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Innovation in manufacturing SMEs during the COVID-19 pandemic: How does environmental dynamism reinforce employee proactive behavior?

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ABSTRACT

In a turbulent environment such as during the COVID-19 pandemic crisis, employee proactive behavior is imperative for innovation initiatives in small- and medium-sized enterprises (SMEs). We ask whether and how turbulent environments motivate employees to proactively engage in innovative behavior. This study argues that employees' perceptions of environmental dynamism reinforce employee proactive innovation behavior. Using a sample comprising 262 innovative employees from 40 manufacturing SMEs in Taiwan, this study tests a moderated-mediation model in which environmental dynamism is expected to increase the indirect effect of creative self-efficacy on employee innovative behavior through knowledge acquisition. The results confirm the mediating role of knowledge acquisition and the positive moderating effect of environmental dynamism. This study sheds light on the issue of employee proactive behavior in response to changing environments.

1. Introduction

The COVID-19 pandemic disrupted the supply chains of the manufacturing sector on a large scale. Small- and medium-sized enterprises (SMEs) were the firms most affected, as they struggled with the short supply of materials and parts, logistics setbacks, and demand fluctuations (Cai and Luo, 2020). As suppliers and partners, manufacturing SMEs are deeply embedded in an industrial system that is conditioned by the market (Ahmed et al., 2022). Creativity and innovation are vital abilities SMEs must have in order to pivot and change in response to uncertain situations (Ratten, 2020). There must also be close interactions among the different supply chain partners to ensure resilience (Thukral, 2021). Consequently, SME employees face the challenge of helping their firm achieve resilience through creative collaboration in the industrial ecosystem.

The issue of employees' responses to change has been debated by theories and research on traits (Bateman and Crant, 1993; Mubarak et al., 2021), behavior (Åmo and Kolvereid, 2005; Parker et al., 2010), and change management (Caldwell and Liu, 2011; Caldwell, 2013). However, the investigations on how employees deal with problems are mostly limited to the context of organizational planned changes (e.g., Caldwell, 2013; Lee et al., 2019). Research on investigating how employees react to external unexpected turbulence still needs more attention. Recently, a few studies have tried to understand how environmental dynamism shapes human behavior in organizations (i.e., Surty and Scheepers, 2020; Lin, 2021). Surty and Scheepers (2020) found that environmental dynamism has a slight significant strengthening effect on the relationship between leadership practices and employee response to change. Lin (2021) found ethical leadership influences team initiatives in highly dynamic work environments. While these studies confirm the moderating role of environmental dynamism on employee behavioral change, they focus on team-level antecedents (i.e., leadership) rather than individual elements.

Employee proactivity, defined as the self-starting and change-oriented action of employees in organizations (Parker et al., 2010; Grant and Ashford, 2008), has been identified as a potential driver of workplace innovation (Lee et al., 2019). Innovative work in manufacturing SMEs mainly relies on employees in technical teams (Hervas-Oliver et al., 2021), because they are on the front line of production and have intimate knowledge of process inefficiencies (Unsworth and Parker, 2003). Such knowledge enables them to identify areas of development and perform innovative behavior at work (Unsworth and Parker, 2003). Scholars have recognized that proactive behavior is a consequence of individual motivation in a particular context (Parker

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et al., 2010). Motivation factors that represent individual psychological states such as role breadth self-efficacy (Parker, 1998; Tierney and Farmer, 2002), felt responsibility for change (Morrison and Phelps, 1999), and change readiness (Rusly et al., 2015), have been demonstrated as antecedents of employee proactive behavior. Following this logic, we focus on creative self-efficacy, which is employees' belief in their own creative ability, and argue that this factor triggers employee proactive learning behavior toward innovation.

Unlike large companies that gain a competitive advantage from cost efficiencies, manufacturing SMEs generally focus on differentiation strategies such as diversified product offerings and flexible customer responses (Terziovski, 2010). SMEs also encounter various obstacles to innovation, such as insufficient financial capital, limited management skills, and a lack of technical information and know-how (Ferreira et al., 2014; Thukral, 2021). Based on their strategic orientation and capability constraints, SMEs rarely innovate by themselves; instead, they rely on external sources to strengthen their internal innovation (Lin and Lin, 2016). The nature of embeddedness of manufacturing SMEs highlights the critical role of collaboration and information exchange activities within a supply chain network. Manufacturing SMEs' inability for solo innovation further impacts their adoption of open innovation and has led to the emerging introduction of supply chain digitalization when faced with turbulence (Madhavan et al., 2022). For example, the turbulence caused by the recent pandemic accelerated SMEs' transference to manufacturing systems that are automated, autonomous, and intelligent (Cai and Luo, 2020). The progress arising from digital transformation creates better connectivity as well as effective communication among supply chain partners (Ahmed et al., 2022). Accordingly, engaging in knowledge acquisition might be a key mechanism through which employees of manufacturing SMEs gain innovative capabilities.

As stated above, whether and how environmental dynamism stimulates employees' proactive behavior to initiate innovation has become a critical question. Our contribution stems from the examination of this issue. This study investigates two personal capabilities of employees, i.e., creative self-efficacy and knowledge acquisition, and aims to discover how these two factors influence employee innovative behavior in response to external turbulence. Accordingly, this study draws on social cognitive theory to apply a theoretical framework to explain individual behavior based on interactions with personal factors as well as the external environment. By additionally including the employee proactivity perspective, this study argues that employees in manufacturing SMEs who have higher creative self-efficacy are more likely to embark on collaborative knowledge acquisition and consequently perform more innovative behavior. That is, knowledge acquisition mediates the impact of creative self-efficacy on employee innovative behavior. We also propose that this mediation relationship will be reinforced by the level of dynamism that exists in the environment. The proposed model is depicted in Fig. 1.

