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Technology Analysis & Strategic Management

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ctas20

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To cite this article: Kyoung-Joo, Lee (2022): Adaptive expertise, career adaptability, and career success of R&D personnel, Technology Analysis & Strategic Management, DOI: 10.1080/09537325.2022.2053517

To link to this article: https://doi.org/10.1080/09537325.2022.2053517

Published online: 17 Mar 2022.

TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT
https://doi.org/10.1080/09537325.2022.2053517

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RESEARCH ARTICLE

Adaptive expertise, career adaptability, and career success of R&D personnel

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ABSTRACT

Cognitive rigidities have long been a serious concern in innovation research, such as disruptive innovation studies and not-invented-here syndrome studies. The existing literature, however, lacks a theoretical perspective and empirical evidence regarding why cognitive rigidities develop and how to deal with the problem. To address this paucity, this study investigates the role that research and development (R&D) personnel's adaptive expertise plays in coping with cognitive rigidities by analyzing its direct effect on career success and its path of influence through career adaptability. On the basis of a survey of 262 R&D personnel in South Korea, this study shows the direct effect of adaptive expertise on the career success of R&D personnel and the mediation effect of career adaptability on the relationship between the two variables. This research provides various theoretical and practical implications to cognitive rigidities in innovation studies, career development studies, and human resource management of R&D personnel.

ARTICLE HISTORY
Received 25 September 2021
Revised 29 January 2022
Accepted 3 March 2022

KEYWORDS
Adaptive expertise; routine expertise; R&D personnel; career adaptability; career success

Introduction

The cognitive rigidities of innovators and managers have long been a serious topic of concern among innovation theorists and practitioners. Disruptive innovation studies have investigated how cognitive rigidities prevent managers from identifying disruptive technological changes that can lead incumbent firms to fail (Lettice and Thomond 2008; Vecchiato 2017; Si and Chen 2020). Researchers of not-invented-here syndrome (NIHS) studies have also regarded cognitive rigidity as a significant cause of innovators' stubborn resistance against external ideas and technologies (Antons and Piller 2015; Antons et al. 2017; Hannen et al. 2019). Despite the detrimental impacts of cognitive rigidities on corporate innovation decisions, existing literature lacks a systematic theory to explain why cognitive rigidities develop and how to cope with them. Indeed, researchers have only just begun paying attention to valid cognitive theory and potential countermeasures to cope with cognitive problems (Hannen et al. 2019).

With the goal of deepening our understanding of countermeasures against cognitive rigidities, this study adopts the theory of *adaptive expertise,* which is a contrary conceptualisation of *routine expertise* in education studies (Hatano and Inagaki 1984; Mercier and Higgins 2013; Bohle Carbonell et al. 2014; Bohle Carbonell et al. 2016; Gube and Lajoie 2020; Kua et al. 2021). Although the concept of routine expertise represents the continuous advancement of knowledge and skills of a specific domain to promote greater efficiency only in stable situations, adaptive expertise means flexible, innovative, and creative competences of experts who control decision-making and tasks effectively

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in a dynamically changing environment (Hatano and Inagaki 1984; Mercier and Higgins 2013; Bohle Carbonell et al. 2014; Bohle Carbonell et al. 2016; Gube and Lajoie 2020; Kua et al. 2021).

As an approach to show the counteractive effect of adaptive expertise on cognitive rigidities of innovators, this study examines the influence of adaptive expertise on the career adaptability and career success of R&D personnel. R&D personnel are the core workforce behind organisational creativity and innovation (Amabile and Pratt 2016; Yun and Lee 2017; Lee, Yun, and Kim 2019). To achieve career success, they should overcome cognitive rigidities effectively and generate creative ideas in the corporate innovation process. For high performance, R&D personnel should have high cognitive flexibility in the innovation process by acquiring information, perspectives, and insights from a variety of sources and combining them creatively to develop effective solutions (Yun and Lee 2017; Lee, Yun, and Kim 2019). In addition to the direct effect of adaptive expertise on career success, this study highlights the mediating role of career adaptability in the relationship. As an individual's career-related capability, career adaptability helps employees adjust to tasks, work roles, and careers in unpredictable and dynamic environments (Rottinghaus, Day, and Borgen 2005; Zacher 2014; Hartung and Cadaret 2017). This study proposes that R&D personnel's adaptive expertise enhances career adaptability, which helps employees achieve high career success.

