector. Additionally, using a professional data collection company and an online questionnaire platform helped maintain consistency in the survey administration and data collection processes.

This study adopted a single key informant sampling approach, as Van de Ven and Ferry (1980) outlined. Although the phenomena investigated are at the team level, the decision to collect data from individual key informants rather than from entire teams aligns with the methodologies used in recent studies in the construction sector, such as those by Talat and Riaz (2020), Badi (2024) and Nasaj et al (2025). We acknowledge that a single key informant approach may not fully capture team-level dynamics; however, the rationale for choosing a single key informant from each organisation rather than surveying all team members is twofold. First, collecting data from key informants across various organisations allows for a broader and more varied understanding of how different STARA implementation appraisals influence team innovation behaviour through collective coping strategies. This method helps avoid potential bias and uniformity in responses that might arise if data were collected from multiple informants within the same organisation. Second, the existing literature supports the effectiveness of using a single key informant to provide accurate and reliable insights into team-based phenomena, especially in studies related to complex implementations, such as STARA (Nasaj et al., 2025; Badi, 2024; Talat and Riaz, 2020).

Questionnaire design and measurement items

The items used to operationalise and measure the study’s constructs were adopted from existing scales and adapted to the context of STARA implementation. The items for all the scales are shown in Supplementary Material Appendix A. Measures of challenge and hindrance appraisal, and problem- and emotion-focused coping, used a 5-point Likert scale, ranging from 5=Strongly Agree to 1=Strongly Disagree.

- Challenge appraisal (CHA): The scale developed by Searle and Auton (2015) was adapted to measure challenge appraisals towards STARA implementation. This scale comprises four items (CHA1–CHA4), reflecting how individuals perceive the implementation of STARA as a challenge that can stimulate their intellectual curiosity, enhance their skills, and broaden their understanding of their work environment. A sample item was '*STARA Implementation will help us to learn a lot*'. Cronbach's alpha was .843.

- Hindrance appraisal (HIN): The scale developed by Searle and Auton (2015) was adapted to measure hindrance appraisals towards STARA implementation. This scale comprises four items (HIN1–HIN4), reflecting how individuals assess the hindering effects of STARA implementation on their ability to achieve goals, utilise resources effectively, perform tasks optimally, and overcome challenges within their work context. A sample item was '*STARA Implementation will restrict our capability*'. Cronbach's alpha was .820.

- Collective problem-focused coping (PRO): Problem-focused coping was measured using a scale developed by Leprince *et al.,* (2019) and recently used in construction research by Badi (2024). The items were categorised under two sub-dimensions: analysis and information sharing (3 items: PRO1–PRO3) and problem-solving (3 items: PRO4–PRO6). The problem-solving subdimension moves beyond cognitive analysis to action-oriented strategies. The items in this category measure a team's ability to formulate, discuss, and execute a concrete work plan. A sample item was '*We think of possible solutions to manage the STARA implementation situation*'. Cronbach's alpha was .847.

- Collective emotion-focused coping (EMO): Emotion-focused coping was measured using a scale developed by Ramadhana (2020) and adapted to the team context by Badi (2024). The scale is organised into two sub-dimensions: emotional openness (4 items: EMO1–EMO4) and a positive outlook (4 items: EMO5–EMO8). The emotional openness subscale measures emotional communication within teams, with items on expressing feelings, sharing positive and negative emotions, and mutual understanding without blame. The positive outlook subscale specifically addresses the team's resilience and proactive strategies in coping with the difficulties and opportunities presented by the STARA implementation. A sample items was '*We express our feelings and are truthful with each other*'. Cronbach's alpha was .881.

- Team innovation behaviour (TIB): The five-item from by Litchfield and colleagues (2018) was used to measure team innovation behaviour (items TIB1 to TIB5). This scale, incorporating elements from De Dreu (2006) and Janssen (2000), was tailored to evaluate team innovation behaviour in technology-driven environments. The scale offered a measure of the frequency and extent of innovative behaviour in teams. Statements such as '*My team creates new ideas for difficult issues'* were assessed using a 5-point Likert scale ranging from 1= Never and 5= Always. Cronbach's alpha was .857

Although demographic information (e.g., age, gender, education level, job position) was collected, these variables were not included as control variables in the final SEM analysis. Preliminary testing indicated they had no significant effect on the dependent variable (team innovation behaviour), and their inclusion did not improve model fit or explanatory power. As such, a more parsimonious model was retained, consistent with best practices in SEM.

Data analysis

Data analysis was conducted using SPSS v23.0 and Amos v23.0. Exploratory Factor Analysis (EFA) using principal component analysis with varimax rotation ensured that items aligned with their constructs (Field, 2013). Confirmatory Factor Analysis (CFA) followed, with model fit indices assessed using $\chi 2$/df, RMR, GFI, CFI, IFI, TLI, and RMSEA (Browne and Cudeck, 1993; Byrne, 2010; Schreiber *et al.,* 2006; Steiger, 2007). Convergent and discriminant validity were tested by comparing the square root of the average variance extracted (AVE) with inter-construct correlations, in line with Hair *et al.,* (2006). Finally, SEM with robust maximum likelihood estimation was used for hypothesis testing. The bootstrapping technique with 2000 resamples was employed to assess indirect effects and mediation, as recommended by Hayes (2017).

Results

Sample demographic characteristics

The questionnaire was distributed in September 2023, and 2,272 surveys were sent. Of these, 763 responses were received, representing a response rate of 33.58%. Upon examining the 763 responses, 487 were complete and usable for analysis. Table I summarises the respondents' demographics.