Our research sample consists of 262 employees from 40 manufacturing SMEs in Taiwan. The empirical results show overall support for our predictions. The present study sheds light on the determinants and mechanism of employees' responses to changing environments and makes the following contributions. First, the confirmed mediating relationship reveals that knowledge acquisition is a necessary mechanism by which employees in manufacturing SMEs access their innovation capabilities. This finding is unique because we consider the collaborative nature of innovation work in manufacturing SMEs, thereby deriving a suggestion for managers to build a workplace that encourages and supports interfirm interpersonal knowledge acquisition. Second, the significant positive moderating effect of environmental dynamism indicates that highly creative self-efficacy employees have a greater tendency to respond to external dynamism and initiate innovative learning activities. We believe this is a pioneer finding that provides novel knowledge about the moderating role of environmental dynamism on proactive behavior at the individual level. Third, this research focuses on the innovative staff in manufacturing SMEs and explores their behavior in a workplace that is influenced by the complex changes at both the industrial and macro levels. Our research setting thus provides an insightful viewpoint that past studies have rarely investigated.

2. Literature review and hypotheses development

2.1. Social cognitive theory

Social cognitive theory, proposed by Bandura (1986), provides a theoretical framework to identify individual behavior based on a triadic structure between cognitive factors, environmental factors, and human behavior. The theory considers both internal and external influential factors in human actions by embracing the cognitive process of self-regulation as well as recognizing the importance of environmental determinants corresponding to behavior (Cai et al., 2022). According to the theory, cognitive factors affect individual behavior while social and environmental factors alter human beliefs (Kim and Chai, 2022).

In this current study, we consider creative self-efficacy as a cognitive factor that influences the innovative behavior of employees. Environmental dynamism is the external determinant affecting people's beliefs and actions. We further propose that knowledge acquisition, which represents a collaborative learning effort, is a necessary action and vehicle for employees to learn to innovate in the context of manufacturing SMEs.

2.2. Creative self-efficacy and innovative behavior

Creative self-efficacy refers to a person's self-judgment of their capacity to pursue a creative goal (Tierney and Farmer, 2002), which is derived from the self-efficacy theory of behavioral change proposed by Bandura (1977). Self-efficacy is defined as the "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). In the research line on employee proactivity, scholars have demonstrated that employees who feel capable of performing tasks are more likely to present self-starting behavior to deal with change (Parker, 1998; Fuller et al., 2018; Grosser et al., 2017). Employee proactivity has been found to predict several individual outcomes, including creativity and innovative behavior (Zhang et al., 2012), as well as to be vital to the promotion of innovative change (Lee et al., 2019).

Innovative behavior is defined as "an initiative from employees concerning the introduction of new processes, new products, new

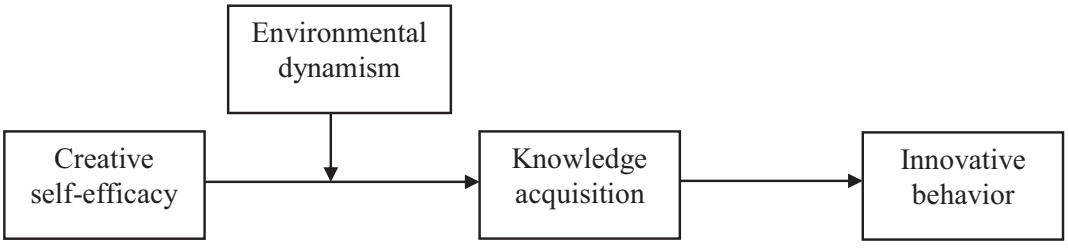

Fig. 1. Research framework.

markets or combinations of such into the organization" (Åmo and Kolvereid, 2005, p. 8). Innovation at the individual level begins with identifying a problem and coming up with a solution (Dhar, 2016). Such behavior consists of generating ideas (i.e., creativity), seeking support (e.g., knowledge acquisition), and implementing ideas (i.e., new product or process) (Hoang et al., 2022). Many studies have examined multilevel factors that influence the innovative behavior of employees, for example, personal traits (Ng and Lucianetti, 2016) and demand (Kwon and Kim, 2020), team-level leadership style, and organizational climate (James et al., 2008; Martins and Terblanche, 2003; Dhar, 2016). Based on the claims of the employee proactivity perspective and social cognitive theory, human behavior is influenced by the individual's internal cognitive state and external environmental factors. We therefore focus on the motivation factor of individual-level cognitive belief, which is creative self-efficacy.

Through the lens of social cognitive theory, scholars have suggested that elevated self-efficacy leads to the sustaining of effort that is linked to innovative behavior (Tierney and Farmer, 2002). Based on the concept that self-efficacy is a cognitive condition that influences human behavior (Bandura, 1977), individuals' perceptions of the essential knowledge, skill, and ability required for specific creative performance are key motivating factors of their behavior in idea generation, dissemination, and implementation (Tierney and Farmer, 2002; Fino and Sun, 2022). As stated above, self-efficacy is a necessary condition for the discovery of new knowledge and creative productivity (Tierney and Farmer, 2002). The literature on creative self-efficacy has demonstrated its significant association with employees' creativity (Tierney and Farmer, 2002; Al Wali et al., 2022). Previous evidence has shown that employees possessing high levels of creative self-efficacy derive satisfaction from innovative pursuits and exhibit greater extraordinary tenacity when encountering challenges inherent to innovational performance (Grosser et al., 2017; Newman et al., 2018; Tierney and Farmer, 2011).