To empirically analyze the role and effect of adaptive expertise, this research conducted a survey of 262 R&D employees in six industries in South Korea and performed hypotheses tests by adopting partial least squares structural equation modelling (PLS-SEM). Addressing numerous gaps in innovation studies, this study first explores the theoretical potential of adaptive expertise to counter the issues of cognitive rigidities. It also advances the literature on R&D personnel's career success by showing the direct effect of adaptive expertise and the mediation effect of career adaptability. Furthermore, it helps R&D human resource management (HRM) develop effective career development programmes to improve adaptive expertise.

Existing literature

Cognitive rigidities in innovation studies

As cognitive rigidities often function as core inhibitors of creativity and innovation in organisations, researchers in innovation studies have long been concerned about critical issues caused by rigidities. On the one hand, *disruptive innovation studies* have investigated the influence of cognitive rigidities in managers' mental models to understand why they resist unknown, novel technological potentials beyond their extant cognitive frameworks (Lettice and Thomond 2008; Vecchiato 2017; Si and Chen 2020). Managers' prior experiences, such as previous risk experience and working experience in a specific industry, play a critical role in developing cognitive rigidities (Lettice and Thomond 2008; Si and Chen 2020). Rejecting incongruent, disruptive ideas, managers' cognitive rigidities generate a false assessment of the actual value of new technology and continue to favour existing customers with extant business models (Lettice and Thomond 2008; Si and Chen 2020).

On the other hand, *NIHS studies* have long investigated the cognitive rigidities of innovators that create negative attitudes toward knowledge, ideas, and technology derived from external sources (Antons and Piller 2015; Antons et al. 2017; Hannen et al. 2019). Cognitive rigidities in NIHS studies focus on the function of existing internal knowledge in constructing a meaningful, systemised, and stable perspective in individuals, which makes innovators strive for cognitive consistency and filter out new information that challenges their attitudes (Antons and Piller 2015). The negative attitude caused by NIHS can cause damage to organisational creativity and innovation as it prevents organisations from absorbing beneficial external ideas and knowledge (Antons and Piller 2015; Antons et al. 2017; Hannen et al. 2019 Although innovation studies have long been concerned about cognitive rigidities, researchers have been slow to investigate effective countermeasures, and there are few in-depth theoretical discussions and evidence (Hannen et al. 2019).

Career adaptability and career success

Although the career success of R&D personnel has strong implications for high innovation performance of both individual employees and organisations, existing literature has long been restricted to explaining how employees achieve successful career outcomes (Igbaria, Kassicieh, and Silver 1999; Kuijpers, Schyns, and Scheerens 2006; Moon and Choi 2017; Lee, Yun, and Kim 2019). Career success refers to a satisfactory perception of one's career in consideration of personal achievement of career goals, wages, and promotion (Heslin 2005; Hofmans, Dries, and Pepermans 2008; Lee, Yun, and Kim 2019). High career satisfaction among R&D employees positively affects organisational commitment as employees who perceive the organisation as meeting their career needs develop a high affective commitment to the organisation (Igbaria, Kassicieh, and Silver 1999; Moon and Choi 2017). Despite the potential influence of career success on innovation performance, existing innovation studies have been limited to investigating predictors of R&D personnel's career success, and only a few researchers have analyzed the influence of career orientation (Igbaria, Kassicieh, and Silver 1999), the impact of personal and organisational career management (Moon and Choi 2017), and the role of political skills and organisational support in explaining critical career outcomes (Lee, Yun, and Kim 2019).

To explain the career success of R&D personnel, this study focuses on the direct effect of adaptive expertise and the mediation effect of career adaptability. Playing a significant role in predicting career satisfaction, career adaptability is a personal capability to deal with unpredictable tasks and work roles effectively and adjust oneself to the uncertainties and changes caused by work environments successfully (Rottinghaus, Day, and Borgen 2005; Zacher 2014; Hartung and Cadaret 2017). Career adaptability, which develops from education, training, and work experiences, enables employees to adopt self-regulation strategies and perform adaptive behaviours to achieve career goals, all of which lead to perceived career success (Zacher 2014). Advancing the literature on R&D personnel's career success, this study focuses on career adaptability as a critical path through which adaptive expertise leads to satisfactory career outcomes for innovators.