Table I: Participants' Profile Summary

*****INSERT TABLE I ABOUT HERE *****

The demographic distribution of participants revealed a diverse group. Regarding sex, we observed a slight male majority (67.6 %), with females accounting for 32.4%. The largest proportion fell within the 31-40 years age range, representing 36.1% of our attendees, followed by the 41-50 age group (24.4 %). Experience levels varied, with a notable presence in the 6-10 years bracket, constituting 34.5% of the participants. Education levels were evenly distributed, with a significant proportion holding a college degree (32.6%) or a higher diploma/bachelor's degree (28.1%). Geographically, the United Kingdom stands out as the country with highest representation, with 26.7% of participants, followed by Sweden at 14.4%. Job levels were also well-balanced, with middle management (33.7%), staff (21.6%) that refers to employees in operational or support roles without supervisory duties and senior staff (18.2%) that denotes more experienced personnel who may hold advanced technical roles or informal leadership responsibilities, but do not occupy formal managerial positions. Finally, in terms of organisation size, organisations with 50-250 employees comprised the largest segment at 37.8%, followed closely by smaller companies with 1-49 employees at 35.3%.

staff (21.6%), and senior staff (18.2%) comprising the majority. *For clarity, "staff" refers to employees in operational or support roles without supervisory duties, while "senior staff" denotes more experienced personnel who may hold advanced technical roles or informal leadership responsibilities, but do not occupy formal managerial positions*

Tests for common method bias, reliability and validity

Testing for common method bias is essential, especially for self-administered surveys (Fuller *et al.,* 2016). Harman's single-factor test (Podsakoff and Organ, 1986) was used for this analysis. The findings show that a single factor accounted for only 34.86% of the variance in the data, which is below the threshold of 50 %. Consequently, it can be concluded that common method bias was not a concern.

Cronbach's alpha tests revealed that all scales had values exceeding 0.7, signifying scale reliability (Field, 2013). Additionally, the Kaiser-Meyer-Olkin (KMO) test was used to evaluate the adequacy of the sample. A result of 0.956 showed adequate sampling; a KMO value near 1.0 denotes sufficient variance in the sample to conduct factor analysis (Field, 2013). Bartlett's test of sphericity was significant, indicating an adequate correlation between the variables to conduct factor analysis (Hair *et al.,* 2010).

To confirm the validity of the variables, Exploratory Factor Analysis (EFA) was performed using principal component analysis for extraction and varimax rotation. The EFA results revealed that all questionnaire items were appropriately aligned with their respective constructs, demonstrating satisfactory values exceeding 0.45, in line with the recommendations of Field (2013).

Confirmatory Factor Analysis (CFA) indicated a robust model fit. All CFA indices were within acceptable ranges: $\chi^2/df = 2.230$ (Schreiber *et al.,* 2006), RMR = .031 (Browne and Cudeck, 1993), GFI = .900 (Mulaik *et al.,* 1989), CFI = .943 (Byrne, 2010), IFI = .943 (Bentler, 2007), TLI = .936 (Marsh *et al.,* 2004), and RMSEA = .050 (Steiger, 2007). Supplementary Material provides the details of the EFA and the CFA; see Appendices B and C.

The convergent and discriminant validity of the measurement scales was assessed with the threshold for acceptable results set at greater than 0.5 (Hair *et al.,* 2006). The discriminant validity assessment involved comparing the square root of the average variance extracted (AVE) against the correlations between constructs. Discriminant validity requires the AVE's square root to exceed the constructs' correlations (Hair *et al.,* 2006). Both convergent and discriminant validity were successfully established. The correlation matrix and descriptive statistics of the study variables are presented in Table II.

Table II: Reliability, Validity and Correlation Analysis

*****INSERT TABLE II ABOUT HERE *****

Hypotheses testing

SEM with robust maximum likelihood estimation was performed to test the research hypotheses. The structural model is shown in Figure 2.

Figure 2: Structural model

*****INSERT FIGURE 2 ABOUT HERE *****

The structural equation model fit indices demonstrated a good model fit: χ^2/df = 2.270, RMR = .079, GFI=.904, CFI =. 942, IFI = .942, TLI =. 934, RMSEA = .051.

Table III presents the results of the relationships among the constructs. The results show a significant positive relationship between STARA challenge appraisal and team innovation behaviour; therefore, H1 is supported. However, H2 is not supported. STARA hindrance appraisal did not have a significant relationship with team innovation behaviour. In addition, the findings show that STARA challenge appraisal and STARA hindrance appraisal are significantly related to both problem- and emotion-focused team coping strategies. In turn, these coping strategies have significant relationships with team innovation behaviour. Hence, the mediating roles of both coping strategies were indicated. Interestingly, the relationship between problem-focused coping strategies and team innovation behaviour was negative, suggesting that while teams may engage in more structured, task-oriented coping mechanisms, these strategies might stifle creativity or limit the flexibility needed for innovation.

Table III SEM Direct Relations

*****INSERT TABLE III ABOUT HERE *****

Bootstrapping (Preacher and Hayes, 2004) was employed further to investigate coping strategies' indirect and mediating roles. Using 2000 resamples, the bootstrapping method was generated at 95% confidence intervals for the indirect impacts of STARA challenge and hindrance appraisals on team innovation behaviour. Table III lists the outcomes. The results indicate that the STARA challenge and hindrance appraisal have significant indirect relationships with team innovation behaviour. In addition, the results show that STARA challenge and hindrance appraisals are mediated by problem- and emotion-focused coping strategies since the results of the two-tailed significance are significant at the 95% confidence level, and the lower and upper bounds of each relationship do not include 0. Therefore, hypotheses H3a, H3b, H4a, and H4b were supported.