2.3. The mediating role of knowledge acquisition

Knowledge acquisition refers to an employee's ability to identify and acquire new knowledge from inside the organization or from external sources (Jiang and Chen, 2018). Acquiring knowledge is a purposeful process that has become an increasingly important strategy for individuals seeking to improve their innovation capability. Searching within personal networks or industrial environments, creative employees can capture valuable knowledge and know-how (Perry-Smith and Shalley, 2003), find solutions to solve challenging tasks (Jiang and Chen, 2018), and inspire innovative outcomes (Xie et al., 2018). The association between knowledge acquisition and positive innovation performance is evidenced in the literature (Papa et al., 2020), both in the case of young firms and SMEs (Chuang et al., 2016; Naldi and Davidsson, 2014; Huang and Liu, 2019) and large companies (Norman, 2004).

Regarding the antecedents of knowledge acquisition, existing studies have mostly focused on intrafirm and inter-firm factors such as human resource management practices (Papa et al., 2020), partner attributes (Norman, 2004), and firms' absorptive capacities (Van Wijk et al., 2008). Little attention has been paid to understanding what stimulates individuals' involvement in the knowledge acquisition process. Individuals represent key players because they are knowledge sources and recipients. As a result, it is reasonable to consider that their willingness and abilities might be critical in initiating collective knowledge activities. Following the logic of the social cognitive theory, understanding whether and how individual-level cognitive factors affect individuals' actions to acquire knowledge can be insightful (Rusly et al., 2015). Rusly et al. (2015) confirmed the impact of an individual's change readiness on knowledge acquisition. This result offers a hint that knowledge acquisition is a mechanism that leads change-oriented individuals toward innovative outcomes. Accordingly, this study argues that knowledge acquisition plays a mediating role between creative self-efficacy and employee innovative behavior.

Small enterprises that are capable of adapting change are considered resilient (Kuckertz et al., 2020). Regularly, a manufacturing SME is seen in the context of an industrial supply chain. Hence, SME resilience, which is key for crisis survival, is argued to be derived from the resilience of an ecosystem (Thukral, 2021). For SMEs, innovation capability generally refers to quick responses to changes in clients' demands through flexibility and agility (Huang and Lu, 2020; Van Auken et al., 2021). This is mainly driven by employees in technical teams (Unsworth and Parker, 2003). Kim and Chai (2022) pointed out the influential role of employees' self-efficacy on the implementation of cooperation, coordination, and communication activities that can lead to supply chain resilience. This is because when creative employees feel capable of making constructive changes, they will search for requisite knowledge on their own accord. In addition, during the recent pandemic, many studies observed that SMEs tried to manage the dislocation of the supply chain using modern technology (Chatterjee et al., 2022). The crisis thereby accelerated a paradigm shift based on ongoing digitization and interconnection in the manufacturing sector (Chen, 2020). By applying technologies of big data analytics, the Internet of Things, digital platforms, and cloud computing, manufacturing supply chains evolved into tightly connected innovation ecosystems that help their members live together (Ahmed et al., 2022; Cenamor et al., 2019). Under such a scenario, knowledge acquisition by means of collaboration within and across company boundaries is essential for employees in manufacturing SMEs to pursue innovation. Collective teamwork activities enable employees to access tacit knowledge (Del Giudice et al., 2019), dialogue on complex issues, and learn from coaching (Hooijberg and Watkins, 2021). As a result, knowledge flows that stimulate the intellectual interest of employees are generated (Lai et al., 2015), which further influences employees' engagement in innovation. As such, this study suggests a mediating role of knowledge acquisition as below:

Hypothesis 1. For employees in manufacturing SMEs, knowledge acquisition has a mediating effect on the relationship between creative self-efficacy and innovative behavior.

2.4. The moderating role of environmental dynamism

Environmental dynamism refers to the level of unpredictability and instability in a firm's environment (Chan et al., 2016). It is commonly accepted as a profound force that can strongly influence not only organizational capabilities and innovation outcomes (Xiao et al., 2020) but the agility and resilience of the industrial open innovation system (Akgul, 2015). Although happening in external contexts, employees' perceptions of workplace dynamism reflect their inability to predict the direction in which their work may change (Waldman et al., 2001), where uncertainty may cause their behaviors to change (Surty and Scheepers, 2020). Therefore, it is necessary to further explore how environmental dynamism influences employees' actions of searching for and developing solutions in response to an unstable work environment.

Most extant literature has applied environmental dynamism as a moderator that needs to be considered in organizational contingencies (Zhang and Zhu, 2021; Ahmed et al., 2022; Do et al., 2022). Limited insight has been provided regarding human aspects in the context of a highly dynamic environment. Ahmed et al. (2022) asked the question of how a changing environment affects a firm's obtainment of intellectual capital, including human capital. The results support their prediction of the negative moderating effect of environmental dynamism on a firm's capability and human capital. Although this work did not link to employee behavior, the results imply that unpredictable conditions can change people's choices in work. Another research, by Lin (2021), focused on team-level proactive actions and confirmed the moderating role of environmental dynamism on the relationship between leadership and team initiative, where proactive initiatives were found to be more likely to occur in highly dynamic environments. Regarding work

behavior at the individual level, the study by Surty and Scheepers (2020) indicated that environmental dynamism has a strengthening effect on the relationship between leadership practices and employees' response to change. Their findings specifically show that environmental dynamism can encourage employees' change-oriented actions.