Theoretical perspective and hypotheses

Adaptive expertise, routine expertise, and cognitive rigidities

Scholars in both education studies (Hatano and Inagaki 1984; Mercier and Higgins 2013; Bohle Carbonell et al. 2014; Bohle Carbonell et al. 2016; Gube and Lajoie 2020; Kua et al. 2021) and business studies (Dane 2010; Furr, Cavarretta, and Garg 2012; Almandoz and Tilcsik 2016) have attempted to understand the development of *expertise* in certain knowledge domains and identify potential dilemmas of cognitive rigidities caused by domain-specific expertise. Effectively accessing and using highly organised knowledge structures, experts show faster and more accurate decision-making performance in their respective domains (Gube and Lajoie 2020). Although the expertise has numerous benefits in the development of domains, education scholars have identified a variety of restrictions that domain-specific experts, or routine experts, frequently face.

Routine expertise indicates continuous enhancement of skills in the existing domain, which enables employees to make high-speed decisions and perform tasks with greater efficiency and accuracy in stable and normal environments (Gube and Lajoie 2020). A key intellectual property of routine expertise is *automaticity* to learned tasks. Automatic information processing is performed precociously without a conscious direction (Sternberg 1984). Routine expertise can increase decision-making effectiveness and improve problem-solving effectiveness in stable context, and individuals with routine expertise are likely to create biases against ideas incongruent with their existing knowledge, perform the automatic selection of previously proven solutions, and make a false assessment of the value of new or alien technology and methods (Dane 2010; Furr, Cavarretta, and Garg 2012; Almandoz and Tilcsik 2016; Bohle Carbonell et al. 2016; Gube and Lajoie 2020; Kua et al. 2021).

Investigating the cognitive rigidities of routine experts, researchers in education studies have advanced understanding of different qualities of expertise and have identified contrasting properties, abilities, and outcomes of *adaptive expertise* (Hatano and Inagaki 1984; Mercier and Higgins 2013; Bohle Carbonell et al. 2014; Bohle Carbonell et al. 2016; Gube and Lajoie 2020; Kua et al. 2021). Adaptive expertise is characterised by flexible, innovative, and creative competencies within the domain (Hatano and Inagaki 1984; Mercier and Higgins 2013; Bohle Carbonell et al. 2014; Bohle Carbonell et al. 2016; Gube and Lajoie 2020; Kua et al. 2021). The core intellectual function to develop adaptive expertise is *metacognition*, which enables experts to use their domain knowledge flexibly and innovatively to respond to new situations (Gube and Lajoie 2020). As a 'higher-order cognition over cognition,' metacognition enables adaptive experts to monitor, assess, and modify their own learning process and knowledge states to cope with changes and novel situations (Sternberg 1984; Kuhn and Dean 2004; Veenman, Van Hout-Wolters, and Afflerbach 2006; De Arment, Reed, and Wetzel 2013).

Adaptive experts avoid relying on automatic processes and make conscious efforts to build new procedures, methods, and solutions to deal with novel situations effectively (Bohle Carbonell et al. 2016). Adaptive expertise helps experts detect anomalies in their tasks and understand whether the existing skills and rules-based behaviour that guide their decision-making are likely to result in suboptimal outcomes under dynamic environmental change (Bohle Carbonell et al. 2016). As a multidimensional concept, adaptive expertise encompasses three sub-dimensions: domain, metacognitive, and innovative skills (Bohle Carbonell et al. 2016). Domain and metacognitive skills are the basic components of both routine and adaptive expertise (Bohle Carbonell et al. 2016). Domain-specific skills play an essential role in developing two types of expertise, as they require continuous accumulation of job knowledge (Bohle Carbonell et al. 2016). However, researchers have failed to confirm the relevance of cognitive skills firmly through empirical tests (Bohle Carbonell et al. 2016). Therefore, this study focuses on innovative skills as the core dimension of adaptive expertise in the process of empirically operationalising and testing the theoretical construct.

Direct effect of adaptive expertise on career success

R&D personnel with high adaptive expertise are well equipped with self-regulation to carefully detect anomalies in their tasks and environment and effectively monitor the validity of existing skills and decision rules in dynamically changing environments (Hatano and Inagaki 1984; Mercier and Higgins 2013; Bohle Carbonell et al. 2014; Bohle Carbonell et al. 2016; Gube and Lajoie 2020; Kua et al. 2021). They have a strong tolerance against cognitive inconsistency and dissonance caused by different perspectives, while showing willingness to accept new information despite the inconsistency with their current beliefs and attitudes. Higher metacognitive capabilities enable them to perform effective self-regulation to monitor the restrictions of current approaches and help identify more effective processes and methods in the innovation process. Rather than adhering to prior experiences and habitual decision-making, R&D personnel with high adaptive expertise seek to adopt new perspectives and take risks to generate innovative solutions.