As there is a significant direct relationship between STARA challenge appraisal and team innovation behaviour, it can be argued that problem-focused and emotion-focused coping strategies partially mediate the relationship between STARA challenge appraisal and team innovation behaviour. However, since there is no significant direct relationship between STARA hindrance appraisal and team innovation behaviour, it can be argued that problem-focused and emotion-focused coping strategies fully mediate the relationship between STARA hindrance appraisal and team innovation behaviour.

Discussion

Adopting the lens of the Transactional Model of Coping (Lazarus and Folkman, 1984), this study examined the effect of construction employees' challenge and hindrance appraisals of STARA implementation on team innovation behaviour and explored the mediating role of collective coping strategies on the relationship. The findings can be summarised as follows: (1) STARA challenge appraisal positively influences team innovation behaviour, (2) STARA hindrance appraisal does not significantly affect team innovation behaviour, and (3) problem- and emotion-focused coping strategies mediate both challenge and hindrance appraisals, ultimately influencing team innovation behaviour.

First, the supported hypothesis H1 provides evidence that the challenge appraisal of STARA implementation positively influences team innovation behaviours. This finding is consistent with the theoretical frameworks proposed by Searle and Auton (2015) and Cavanaugh *et al.,* (2000).

Our research builds on the work of Ding (2022), who claims that considering STARA implementation as an opportunity for growth and skill advancement encourages individual innovation. This perspective is supported by our research, which shows that it can be extended to the team level. A challenge appraisal of STARA implementation may inspire experimentation, creative thinking, and cooperation within teams while also improving team innovation behaviour.

The unsupported hypothesis H2 suggests that STARA hindrance appraisal has no significant relationship with team innovation behaviour. This result contrasts the existing literature that links hindrance stressors, such as perceived risks and constraints, to reduced innovation and creativity (Cavanaugh *et al.,* 2000; Pindek et al., 2024) One possible explanation for this divergence is that the effects of hindrance appraisal on innovation may be more context-dependent than previously understood. For instance, while some studies indicate that hindrance appraisals foster risk-averse behaviour and a reluctance to embrace change (Brockner *et al.,* 2004), it is possible that in certain team environments, even perceived threats or barriers can stimulate problem-solving and adaptive thinking to cope with challenges. This aligns with recent research suggesting that not all negative appraisals lead to adverse outcomes; under specific conditions, they may trigger resilience and proactive efforts to overcome perceived limitations (Wilson *et al.,* 2024). Additionally, the mixed results could be attributed to moderating factors, such as team dynamics (Roma and Bedwell, 2017), organisational culture (Badi, 2024), and team differences in coping mechanisms (Badi, 2024), which may buffer the negative impact of hindrance appraisal on innovation. Thus, while previous research emphasises the detrimental effects of hindrance appraisals on innovation, our findings suggest a more complex relationship, warranting further exploration of the conditions under which hindrance stressors may or may not impede team creativity.

Third, Hypotheses H3a, H3b, H4a, and H4b indicated statistically significant relationships between STARA challenge appraisal, STARA hindrance appraisal, and problem-focused and emotion-focused coping strategies. This result supports the idea that the introduction of STARA can be a disruptive event for employees in the construction sector (Păvăloaia and Necula, 2023). Whether teams consider STARA as an opportunity for development or an obstacle to achieving their goals, they deploy coping strategies to deal with the psychological impact. Interestingly, our results suggested that the relationships between challenge appraisal and coping strategies was stronger than the relationships between hindrance appraisal and coping strategies (β of 0.93 and

0.82 for the relationships between STARA challenge appraisal and problem-focused and emotion-focused coping strategies, respectively; β of 0.13 and 0.24 for the relationships between STARA hindrance appraisal and problem-focused and emotion-focused coping strategies respectively; see Table III). This suggests that introducing STARA within their work roles in construction may be more disruptive and psychologically demanding for teams when they see it as a challenge. The notion of greater psychological demands following STARA challenge appraisal is consistent with the finding that STARA challenge appraisal has a direct relationship with team innovation behaviour. Challenge appraisal tends to be characterised by enthusiasm, perceptions of opportunity for growth, and a positive outlook. These positive emotions will likely motivate more engagement and persistence in determining different ways of working (Løvoll *et al.,* 2017). In particular, for work teams in construction, STARA implementation requires communication and shared problem-solving, which, in turn, supports team innovation behaviour (Hülsheger *et al.,* 2009). Conversely, less psychological effort following a STARA hindrance appraisal is consistent with the idea that teams with a more negative view are less motivated to adjust and expend less effort on problem- or emotion-focused coping. They aim to remain closer to the status quo and avoid innovation challenges.

Considering these findings together, this study underscores the complex and nuanced relationship between appraisals of STARA implementation and team innovation behaviour. Challenge appraisals emerge as a catalyst for innovation, consistent with studies highlighting the motivating power of perceiving technological change as an opportunity for growth and skill development (Ding, 2022). By contrast, the lack of a significant relationship between hindrance appraisal and innovation suggests that the negative effects of perceived barriers may not be as straightforward as previously assumed. This divergence could imply that other factors, such as team dynamics, organisational culture, or individual differences, may moderate the impact of hindrance appraisals, leading to varied outcomes in different contexts. Moreover, the mediating role of coping strategies in both challenge and hindrance appraisals highlights how teams cope with STARA, which is crucial in shaping the final impact on innovation. The stronger link between challenge appraisal and coping strategies, especially problem-focused strategies, reinforces the idea that challenge appraisals drive teams to invest more psychological resources in adapting and innovating. These findings suggest that fostering a challenge mindset and encouraging proactive coping strategies may be key to unlocking the full innovative potential of teams facing technological disruptions such as STARA.