Compared to large businesses, SMEs have been hardest hit by COVID-19. The manufacturing sector still suffers from supply chain disruption, demand has diminished, there is a raw materials shortage and a severe transportation disruption, and so on (Shafi et al., 2020). Most SMEs have been unable to adjust sufficiently to the unpredictable changes and have thus suffered losses (Ahmed et al., 2022). Such a highly turbulent event is expected to heighten employee awareness and stress in response to the changing environment (Shao et al., 2021; Steinbach et al., 2021; Zhong et al., 2021). In reaction, highly creative self-efficacy employees who feel capable of overcoming obstacles and uncertainties would start their actions of problem-solving (Tantawy et al., 2021). In the context of the manufacturing sector, the nature of external uncertainty is present in terms of fast-changing technologies, varying customer preferences, and fluctuating demand and supply of materials (Hou et al., 2019; Huang and Lu, 2020). In dealing with these problems employees in SMEs have been required to embark on collaborative teamwork across the supply chain. Therefore, for employees of manufacturing SMEs, innovation is a consequence of collaborative learning in an industrial network wherein knowledge is acquired, shared, and combined (Jiang and Chen, 2018; Van Auken et al., 2021). In brief, under highly volatile environments, risky situations push employees who believe in their creative ability to initiate a process of knowledge acquisition, where accessed knowledge further aids employees to engage in innovation activities. Considering the above arguments, our second hypothesis is:

Hypothesis 2. The mediating effect of creative self-efficacy on innovative behavior through knowledge acquisition is stronger when employees in manufacturing SMEs sense greater environmental dynamism.

3. Methodology

3.1. Data collection and sample

This study conducts a survey targeting innovation staff in Taiwan manufacturing SMEs due to three reasons. First, the economy in Taiwan is known as an SME-dominant structure (Lee and Jioe, 2017); specifically, SMEs account for 98 % of entrepreneurs and employ 71 % of the nation's workforce (Chen et al., 2021). In the manufacturing sector, most SMEs are key suppliers to large companies, responsible for much of the innovation and productivity in the business community (Wu and Chiu, 2016). Second, the manufacturing sector in Taiwan is featured by industrial clustering and is considered a business ecosystem. Small entrepreneurial companies usually form a network of center–satellite systems in which many center factories and cooperative factories cluster together (Chen et al., 2021). The operation of such interconnected systems aids technical knowledge spillover effects (Del Giudice et al., 2019). Third, manufacturing SMEs in Taiwan have invested in industry 4.0 and digitalization (Chen, 2020). Based on these reasons, we believe sampling from Taiwanese manufacturing SMEs is appropriate to test our arguments because these firms are highly embedded in the innovation system and urgently need to adapt to industry and market changes.

As our research aims to investigate the innovative behavior of employees, we choose workers in the production and R&D divisions who are responsible for technological processes and product innovation in manufacturing SMEs. We further adopt the governmental definition of SMEs in Taiwan, i.e., enterprises with no more than 200 employees and paid-in capital of less than NT$100 million. We use the list of manufacturing SMEs provided by the Taiwan Ministry of Economic Affairs. We first randomly send 1000 invitations by email to the leaders of targeted divisions in companies on the list, along with a letter explanting the purpose of our study. This step receives 92 companies expressing interest in participating in the study. Next, a questionnaire is sent to these firms. To reduce the issue of potential common method variance, we follow previous studies and send questionaries in two waves within a two-week interval (Liu et al., 2017; Wu et al., 2010). The first wave, which includes 225 questionnaires sent to 45 willing companies, results in 138 responses, 125 of which are valid. The second wave, which includes 235 questionnaires sent to 47 companies, yields 137 valid responses out of the 158 questionnaires returned. Taken together, our survey obtains 262 valid responses from 40 manufacturing SMEs. Among the respondents, 52 % are male, the average age is 38.7, and 67.6 % hold a bachelor's degree or higher.

3.2. Measures

This study uses the five-point Likert scale to measure all variables; in the scale, one represents strongly disagree and five represents strongly agree. Following Hou et al. (2019), we translate the English scales into Chinese. To verify the translation, a bilingual expert translates from English to Chinese and then back to English to ensure the quality of the conversation. The measurements of variables are explained below.

3.2.1. Employee innovative behavior

The dependent variable is a self-reporting assessment based on the respondents' subjective perceptions of their actions within the workplace (Mitchell et al., 2021). A six-item scale adopted from Dhar (2016) is used: “At work, I come up with innovative and creative notions”; “At work, I try to propose my own creative ideas and convince others”; “At work, I seek new methods, or techniques”; “At work, I provide a suitable plan for developing new ideas”; “At work, I try to secure the funding and resources needed to implement innovations”; and “Overall, I consider myself a creative employee of my organization”. The Cronbach's alpha for the scale is 0.71.

3.2.2. Creative self-efficacy

We measure this independent variable using a three-item scale developed by Tierney and Farmer (2002). The items are “I have confidence in my ability to solve problems creatively”; “I feel that I am good at generating novel ideas”; and “I have a knack for further developing the ideas of others”. The Cronbach's alpha for the scale is 0.84.

3.2.3. Knowledge acquisition

To measure the knowledge acquisition ability of employees, we draw on Jiang and Chen's (2018) team knowledge acquisition scale. The four items are adapted as “I usually scan the environment inside and outside my organization for knowledge about the market”; “I usually scan the environment inside and outside my organization for technical knowledge”; “I usually seek ideas/expertise from people inside and outside my organization to perform tasks”; and “I usually seek feedback about my work from people outside my team and organization”. The Cronbach's alpha for the scale is 0.75.