The adaptive expertise of R&D personnel can be closely related to achievement of career success, as it helps them achieve flexible, innovative, and creative outcomes within the job domain. Career success is the level of career satisfaction, and it represents the outcome of a person's career process (Heslin 2005; Hofmans, Dries, and Pepermans 2008; Lee, Yun, and Kim 2019). Career success is defined as an individual's internal apprehension and evaluation of their career across important work dimensions, such as income, employment security, status, advancement, access to learning opportunities, and achievement of work–family balance (Heslin 2005). R&D personnel with adaptive expertise can gain greater organisational rewards and promotion chances than others, developing a strong perception of career success. Thus, it is predictable that adaptive expertise is positively related to R&D personnel's career success (Figure 1).

H1: Adaptive expertise has a positive effect on R&D personnel's career success.

Mediation effect of career adaptability

In addition to the direct effect of adaptive expertise on career success, this study presumes the mediation effect of career adaptability on the relationship between adaptive expertise and career success of R&D personnel. The major function of a mediator variable is to elucidate how or why an independent variable affects a dependent variable (Baron and Kenny 1986; Wu and Zumbo 2008). Career adaptability is the readiness to cope with unpredictable tasks of the work role, as well as unpredictable adjustments brought about by changes in work and work environments (Rottinghaus, Day, and Borgen 2005; Zacher 2014; Hartung and Cadaret 2017). As a meta-competency for effective career construction and life design, career adaptability enables individuals to plan and adjust to changing career plans in the face of unpredictable events (Creed, Fallon, and Hood 2009; Hartung and Cadaret 2017).

R&D personnel with strong adaptive expertise successfully achieve career adaptability in managing the relationship between self and situation, given their high level of metacognition to effectively monitor and assess dynamically changing situations (De Arment, Reed, and Wetzel 2013). Adaptive expertise helps them modify their own learning processes and knowledge conditions effectively to cope with novel, non-standard situations, enhancing career adaptability to cope with environmental dynamism effectively. Career adaptability, which ensures high personal competence in self-regulation and environment exploration, is closely associated with the achievement of career success (Zacher 2014). Self-regulation enables employees to identify available career opportunities, plan for the future, and manage necessary intrapersonal, interpersonal, and environmental factors to achieve career goals (Creed, Fallon, and Hood 2009). Leveraged by the competencies of self-regulation and environment exploration, R&D personnel with high career adaptability can cope with both predictable tasks and unpredictable adjustments necessary in a dynamic work environment and achieve successful career outcomes (Rottinghaus, Day, and Borgen 2005; Hartung and Cadaret 2017).

R&D personnel with high adaptive expertise successfully achieve career adaptability, as they have a level of metacognition to manage the relationship between personal competences and environmental changes. Being equipped with the competence to modify the learning process and knowledge base, they can successfully plan and adjust their career progress in the face of unpredictable events. The high level of career adaptability achieved by adaptive expertise enables R&D personnel to achieve crucial work-related outcomes, such as income, promotion, and status, all of which lead to career success. Thus, it is predictable that career adaptability mediates the relationship between R&D personnel's adaptive expertise and career success.

H2: Career adaptability mediates the relationship between R&D personnel's adaptive expertise and career success.

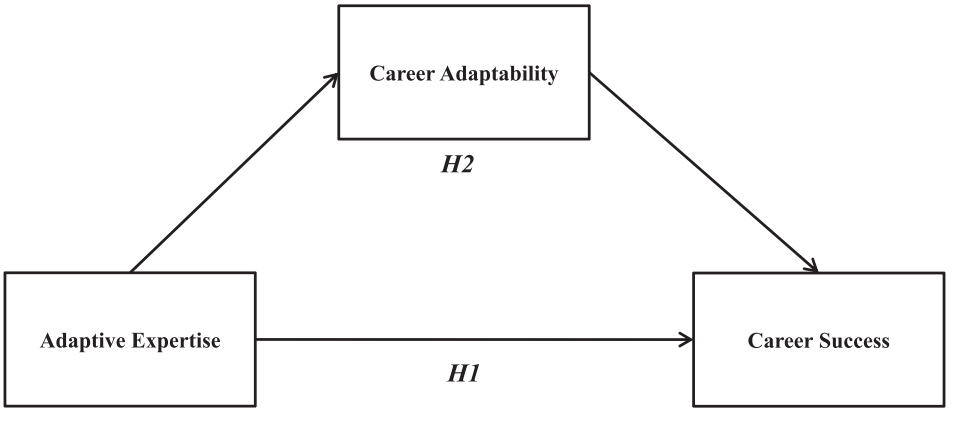

Figure 1. Research model.