Conclusion

The findings provide significant insights into the psychological demands of STARA implementation on construction employees. One of the key contributions of this study is the nuanced understanding of how different types of psychological appraisal impact innovation. Specifically, the study reveals that the challenge appraisal of STARA implementation, associated with perceptions of opportunities for growth and learning, is significantly linked to team innovation behaviour. In contrast, hindrance appraisals are not significantly related to innovation outcomes. Additionally, this study is the first to demonstrate that both problem- and emotion-focused coping strategies significantly mediate the relationship between challenge and hindrance appraisals and team innovation behaviours in construction firms. These results offer a comprehensive understanding of the psychological and coping mechanisms that influence how employees in construction organisations navigate STARA-related technological disruptions and that can enhance team innovation.

Theoretical contributions

The results of this study contribute to the existing body of knowledge in several ways. First, despite its increasing significance, empirical inquiry into STARA's psychological impact on innovation performance is still in its infancy. While STARA technologies have been increasingly adopted in the construction industry, prior research has primarily focused on technical aspects of implementation (Baduge *et al.,* 2022; Bello *et al.,* 2021; Emaminejad and Akhavian, 2022; Goel and Gupta, 2020) and empirical studies on STARA's psychological and behavioural effects in this sector are scarce.

Second, although innovation behaviour in construction has been a longstanding research topic, no prior studies have examined how STARA, an emerging technological phenomenon, influences employees' psychological processes and their capacity to innovate. This study addresses a critical theoretical gap by exploring employees' psychological appraisals of STARA implementation and how these cognitive appraisals affect team innovation behaviour.

Third, this study advances innovation literature by examining previously unexplored antecedents of innovation behaviour in the context of technological implementation. Although collective coping strategies have been proposed as essential for understanding team dynamics (Lansisalmi *et al.,* 2000), these constructs have not been explicitly examined in relation to innovation behaviour in the construction industry. To our knowledge, this study is the first to apply the Transactional Model of Coping to illustrate how employee appraisals (challenge versus hindrance) and collective coping strategies (problem-focused and emotion-focused) influence team innovation behaviour.

Finally, by focusing on the collective level of analysis, this study provides a unique perspective on how challenge and hindrance appraisals and collective coping strategies shape collective outcomes within construction organisations.

Practical contributions

The findings of this study offer several important implications for managers and policymakers in the construction industry. First, organisations should proactively foster a team environment that encourages challenge appraisals of STARA implementation. This can be achieved by promoting a narrative that frames technological change as an opportunity for growth and learning, rather than a threat to existing roles.

Second, the study highlights the importance of collective coping strategies—particularly problem-focused and emotion-focused coping—in mitigating stress and promoting team innovation. Construction firms should consider implementing structured team-based interventions, such as coaching sessions, peer support groups, or reflective debriefings, to build shared coping capacity. Such programs, supported by research on team resilience and coping (e.g., Meneghel et al., 2016; Stephens and Carmeli, 2016), can help teams jointly process challenges, reduce anxiety, and strengthen collective adaptability during the adaptation to STARA.

Third, human resources and project managers should tailor onboarding and continuous training efforts to include not only technical upskilling but also psychological preparedness for change.

Building awareness around cognitive appraisal and coping styles can help teams navigate disruption more effectively.

Finally, organisations could benefit from developing a feedback loop between technological implementers and frontline team leaders to monitor ongoing team stress and innovation outcomes. This would enable real-time support and adaptive management strategies as teams work with emerging technologies.

Limitations and future research directions

The current study has several limitations. Although we adopted existing measures from the literature, the scales used to assess coping strategies and team innovation behaviour comprised only a small number of items, which may not fully capture the complexity of these constructs, especially when considered as collective responses. Future research would benefit from developing and validating more comprehensive instruments to measure both problem- and emotion-focused coping strategies, as well as innovative behaviour within teams in organisational settings.

In addition, the impact of self-selection on the data remains uncertain. To address this limitation and the constraints posed by the single-key informant approach used in this study, we recommend conducting within-organisation studies. By collaborating with organisations and incentivising broader participation, future researchers can gather data from multiple team members. Future research should consider employing qualitative methods such as interviews or focus groups with employees to understand better the contextual factors. Additionally, cross-cultural studies could explore whether employees in individualistic versus collectivist cultures appraise STARA differently, and how this affects their coping and innovation strategies. This study paves the way for future research in this fledgling area.

References

Agency for Digitisation (2022), *National Strategy for Digitalisation: Together in the Digital Development*, Government of Denmark, Copenhagen, available at:

https://en.digst.dk/media/mndfou2j/national-strategy-for-digitalisation-together-in-the-digital-development.pdf

Alkan, I.B. and Basaga, H.B. (2023), "Augmented reality technologies in construction project assembly phases", *Automation in Construction*, Vol. 156, p. 105107.

Al Masud, M.M., Mohiuddin, M., Hossain, M.S. and Hasan, M.M. (2024), "Fostering sustainability through technological brilliance: a study on the nexus of organizational STARA capability, GHRM, GSCM, and sustainable performance", *Journal of Cleaner Production*, Vol. 451, p. 140129, https://doi.org/10.1016/j.jclepro.2024.140129.

Anderson, N., Potočnik, K. and Zhou, J. (2014), "Innovation and creativity in organisations: A state-of-the-science review, prospective commentary, and guiding framework", *Journal of Management*, Vol. 40 No. 5, pp. 1297–1333.