3.2.4. Environmental dynamism

The environmental dynamism measure reflects employees' subjective assessments of market change (Mitchell et al., 2021). This variable is measured using a five-item scale developed by Jansen et al. (2009). The items include “Recently, environmental changes in our local market are intense”; “Recently, our clients regularly ask for new products and services”; “Recently, changes are taking place continuously in our local market”; and “Recently, the volumes of products and services to be delivered change fast and often in our market”. The Cronbach's alpha for the scale is 0.71.

3.2.5. Control variables

This study includes the employees' education, gender, and age as control variables. These variables could affect the employees' efficacy to initiate organizational change (Fuller et al., 2006) and could impact

their work performance (Rofcanin et al., 2021).

3.3. Common method bias and non-response bias

We test for the possibility of common method bias (CMB) by using Harmen's single-factor test. The total variance extracted by one factor is 22.32 %, which is less than the recommended threshold of 50 % (Podsakoff and Organ, 1986), indicating that CMB is not a major concern in this study. Furthermore, to control for errors in respondent selection, we evaluate non-response bias by testing for significant differences between the two waves of respondents. Performing *t*-tests on the variables of age and gender, the results indicate that early and late respondents have no significant differences. This suggests that there is no concern regarding non-response bias.

4. Results

4.1. Validity, reliability, and correlations

Table 1 presents the scale reliability and validity analysis results. Regarding the reliability of scales, the values of composite reliability (CR) range from 0.77 to 0.92, which are larger than the threshold of 0.6, and the values of Cronbach's α range from 0.71 to 0.84, passing the α < 0.7 criteria (Hair et al., 2018). Next, convergent validity is determined using confirmatory factor analysis. The factor loading values of all the items range between 0.55 and 0.85, exceeding the acceptable threshold of 0.5. Furthermore, the average variance extraction (AVE) of all constructs is better than the AVE > 0.5 cutoff (Hair et al., 2018). In addition, considering evaluating discriminant validity, the square roots of the AVE of all the variables exceed the correlations between the focal variable and other variables in Table 2; thus, the discriminant validity of variables is supported. Overall, the results indicate that our constructs have acceptable validity and reliability.

Table 2 provides the means, standard deviations, and correlations of the variables. We additionally conduct collinearity diagnostic tests on all variables. The results reveal that all the variance inflation factor (VIF) values range from 1.01 to 2.03, well below the standard cutoff of 10. Thus, multicollinearity is not a concern in our study.

Table 1
Results of reliability and validity test.

Constructs and items	Loadings
Creative self-efficacy (AVE = 0.53, CR = 0.77, α = 0.84)	
1. I have confidence in my ability to solve problems creatively.	0.79
2. I feel that I am good at generating novel ideas.	0.70
3. I have a knack for further developing the ideas of others.	0.68
Knowledge acquisition (AVE = 0.61, CR = 0.86, α = 0.75)	
1. I usually scan the environment inside and outside my organization for knowledge about the market.	0.81
	0.74
2. I usually scan the environment inside and outside my organization for technical knowledge.	0.83
	0.75
3. I usually seek ideas/expertise from people inside and outside my organization to perform tasks.	
4. I usually seek feedback about my work from people outside my team and organization.	
Environmental dynamism (AVE = 0.62, CR = 0.87, α = 0.71)	
1. Recently, environmental changes in our local market are intense.	0.81
2. Recently, our clients regularly ask for new products and services.	0.77
3. Recently, changes are taking place continuously in our local market.	0.79
4. Recently, the volumes of products and services to be delivered change fast and often in our market.	0.78
Employee innovative behavior (AVE = 0.66, CR = 0.92, α = 0.71)	
1. At work, I come up with innovative and creative notions.	0.55
2. At work, I try to propose my own creative ideas and convince others.	0.84
3. At work, I seek new techniques, methods, or techniques.	0.85
4. At work, I provide a suitable plan for developing new ideas.	0.85
5. At work, I try to secure the funding and resources needed to implement innovations.	0.94
	0.79
6. Overall, I consider myself a creative employee of my organization.	

Note: AVE = average variance extracted, CR = composite reliability, α = Cronbach's alpha.

4.2. Regression analysis

Table 3 displays the results of the ordinary least squares regression analysis. This study employs a three-step regression to test the mediation effect (Baron and Kenny, 1986); Models 1–3 show the three steps. In Model 1, creative self-efficacy has a significant positive impact on innovative behavior (β = 0.50, $p < 0.001$). In Model 2, creative self-efficacy has a significant positive influence on knowledge acquisition (β = 0.29, p < 0.001). In Model 3, controlling for knowledge acquisition, the relationship between creative self-efficacy and innovative behavior remains positively significant (β = 0.34, p < 0.001). Regarding the influence of creative self-efficacy on innovative behavior, the direct effect in Model 1 is larger than the indirect effect in Model 3 (0.50 > 0.34). Taken together, the combination of Models 1–3 satisfies Baron and Kenny's (1986) mediator test. Furthermore, the Sobel test yields a value of 3.34, which exceeds the critical value of ±1.96, thus confirming knowledge acquisition is a mediator between creative self-efficacy and innovative behavior. The mediation effect predicted in Hypothesis 1 is thereby supported. In addition, we test the moderated mediation effect by using the first-stage conditional process model (Hayes and Rockwood, 2020). Results in Model 4 show the interaction term has a significant positive moderating effect (β = 0.44, $p < 0.01$), providing support for our prediction in Hypothesis 2.