Methodology

Data collection

To empirically analyze the relationship between adaptive expertise, career adaptability, and career success, this study conducted a survey of R&D personnel employed in corporate R&D organisations in South Korea. For a survey, this research tapped into a list of R&D organisations published by the Korea Industrial Technology Association, which is a government-recognized trade association that supports and promotes industrial R&D activities. Based on the list, the first e-mail questionnaires were sent to 9,096 R&D personnel in 2,937 organisations in six major South Korean industries, including electronics, electricity, machinery, chemicals, bio-technology, and software. The survey was designed so that respondents could answer through both PCs and smartphones. The first survey request was accompanied with information acknowledging the goal of the survey in brief, assuring the confidentiality of survey data and explaining the eligibility of respondents. As R&D activities require a relatively long-term horizon to obtain valid job and career evaluations, this survey was restricted to respondents with more than three years of experience in R&D. A total of 1,403 respondents initially accessed the e-mail questionnaires, and a total of 300 respondents from 245 organisations completed the first questionnaires from January 15 to January 20 2020.

To ease concerns over common method bias (CMB) (MacKenzie and Podsakoff 2012), this study set a temporal separation and sent the second questionnaire to the 300 respondents to the first survey and finally obtained 262 complete responses from them during the period from February 19 to February 24, 2020. CMB becomes an important issue when variable evaluation relies on self-reported measures (MacKenzie and Podsakoff 2012). As an effective remedial approach, this research conducted two rounds of surveys. The temporal separation can reduce bias, as it can limit the possibility that the answers to the first set of measures affect the respondents' short-term memory when they answer the second set of questionnaire items (MacKenzie and Podsakoff 2012). Furthermore, this study performed Harman's single factor test and obtained a result of 37.24%, which is less than the recommended threshold of 50% (Table 1).

Regarding the demographic characteristics of the sample, the 20–29 age bracket accounted for 6.1%; 30–39 accounted for 38.2%; 40–49 accounted for 40.6%; and 50–59 accounted for 14.1%. Male respondents accounted for 82.4%, and female respondents accounted for 17.6%. Regarding education level, 53.4% of respondents had bachelor's degrees; master's graduates accounted for 35.1%; and 11.5% of respondents had doctoral degrees. Regarding the rank of respondents, rank-and-file employees accounted for 7.6%, assistant managers for 19.1%, and junior managers for 26.3%; senior managers accounted for 28.2%, and executives for 18.7%. Finally, regarding tenure, respondents with less than 10 years of experience accounted for 53.4%; those with 10–19 years accounted for 38.2%; those with 20–29 years accounted for 7.3%; and those with over 30 years of experience accounted for 1.1%.

Measurements

The independent variable in this study is adaptive expertise. The measurement of adaptive expertise is adopted from existing literature (Bohle Carbonell et al. 2016) and focused on assessing R&D employees' development and integration of new knowledge into existing personal knowledge during past projects, continuity of learning new knowledge, success in applying prior knowledge to new situations, focus on new challenges, high performance in unfamiliar situations and tasks, and flexibility in applying personal knowledge (Table 1). For the measurement scale, this study adopted a five-point Likert scale for all variables.

The mediation variable in this study was career adaptability. To measure career adaptability, this study adopted questionnaire items from the existing literature (Rottinghaus, Day, and Borgen 2005) and focused on the evaluation of adaptability in new work settings, changing career plans,

Table 1. Measurement of theoretical constructs.