Arias-Pérez, J. and Vélez-Jaramillo, J. (2022), "Understanding knowledge hiding under technological turbulence caused by artificial intelligence and robotics", *Journal of Knowledge Management*, Vol. 26 No. 6, pp. 1476–1491.

Badi, S. (2017), "Public sustainable-energy requirements and innovation in UK PFI school projects", *Construction Management and Economics*, Vol. 35 No. 4, pp. 218–238.

Badi, S. (2024), "Relationship between organisational culture and collective coping strategies in project teams: An exploratory quantitative study in the UAE construction industry", *International Journal of Productivity and Performance Management*, Vol. 73 No. 3, pp. 794–816, https://doi.org/10.1108/IJPPM-12-2021-0685.

Baduge, S.K., et al. (2022), "Artificial intelligence and smart vision for building and construction 4.0: Machine and deep learning methods and applications", *Automation in Construction*, Vol. 141, p. 104440.

Bandura, A. (1997), *Self-efficacy: The Exercise of Control*, W.H. Freeman, New York, NY.

Bello, S.A., et al. (2021), "Cloud computing in construction industry: Use cases, benefits and challenges", *Automation in Construction*, Vol. 122, p. 103441.

Brougham, D. and Haar, J. (2018), "Smart technology, artificial intelligence, robotics, and algorithms (STARA): Employees' perceptions of our future workplace", *Journal of Management & Organization*, Vol. 24 No. 2, pp. 239–257.

Brockner, J., Higgins, E.T. and Low, M.B. (2004), "Regulatory focus theory and the entrepreneurial process", *Journal of Business Venturing*, Vol. 19 No. 2, pp. 203–220.

Browne, M.W. and Cudeck, R. (1993), "Alternative ways of assessing model fit", *Sage Focus Editions*, Vol. 154, pp. 136–136.

Bentler, P.M. (2007), "On tests and indices for evaluating structural models", *Personality and Individual Differences*, Vol. 42 No. 5, pp. 825–829.

Byrne, B.M. (2010), *Structural Equation Modeling with AMOS: Basic Concepts, Applications and Programming*, Lawrence Erlbaum Associates Publishers, New Jersey.

Brattberg, E., Rugova, V. and Csernatoni, R. (2020), *Europe and AI: Leading, Lagging Behind, or Carving Its Own Way?*, Carnegie Endowment for International Peace, Washington, DC.

Cavanaugh, M.A., Boswell, W.R., Roehling, M.V. and Boudreau, J.W. (2000), "An empirical examination of self-reported work stress among U.S. managers", *Journal of Applied Psychology*, Vol. 85 No. 1, pp. 65–74, https://doi.org/10.1037/0021-9010.85.1.65.

Dackert, I. (2010), "The impact of team climate for innovation on well-being and stress in elderly care", *Journal of Nursing Management*, Vol. 18 No. 3, pp. 302–310.

Dadakhanov, F., Avazov, B., Muratov, B. and Sattarov, K. (2022), "Prospects of innovative materials production in the building materials industry", *Journal of New Century Innovations*, Vol. 18 No. 1, pp. 162–167.

De Dreu, C.K.W. (2006), "When too little or too much hurts: Evidence for a curvilinear relationship between task conflict and innovation in teams", *Journal of Management*, Vol. 32 No. 1, pp. 83–107.

Ding, L. (2022), "Employees' STARA awareness and innovative work behavioural intentions: Evidence from US casual dining restaurants", in Tabari, S. and Chen, W. (Eds), *Global Strategic Management in the Service Industry: A Perspective of the New Era*, Emerald

Publishing Limited, Bingley, pp. 17–56, https://doi.org/10.1108/978-1-80117-081-920221003.

Dorée, A.G. and Holmen, E. (2004), "Achieving the unlikely: Innovating in the loosely coupled construction system", *Construction Management and Economics*, Vol. 22 No. 8, pp. 827–838.

Emaminejad, N. and Akhavian, R. (2022), "Trustworthy AI and robotics: Implications for the AEC industry", *Automation in Construction*, Vol. 139, p. 104298.

European Commission (2020), *Shaping Europe's Digital Future*, European Commission, Brussels, available at: https://digital-strategy.ec.europa.eu/en/policies/digital-compass

European Construction Sector Observatory (2020a), *Country Fact Sheet: The Netherlands*, European Commission, Brussels, available at: https://single-market-economy.ec.europa.eu/system/files/2021-03/ecso_cfs_netherlands_2021_0.pdf

European Construction Sector Observatory (2020b), *Country Fact Sheet: Portugal*, European Commission, Brussels, available at: https://single-market-economy.ec.europa.eu/document/download/b30ec683-5283-40aa-bf49-904eff1de9ea_en

European Construction Sector Observatory (2021), *Analytical Report: Digitalisation in the Construction Sector*, European Commission, Brussels, available at: https://single-market-economy.ec.europa.eu/system/files/2021-03/ecso_pfs_de_bim-ic_0.pdf

Field, A. (2013), *Discovering Statistics Using IBM SPSS Statistics*, Sage Publications, London.

Fuller, C.M., Simmering, M.J., Atinc, G., Atinc, Y. and Babin, B.J. (2016), "Common methods variance detection in business research", *Journal of Business Research*, Vol. 69 No. 8, pp. 3192–3198.

Goel, R. and Gupta, P. (2020), "Robotics and Industry 4.0", in Nayyar, A. and Kumar, A. (Eds), *A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development*, Advances in Science, Technology & Innovation, Springer, Cham, pp. 157–169, https://doi.org/10.1007/978-3-030-14544-6_9.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010), *Multivariate Data Analysis*, Pearson Education, Harlow.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L. (2006), *Multivariate Data Analysis*, 6th ed., Pearson Prentice Hall, Upper Saddle River, NJ.