This study further verifies the moderated mediation effects using the PROCESS macro and bootstrapping methods (Hayes, 2015). With creative self-efficacy (CSE) as the independent variable, environmental dynamism (ED) as the moderator, knowledge acquisition (KA) as the mediator, and innovative behavior (IB) as the dependent variable, Model 7 of the PROCESS tool is used to access the first-stage conditional process model (Hayes and Rockwood, 2020). The results are presented in Table 4. When the moderator is at its low level (ED = 3.36), the indirect effect of 0.030 shows no significance due to the confidence interval including zero (95 % confidence interval from −0.079 to 0.115). At the middle level of the moderator (ED = 4.10), the indirect effect of 0.125 is significant (95 % confidence interval from 0.044 to 0.206). Similarly, when the value of the moderator comes to a high level (ED = 4.84), the indirect effect of 0.221 is significant (95 % confidence interval from 0.106 to 0.344). In sum, the indirect effect of creative self-efficacy on innovative behavior through knowledge acquisition increases as the value of the moderator (i.e., environmental dynamism) increases. Overall, the index of moderated mediation, which is a test of the moderation of the indirect effect by the moderator (Hayes and Rockwood, 2020), presents a slope of 0.129 and is significant because the confidence interval does not include zero (95 % confidence interval from 0.046 to 0.237). Therefore, our claim in Hypothesis 2 regarding the moderated mediation effect is confirmed. The conditional indirect effects (Table 4) indicate that environmental dynamism moderates the indirect effect of CSE → KA → IB, however, the indirect effect holds only at the middle and high levels of environmental dynamism. The estimated moderating effect is depicted in conceptual form in Fig. 2, in which the slopes of the creative self-efficacy–knowledge acquisition relationship increases as the level of environmental dynamism rises, indicating a positive moderating effect of environmental dynamism.

4.3. Supplementary analysis

To test the robustness of our results, this study conducts two supplementary analyses. First, as the 262 observations are nested by 40 firms, we examine whether our findings vary across firms by applying a firm dummy. The results remain unchanged. Second, the predicted moderating effect of environmental dynamism might also influence the relationship between knowledge acquisition and innovative behavior. Accordingly, we test the moderated mediation effect of the second-stage

Table 2
Descriptive statistics and correlations.

	Variables	Mean	S.D.	1		2		3		4		5	6	VIF
1	Employee innovative behavior	4.03	0.68	**0.81**										
2	Creative self-efficacy	3.88	0.84	0.335	***	**0.73**								2.03
3	Knowledge acquisition	4.05	0.74	0.524	***	0.144	*	**0.78**						1.07
4	Environmental dynamism	4.10	0.74	0.203	**	0.409	***	0.161	**	**0.79**				1.24
5	Gender	1.48	0.50	−0.090		−0.667	***	0.025		−0.323	***			1.87
6	Age	38.70	5.74	−0.007		−0.090		0.003		0.042		0.045		1.02
7	Education	1.95	0.77	0.059		0.068		0.008		0.009		−0.066	0.010	1.01

Note: $n = 262$, Bold numbers on the diagonal line are the square root values of the AVE for each variable.
*** Significant at $p < 0.001$ level.
** Significant at $p < 0.01$ level.
* Significant at $p < 0.05$ level.

Table 3
Results of moderated mediation analysis.

	Model 1			Model 2			Model 3			Model 4		
Dependent variable→	Innovative behavior			Knowledge acquisition			Innovative behavior			Innovative behavior		
	Coef.		SE	Coef.		SE	Coef.		SE	Coef.		SE
(Constant)	1.79	***	0.48	2.47	***	0.55	1.62	***	0.35	1.89	***	0.46
Gender	0.24	**	0.11	0.22	**	0.12	0.06		0.07	0.03		0.07
Age	0.03		0.01	0.02		0.08	0.00		0.01	0.01		0.01
Education	0.04		0.05	0.00		0.06	0.02		0.03	0.03		0.03
Creative self-efficacy	0.50	***	0.06	0.29	***	0.07	0.34	***	0.05	0.07		0.07
Knowledge acquisition							0.26	***	0.05	0.21	***	0.05
Environmental dynamism										0.02		0.10
Creative self-efficacy * environmental dynamism										0.44	**	0.02
Model R^2	0.15			0.05			0.38			0.39		
F-value	11.01	***		3.20	*		31.28	***		23.27	***	

Coef. = standardized coefficient; SE = standard error.
n = 262 observations.
*** Significant at $p < 0.001$ level.
** Significant at $p < 0.01$ level.
* Significant at $p < 0.05$ level.

Table 4
Indirect effect of creative self-efficacy on innovative behavior through knowledge acquisition moderated by environmental dynamism.

Conditional indirect effects (PROCESS Model 7) Moderator: ED, Mediator: KA, Indirect effect: CSE → KA → IB				
Condition of moderator	Value of moderator	Effect	Standard error	95 % confidence interval
Low	3.36	0.030	0.048	−0.079, 0.115
Middle	4.10	0.125	0.041	0.044, 0.206
High	4.84	0.221	0.061	0.106, 0.344
Index of moderated mediation:		0.129	0.048	0.046, 0.237

Note: CSE = creative self-efficacy, KA = knowledge acquisition, IB = innovative behavior, ED = environmental dynamism. Bootstrap analysis based on 10,000 replications, n = 262 observations.

conditional process model (Hayes and Rockwood, 2020). The evaluation of conditional indirect effects is accessed by Model 14 of the PROCESS tool. The interaction term of knowledge acquisition and environmental dynamism shows no significance ($\beta = 0.09$, $p = 0.195$), and the index of moderated mediation presents a slope of 0.025 and is not significant as the confidence interval includes zero (95 % confidence interval from −0.066 to 0.006). Thus, our results indicate that the moderated mediation effect does not exist in the second-stage conditional process model.