Measurement	SFL	α/CR/ AVE
Adaptive Expertise		**.88/.91/ .63(.79)**
1. During past projects, I was able to develop and integrate new knowledge with what I learned in the past.	.80	
2. During past projects, I showed that I am willing to keep on learning new aspects related to my discipline.	.78	
3. During past projects, I applied my knowledge in new and unfamiliar situations in areas related to my discipline with a degree of success.	.78	
4. During past projects, I focused on new challenges.	.84	
5. During past projects, I was able to keep on performing at a high level when confronted with unfamiliar situations or tasks.	.81	
6. During past projects, I was able to apply my knowledge flexibly to the different tasks within the project.	.78	
Domain Skills of Adaptive Expertise		**.83/.88/ .66(.81)**
1. During past projects, I concerned myself with the latest development in the domain of my discipline.	.86	
2. During past projects, I gained a better understanding of concepts in my discipline.	.84	
3. During past projects, I realised that the knowledge in my discipline keeps on developing.	.85	
4. During past projects, I realised that I need to learn continuously to become and stay an expert in my field.	.69	
Career Adaptability		**.89/.91/ .64(.80)**
1. I am good at adapting to new work settings.	.82	
2. I can adapt to change in my career plans.	.79	
3. I can overcome potential barriers that may exist in my career.	.81	
4. I can adapt to change in the world of work.	.83	
5. I will adjust easily to shifting demands at work.	.79	
6. I tend to bounce back when my career plans don't work out quite right.	.76	
Career Success		**.88/.91/ .63(.79)**
1. I am satisfied with the success I have achieved in my career.	.82	
2. I am satisfied with the progress I have made toward meeting my overall career goals.	.83	
3. I am satisfied with the progress I have made toward meeting my goals for advancement.	.78	
4. I am satisfied with the progress I have made toward meeting my goals for income.	.75	
5. I think I receive an appropriate level of payment, considering my career to date	.74	
6.When compared with coworkers, my current capability is highly valued by the organisation.	.83	
Harman's Single Factor Test: 37.24%		

Note: SFL (Standardised Factor Loadings), CR (composite reliability), AVE (average variance extracted), Parenthesis denotes squared root of AVE.

overcoming career barriers, adapting to work change, adjusting to shifting work demands, and resilience against difficulties in career plans.

The dependent variable in this study was career success. The measurement of perceived career success was adopted from the existing literature (Heslin 2005; Hofmans, Dries, and Pepermans 2008). Measuring career success evaluates R&D personnel's perceived satisfaction with their career, achievement of career goals, advancement, income and pay levels, and capability recognition from the organisation (Heslin 2005; Hofmans, Dries, and Pepermans 2008).

The control variable in the research model included not only demographic characteristics and status but also respondents' *domain skills* for their work and job (Bohle Carbonell et al. 2016). Although R&D personnel with adaptive expertise acquire more extensive skills and new knowledge beyond the boundaries of domains, prior domain skills and knowledge lay a firm base for their adaptive expertise, affecting the perception of career adaptability and success (Bohle Carbonell et al. 2016). Regarding demographic characteristics, this study considered age as it may affect salaries and status in organisations (Kuijpers, Schyns, and Scheerens 2006). Gender was considered by taking a value of 0 for women and 1 for men, because males and females often show different career choices and orientations (Kuijpers, Schyns, and Scheerens 2006). This study considered educational level by inputting a value of 1 for a bachelor's degree, 2 for a master's degree, and 3 for a doctorate, as it may affect the respondents' career competence (Kuijpers, Schyns, and Scheerens 2006). Finally, job position was classified into five hierarchical levels, as it can positively affect salary and career satisfaction (Kuijpers, Schyns, and Scheerens 2006).

Analysis results

The statistical analysis of the research model in this study comprises two phases. The first phase estimated both the reliability and validity of the construct measurements. The second phase performed the hypothesis tests proposed in the research model using PLS-SEM. PLS-SEM has various benefits for the hypothesis tests of this research as it enables researchers to attain reliable analysis results under the condition of non-normal data, with small sample sizes (even less than 100 samples), and to analyze complex structural models, including mediation and moderation relationships (Hair et al. 2014).

Reliability and validity

To confirm the reliability of the construct measurements, this study calculated a set of statistics (Table 2), such as Cronbach's α, standardised factor loading, and composite reliability. The analysis results confirm the reliability of measurement by showing that Cronbach's α ranged from .83 to .89; the standardised factor loadings ranged from .69 to .86; and the composite reliability of the constructs ranged from .88 to .91, higher than the acceptable level of .70.