Hayes, A.F. (2017), *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*, 2nd ed., Guilford Publications, New York, NY.

Hülsheger, U.R., Anderson, N. and Salgado, J.F. (2009), "Team-level predictors of innovation at work: A comprehensive meta-analysis spanning three decades of research", *Journal of Applied Psychology*, Vol. 94 No. 5, pp. 1128–1145, https://doi.org/10.1037/a0015978.

Hur, W.M. and Shin, Y. (2024), "Service employees' STARA awareness and proactive service performance", *Journal of Services Marketing*, Vol. 38 No. 4, pp. 426–442.

Janssen, O. (2000), "Job demands, perceptions of effort-reward fairness and innovative work behavior", *Journal of Occupational and Organizational Psychology*, Vol. 73 No. 3, pp. 287–302.

Kamphuis, W., Delahaij, R. and de Vries, T.A. (2021), "Team coping: Cross-level influence of team member coping activities on individual burnout", *Frontiers in Psychology*, Vol. 12, Article 711981, https://doi.org/10.3389/fpsyg.2021.711981.

Koolhaas, J.M., Bartolomucci, A., Buwalda, B., de Boer, S.F., Flugge, G., Korte, S.M., Meerlo, P., Murison, R., Olivier, B., Palanza, P., Richter-Levin, G., Sgoifo, A., Steimer, T., Stiedl, O., van Dijk, G. and Fuchs, E. (2011), "Stress revisited: A critical evaluation of the stress concept", *Neuroscience & Biobehavioral Reviews*, Vol. 35 No. 5, pp. 1291–1301.

Kang, D.Y., Hur, W.M. and Shin, Y. (2023), "Smart technology and service employees' job crafting: Relationship between STARA awareness, performance pressure, receiving and giving help, and job crafting", *Journal of Retailing and Consumer Services*, Vol. 73, p. 103282, https://doi.org/10.1016/j.jretconser.2023.103282.

Krause, D., Luzzini, D. and Lawson, B. (2018), "Building the case for a single key informant in supply chain management survey research", *Journal of Supply Chain Management*, Vol. 54 No. 1, pp. 42–50.

Lazarus, R.S. and Folkman, S. (1984), *Stress, Appraisal, and Coping*, Springer, New York, NY.

Lansisalmi, H., Peiro, J.M. and Kivimaki, M. (2000), "Collective stress and coping in the context of organisational culture", *European Journal of Work and Organisational Psychology*, Vol. 9 No. 4, pp. 527–559.

Lestari, N.S., Rosman, D. and Millenia, E. (2023), "The association between smart technology, artificial intelligence, robotics, and algorithms (STARA) awareness, job stress, job insecurity, and job satisfaction among hotel employees during COVID-19 pandemic", *E3S Web of Conferences*, Vol. 388, Article 05018, https://doi.org/10.1051/e3sconf/202338805018.

Leprince, C., d'Arripe-Longueville, F., Chanal, J. and Doron, J. (2019), "Development and preliminary validation of the communal coping strategies inventory for competitive team sports", *Psychology of Sport and Exercise*, Vol. 45, p. 101569, https://doi.org/10.1016/j.psychsport.2019.101569.

Litchfield, R.C., Ford, C.M., Gentry, R.J. and Lam, H. (2018), "When team identity helps innovation and when it hurts: Team identity and its relationship to team and cross-team innovative behavior", *Journal of Product Innovation Management*, Vol. 35 No. 3, pp. 350–366.

Li, J.J., Bonn, M.A. and Ye, B.H. (2019), "Hotel employee's artificial intelligence and robotics awareness and its impact on turnover intention: The moderating roles of perceived organisational support and competitive psychological climate", *Tourism Management*, Vol. 73, pp. 172–181.

Lindblad, H. and Guerrero, J.R. (2020), "Client's role in promoting BIM implementation and innovation in construction", *Construction Management and Economics*, Vol. 38 No. 5, pp. 468–482.

Løvoll, H.S., Røysamb, E. and Vittersø, J. (2017), "Experiences matter: Positive emotions facilitate intrinsic motivation", *Cogent Psychology*, Vol. 4 No. 1, p. 1340083, https://doi.org/10.1080/23311908.2017.1340083.

Marsh, H.W., Hau, K.T. and Wen, Z. (2004), "In search of golden rules: Comment on hypothesis-testing approaches to setting cut-off values for fit indexes and dangers in overgeneralising Hu and Bentler's (1999) findings", *Structural Equation Modeling*, Vol. 11 No. 3, pp. 320–341.

Martínez-Rojas, M., Antolín, R.M., Salguero-Caparrós, F. and Rubio-Romero, J.C. (2020), "Management of construction safety and health plans based on automated content analysis", *Automation in Construction*, Vol. 120, p. 103362.

Melenbrink, N., Werfel, J. and Menges, A. (2020), "On-site autonomous construction robots: Towards unsupervised building", *Automation in Construction*, Vol. 119, p. 103312.

Meneghel, I., Salanova, M. and Martínez, I.M. (2016), "Feeling good makes us stronger: How team resilience mediates the effect of positive emotions on team performance", *Journal of Happiness Studies*, Vol. 17 No. 1, pp. 239–255.

Mirzaei, E. (2024), "Artificial intelligence and work transformations: integrating sensemaking and workplace learning perspectives", *Information Technology & People*, Vol. 37 No. 7, pp. 2441–2461, https://doi.org/10.1108/ITP-05-2023-0336.