5. Discussion and conclusion

This study considers employees' proactive behavioral response to environmental turbulence, in the context of manufacturing SMEs. The purpose of this study is to understand how employees' personal capabilities influence their proactive behavior in dealing with intense uncertainty. Drawing on social cognitive theory, this study theorizes and tests a mediated moderation model illustrating how creative self-efficacy and knowledge acquisition influence employees' innovative behavior under conditions of varying environmental dynamism. We test the model using 262 samples collected from manufacturing SMEs in Taiwan. The results indicate that, first, knowledge acquisition mediates the relationship between creative self-efficacy and innovative behavior. Second, environmental dynamism moderates the mediation relationship; i.e., employees' innovative behavior that is motivated by creative self-efficacy and knowledge acquisition is reinforced by higher levels of dynamism.

5.1. Discussion and theoretical contributions

Our findings are novel and insightful to the literature in several ways. First, the supported Hypothesis 1 confirms the mediating role of knowledge acquisition. This result supports the literature on organizational learning that treats knowledge acquisition as a process of innovation (Huber, 1991; Norman, 2004; Jiang and Chen, 2018; Duong et al., 2022). Different from the past interest in learning at the firm and inter-firm levels (e.g., Norman, 2004; Huang and Liu, 2019; Papa et al., 2020), our findings offer complementary insights by extending the concept into individual learning behavior. Although the influence of creative self-efficacy and knowledge acquisition on individual innovation has been proposed in prior research (Newman et al., 2018; Xie et al., 2018), our examination of the knowledge acquisition process further links to the consequence of innovation behavior. In other words, the supported mediation relationship highlights that knowledge acquisition is a crucial mechanism for employees with high levels of creative self-

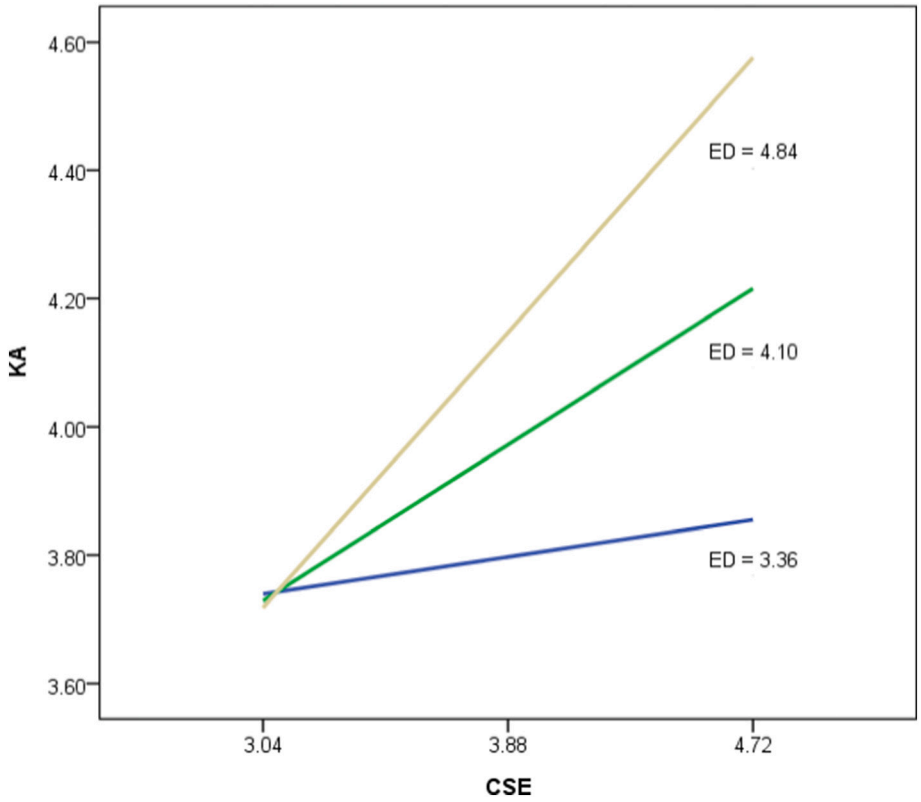

Fig. 2. The moderating effect of environmental dynamism on the relationship between creative self-efficacy and knowledge acquisition.
Note: CSE = creative self-efficacy, KA = knowledge acquisition, ED = environmental dynamism.

efficacy to achieve innovation, especially for employees of manufacturing SMEs who face a more interconnected industrial ecosystem.

Second, the supported moderated mediation effect suggests that, as the level of environmental dynamism increases, creative self-efficacy employees are more likely to conduct knowledge acquisition activities that will lead to innovative behavior. This result is consistent with the social cognitive theory (Bandura, 1986), in that personal, environmental, and behavioral determinants have a dynamic, bi-directional interaction with each other (Cai et al., 2022). Our findings present unanimous support for the strengthening role of environmental dynamism on employees' change-oriented initiatives (Surty and Scheepers, 2020; Lin, 2021). Our findings thus advance the current understanding of employee behavior in response to external change. The focus on external environmental turbulence, such as the COVID-19 pandemic, therefore, benefits the change management literature (Caldwell and Liu, 2011; Caldwell, 2013). Our work answers a call from Ford (2009) to extend the boundary of change research from organizational planned changes (Caldwell, 2013) to the macro-level of external environmental changes.

Third, this study enriches the research lens of employee proactivity, which claims that proactive behavior is an important driver of innovation (Lee et al., 2019). Our results show that a highly dynamic environment could motivate employees with creative self-efficacy to start to learn through knowledge acquisition (i.e., the supported first-stage conditional process model in Table 4), while it could fail to inspire employees with a strong knowledge acquisition capability to engage in innovative behavior (i.e., the insignificant second-stage conditional process model in the supplementary analysis). These results indicate that creative self-efficacy drives employees' proactive innovation, which is insightful because it echoes the findings of Lee et al. (2019) and confirms that employees' proactive behavior is a consequence of their cognitive state.

Fourth, this study contributes to the debate concerning managing the transitioning workplace and turbulent market environment that manufacturing SMEs face (Cenamor et al., 2019; Chen, 2020; Chen et al., 2021; Melnyk et al., 2021; Ahmed et al., 2022). The sector of manufacturing SMEs in Taiwan plays an essential role in global manufacturing systems, especially in the information technology supply chain (Huang and Lu, 2020). During the COVID-19 crisis, the movement to restructure industrial innovation systems (e.g., industry 4.0) opened new opportunities for manufacturing SMEs to adapt to changes and improve resilience at the supply chain level (Chen, 2020). In this study, we claim that the nature of collaborative teamwork in the manufacturing system highlights the indispensable process of knowledge acquisition. We find that the mediation of creative self-efficacy influences innovative behavior through knowledge acquisition and exhibits a stronger relationship as the external environment turns dynamic. The results indicate that, for employees in manufacturing SMEs, the importance of conducting knowledge acquisition and learning activities increases as the turbulence of the market environment increases. In sum, our findings show that manufacturing SMEs' innovation management should emphasize nurturing employees' proactive initiatives and facilitating the process of knowledge learning when designing a resilient organization.

5.2. *Managerial implications*

Our findings lead to several managerial implications. First, the findings suggest that managers who aim at facilitating the emergence of innovative behavior in the workplace should increase human capital and focus on creative self-efficacy. Because our findings confirm that it is the personal belief in their creative ability that motivates employees to take actions toward learning and innovation, and that a higher level of environmental dynamism reinforces this motivation. We suggest obtaining people with creative self-efficacy could help increase

manufacturing SMEs' initiatives in change-relevant innovation activities during a dynamic time. In addition, managers could consider using human resource practices to encourage proactive employee initiatives, such as providing rewards for pertinent behaviors and subsequent achievements (Lee et al., 2019).

Second, knowledge acquisition is a critical mechanism identified in this study as the process through which self-efficacy employees learn to innovate. Accordingly, managers of innovative work in manufacturing SMEs are suggested to consider developing supportive work environments and building information exchange systems to assist knowledge flows among interpersonal, intergroup, and inter-organizational collaborative activities. The post-pandemic future of teamwork has shifted to a combination of virtual coordination and in-person collaboration. To facilitate collaboration and innovation, managers in innovative workplaces are suggested to support work that cannot be done effectively by virtual means, such as integrative work in teams, building relationships and networking, and having difficult conversations (Hooijberg and Watkins, 2021).

5.3. Limitations and future directions

Our study has several limitations that may offer some suggestions for future research. The first is the restricted generalizability of our findings. Our sampling from manufacturing SMEs in Taiwan limits the generalizability of our findings to other contexts. Taiwan has built a complete supply chain of electronic components (Huang and Lu, 2020), which demands urgent transformation to smart factories and supply chain digitalization under the threat of disasters. Manufacturing SMEs in Taiwan are concentrated around high-technology production and are featured by industrial clustering. Therefore, we choose manufacturing SMEs in Taiwan, because they are suitable for testing the multiple changes that happen in industry and external environments. However, the two hypotheses of our moderated mediating model may also apply to larger firms and firms in other industries if innovation is a key aspect of their business recovery and resilience. Therefore, we suggest future studies examine employee self-starting innovation behavior in different contexts, such as big firms or SMEs in different industries or country contexts.

Second, this study discusses only the moderating effect of environmental dynamism on the relationships between creative self-efficacy, knowledge acquisition, and employee innovative behavior. It is valuable to investigate potential influencing factors related to how employee behavior is impacted by changes in various levels of an individual's environment. We suggest future studies consider other moderators, for example, culture and nationality at the macro-level, industrial competitiveness at the meso-level, organizational culture or strategic actions at the firm level, or innovation climate or leadership at the team level.

Third, as our data is cross-sectional, we suggest collecting longitudinal data to observe the evolution of employee behavior, and how the antecedents and consequences interact with the level of change. The transformation of the innovative workplace will continue in the post-pandemic era; longitudinal data can offer better insight regarding what drives employees to show proactive behavior and how the mechanism operates in inspiring employees to make a change.

5.4. Conclusion

Combining the employee proactivity perspective and social cognitive theory, this study proposes a moderated-mediation model and examines it using data collected from manufacturing SMEs in Taiwan. The results identify knowledge acquisition as a crucial mediator, through which proactive employees in manufacturing SMEs learn to achieve innovative work. Our work also verifies the positive moderating effect of environmental dynamism. That is, as the level of environmental dynamism increases, employees with creative self-efficacy are more likely to sense the challenging tasks and initiate reactions to acquire essential knowledge, which leads to more innovative behavior at work. In conclusion, the findings reveal a clear picture of employees' proactive innovative behavior in response to environmental changes.

CRediT authorship contribution statement

Yi-Fen Huang: Conceptualization, Methodology, Software, Writing - Original draft, Visualization, Writing - Reviewing and Editing.
Hung-Chun Lin: Data curation, preparation, Investigation.
Hsu-Mei Lee: Writing - Reviewing and Editing.

Data availability

The authors do not have permission to share data.

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