Mulaik, S.A., James, L.R., Van Alstine, J., Bennett, N., Lind, S. and Stilwell, C.D. (1989), "Evaluation of goodness-of-fit indices for structural equation models", *Psychological Bulletin*, Vol. 105 No. 3, pp. 430–445.

Nasaj, M. (2020), *Understanding Individual's Innovative Behaviours: Integrated Personality Traits and Social Capital Perspective*, Doctoral dissertation, The British University in Dubai, Dubai.

Nasaj, M. (2021), "Proactive personality and employees' innovative behaviours: The role of network building ability", *International Journal of Innovation Management*, Vol. 25 No. 8, p. 2150086.

Nasaj, M., Badi, S., Murtagh, N. and Blaique, L. (2022), "Intrapreneurial personality and individual innovation behaviour in service organisations: Network building ability as a mediator", *International Journal of Innovation Management*, Vol. 26 No. 4, p. 2250029.

Nasaj, M., Badi, S., Murtagh, N. and Ding, L. (2025), "Collective AI anxiety and team innovative behaviour: the role of coping strategies", *Construction Innovation*, [EarlyCite], https://doi.org/10.1108/CI-08-2024-0222.

Niederman, F. (2021), "Project management: Openings for disruption from AI and advanced analytics", *Information Technology & People*, Vol. 34 No. 6, pp. 1570–1599.

Nordbäck, E., Nurmi, N., Gibbs, J.L., Boyraz, M. and Logemann, M. (2024), "The multilevel well-being paradox: Towards an integrative process theory of coping in teams", *Journal of Organizational Behavior*, Vol. 45 No. 5, pp. 663–683.

Norwegian Ministry of Local Government and Modernisation (2019), *Digitalisation Strategy for the Public Sector 2019–2025*, Government of Norway, available at: https://www.regjeringen.no/contentassets/c499c3b6c93740bd989c43d886f65924/en-gb/pdfs/digitaliseringsstrategi_eng.pdf

Ogbeibu, S., Senadjki, A., Gaskin, J. and Kaivo-oja, J. (2021), "Leveraging STARA competencies and green creativity to boost green organisational innovative evidence: A praxis for sustainable development", *Business Strategy and the Environment*, Vol. 30 No. 5, pp. 2421–2440.

Oosthuizen, R.M. (2019), "Smart technology, artificial intelligence, robotics and algorithms (STARA): Employees' perceptions and well-being in future workplaces", in Potgieter, I.L., Ferreira, N. and Coetzee, M. (Eds), *Theory, Research and Dynamics of Career Well-being*, Springer Nature, Cham, pp. 163–180.

Oosthuizen, R.M. (2022), "The fourth industrial revolution–Smart technology, artificial intelligence, robotics and algorithms: Industrial psychologists in future workplaces", *Frontiers in Artificial Intelligence*, Vol. 5, p. 913168, https://doi.org/10.3389/frai.2022.913168.

Pan, Y. and Zhang, L. (2021), "Roles of artificial intelligence in construction engineering and management: A critical review and future trends", *Automation in Construction*, Vol. 122, p. 103517.

Pan, Y., Zhang, L., Koh, J. and Deng, Y. (2021), "An adaptive decision-making method with copula Bayesian network for location selection", *Information Sciences*, Vol. 544, pp. 56–77.

Păvăloaia, V.D. and Necula, S.C. (2023), "Artificial intelligence as a disruptive technology—a systematic literature review", *Electronics*, Vol. 12 No. 5, p. 1102, https://doi.org/10.3390/electronics12051102.

Pindek, S., Meyer, K., Valvo, A. and Arvan, M. (2024), "A dynamic view of the challenge–hindrance stressor framework: A meta-analysis of daily diary studies", *Journal of Business and Psychology*, Vol. 39 No. 5, pp. 1107–1125, https://doi.org/10.1007/s10869-024-09933-y.

Pinto, J.K., Dawood, S. and Pinto, M.B. (2014), "Project management and burnout: Implications of the Demand–Control–Support model on project-based work", *International Journal of Project Management*, Vol. 32 No. 4, pp. 578–589.

Podsakoff, N.P., LePine, J.A. and LePine, M.A. (2007), "Differential challenge stressor-hindrance stressor relationships with job attitudes, turnover intentions, and withdrawal behavior: A meta-analysis", *Journal of Applied Psychology*, Vol. 92 No. 2, pp. 438–454.

Podsakoff, P.M. and Organ, D.W. (1986), "Self-reports in organisational research: Problems and prospects", *Journal of Management*, Vol. 12 No. 4, pp. 531–544.

Preacher, K.J. and Hayes, A.F. (2004), "SPSS and SAS procedures for estimating indirect effects in simple mediation models", *Behavior Research Methods, Instruments, & Computers*, Vol. 36 No. 4, pp. 717–731.

Rakha, T. and Gorodetsky, A. (2018), "Review of unmanned aerial system (UAS) applications in the built environment: Towards automated building inspection procedures using drones", *Automation in Construction*, Vol. 93, pp. 252–264.

Ramadhana, M.R. (2020), "A dataset for emotional reactions and family resilience during COVID-19 isolation period among Indonesian families", *Data in Brief*, Vol. 31, p. 105946.

Rane, N. (2023), "Integrating Building Information Modelling (BIM) and Artificial Intelligence (AI) for Smart Construction Schedule, Cost, Quality, and Safety Management: Challenges and Opportunities", in Shah, R. and Kumar, A. (Eds), *Cost, Quality, and Safety Management: Challenges and Opportunities*, Springer, Singapore, pp. 57–72.

Rogers, E.M. (2003), *Diffusion of Innovations*, 5th ed., Free Press, New York, NY.

Roma, P.G. and Bedwell, W.L. (2017), "Key factors and threats to team dynamics in long-duration extreme environments", in Salas, E., Vessey, W.B. and Landon, L.B. (Eds), *Team Dynamics Over Time*, Emerald Publishing Limited, Bingley, pp. 155–187.

Royal Institution of Chartered Surveyors (2023), *Digitalisation in Construction*, RICS, London, available at: https://www.rics.org/news-insights/digitalisation-in-construction-report

Savelsbergh, C., Gevers, J.M., van der Heijden, B.I. and Poell, R.F. (2012), "Team role stress: Relationships with team learning and performance in project teams", *Group & Organization Management*, Vol. 37 No. 1, pp. 67–100.

Schreiber, J.B., Nora, A., Stage, F.K., Barlow, E.A. and King, J. (2006), "Reporting structural equation modeling and confirmatory factor analysis results: A review", *The Journal of Educational Research*, Vol. 99 No. 6, pp. 323–338.

Schwarzer, R. and Knoll, N. (2003), "Positive coping: Mastering demands and searching for meaning", in Lopez, S.J. and Snyder, C.R. (Eds), *Positive Psychological Assessment: A Handbook of Models and Measures*, American Psychological Association, Washington, DC, pp. 393–409.

Searle, B.J. and Auton, J.C. (2015), "The merits of measuring challenge and hindrance appraisals", *Anxiety, Stress and Coping*, Vol. 28 No. 2, pp. 121–143, https://doi.org/10.1080/10615806.2014.931378.

Senaratne, S. and Rasagopalasingam, V. (2017), "The causes and effects of work stress in construction project managers: The case in Sri Lanka", *International Journal of Construction Management*, Vol. 17 No. 1, pp. 65–75.

Sharma, A. and Gupta, H. (2025), "Organizational coping with AI-driven workplace disruption: the role of cognitive framing and collective sensemaking", *Journal of Organizational Computing and Electronic Commerce*, Vol. 35 No. 1, pp. 1–22, https://doi.org/10.1080/15578771.2025.2486617.

Silva, B.N., Khan, M. and Han, K. (2018), "Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities", *Sustainable Cities and Society*, Vol. 38, pp. 697–713.

Skibniewski, M.J. (2025), "The present and future of smart construction technologies", *Engineering*, Vol. 44, pp. 21–23, https://doi.org/10.1016/j.eng.2024.12.024.

Spatz, D.M. (2000), "Team-building in construction", *Practice Periodical on Structural Design and Construction*, Vol. 5 No. 3, pp. 93–105.

Statsenko, L., Samaraweera, A., Bakhshi, J. and Chileshe, N. (2023), "Construction 4.0 technologies and applications: A systematic literature review of trends and potential areas for development", *Construction Innovation*, Vol. 23 No. 5, pp. 961–993.

Steiger, J.H. (2007), "Understanding the limitations of global fit assessment in structural equation modeling", *Personality and Individual Differences*, Vol. 42 No. 5, pp. 893–898.

Stephens, J.P. and Carmeli, A. (2016), "The positive effect of expressing negative emotions on knowledge creation capability and performance of project teams", *International Journal of Project Management*, Vol. 34 No. 5, pp. 862–873.

Talat, A. and Riaz, Z. (2020), "An integrated model of team resilience: Exploring the roles of team sense-making, team bricolage and task interdependence", *Personnel Review*, Vol. 49 No. 9, pp. 2007–2033.

US Department of Commerce (2024), *Sweden: Smart Built Environment Technologies*, US Commercial Service, available at: https://www.trade.gov/country-commercial-guides/sweden-smart-built-environment-technologies

Van de Ven, A.H. and Ferry, D.L. (1980), *Measuring and Assessing Organisations*, John Wiley & Sons, New York, NY.

Veiga, R.T., Lopes, E.L., de Araújo, C.F. and Azevedo, L.R. (2024), "Exploring the connections: ambidexterity, digital capabilities, resilience, and behavioral innovation", *Journal of Business Research*, Vol. 170, p. 114300, https://doi.org/10.1016/j.jbusres.2023.114300.

Wang, Q. and Kim, M.K. (2019), "Applications of 3D point cloud data in the construction industry: A fifteen-year review from 2004 to 2018", *Advanced Engineering Informatics*, Vol. 39, pp. 306–319.

Wilson, B.L., Davis, J.L., Goodwin, D.E., Johnson, D.J., McDonald, J.D. and Womack, V.Y. (2024), "'Take a mental break': examining the coping efforts of Black college students exposed to police killings", *Journal of Black Psychology*, Vol. 50 No. 1, pp. 30–67.

Wipulanusat, W., Sunkpho, J. and Stewart, R.A. (2021), "Effect of cross-departmental collaboration on performance: Evidence from the Federal Highway Administration", *Sustainability*, Vol. 13 No. 11, p. 6024, https://doi.org/10.3390/su13116024.

Yam, K.C., Jackson, J.C., Barnes, C.M., Lau, J. and Johnson, R.E. (2023), "The rise of robots increases job insecurity and maladaptive workplace behaviors: Multimethod evidence", *Journal of Applied Psychology*, Vol. 108 No. 5, p. 850, https://doi.org/10.1037/apl0001049.

Zhang, Q. and Hao, S. (2022), "Construction project manager's emotional intelligence and team effectiveness: The mediating role of team cohesion and the moderating effect of time", *Frontiers in Psychology*, Vol. 13, p. 845791, https://doi.org/10.3389/fpsyg.2022.845791.