To examine the validity of the construct measurements, this study estimated average variance extracted (AVE) and examined both the convergent and discriminant validity of measurements (Hair et al. 2014). On the one hand, the statistical results confirmed the convergent validity of measurements as AVEs ranged from .63 to .66, exceeding the acceptable level of .50 (Table 1). On the other hand, the analysis results confirmed the discriminant validity of measurements by showing that correlations between key constructs ranged from .24 to .77, as shown in Table 2, and none of the squared correlations between constructs was higher for the AVEs. This result confirmed that the construct measurement had an acceptable level of discriminant validity. In summary, the statistical results show that the measurement of the model in this research has a high level of reliability and validity of constructs, suggesting the high suitability of hypothesis tests.

Hypothesis tests

The descriptive statistics in Table 2 present the means of the variables, standard deviations, and correlations between the variables. The statistics show positive and significant correlations between key variables, such as adaptive expertise, career adaptability, career success, and domain skills, all of which ensure the high feasibility of confirming hypotheses. Regarding the direct effect, this study predicted in H1 that adaptive expertise has a positive effect on R&D personnel's career success. The analysis results in Table 3 support H1 by showing that adaptive expertise has a positive impact on career success ($\beta = .471$, $p < .001$, $R^2 = .120$). Regarding goodness of fit, SRMR is .066, showing the acceptable level of less than .08 (Hu and Bentler 1999) (Table 3).

In addition to the direct effect above, this study proposed a mediation model in H2 that career adaptability mediates the relationship between adaptive expertise and career success of R&D

Table 2. Descriptive statistics and correlations.

	Mean	S.D.	1.	2.	3.	4.	5.	6.	7.
Age	40.95	7.54							
Gender	1.18	.38	-.28**						
Education	1.58	.69	.02	.06					
Rank	3.31	1.20	.65**	-.26**	.18**				
Domain Skills	1.88	.67	-.31**	.15*	-.18**	-.3**			
Adaptive Expertise	2.03	.61	-.23**	.09	-.12	-.21**	.77**		
Career Adaptability	2.25	.63	-.15*	.11	.01	-.16*	.48**	.64**	
Career Success	2.69	.75	-.07	.02	.01	-.04	.24**	.34**	.43**

*$p < 0.05$, **$p < 0.01$

personnel, and the statistical analysis in Table 3 supports this hypothesis. Testing the mediation effect in this study follows the three-step process suggested by researchers (Baron and Kenny 1986; Wu and Zumbo 2008). The first step is to confirm the significant direct effect from an independent variable to the dependent variable, because without the direct effect, there is no relation to mediate. The analysis result of H1 confirmed a significant direct effect, meeting the basic condition for testing the mediation effect. The second step is to evaluate whether an independent variable affects the dependent variable via a mediator variable by showing that the independent variable significantly affects the mediation variable, and the mediator also significantly affects the dependent variable. The analysis results in Table 3 show that adaptive expertise has a positive effect on R&D personnel's career adaptability ($\beta = .659$, $p < .001$, $R^2 = .428$) and career adaptability also has a positive effect on career success ($\beta = .349$, $p < .001$, $R^2 = .202$, SRMR = .060), fulfilling the mediatory conditions. The third step of testing a mediation model requires Sobel's z-test or bootstrapping to evaluate not only the statistical significance of the indirect effect but also the relative size of the indirect (mediation) effect. The analysis of the mediation effect showed that the standardised indirect coefficient of career adaptability between adaptive expertise and career success was .230 ($p <$ 0.001), with Sobel's z score of 59.585 ($p < 0.001$). The proportion mediation measure accounted for 84.6% of the relationships, suggesting a full mediation effect. These results strongly suggest that career adaptability is a more significant path than others through which adaptive expertise of R&D personnel leads to achievement of career success.

Discussions and conclusion

Although researchers of innovation studies have identified the detrimental effects of cognitive rigidities on organisational creativity and innovation, few studies have presented a systematic theoretical approach toward effective countermeasures to overcome cognitive inflexibility (Hannen et al. 2019). To fill this gap, this study drew on the theory of adaptive expertise, which has been formulated as an oppositional concept of routine expertise in education studies (Hatano and Inagaki 1984; Mercier and Higgins 2013; Bohle Carbonell et al. 2014; Bohle Carbonell et al. 2016; Gube and Lajoie 2020; Kua et al. 2021). To elaborate the role and personal effect of adaptive expertise in innovation, this study proposes a research model that postulates the direct effect of adaptive expertise on the career success of R&D personnel and career adaptability's mediating effect between two variables.

Table 3. Analysis results of direct and mediation effects.

	Direct Effects		Mediation Effects			
	Career Success		Career Adaptability		Career Success	
	Path Coefficient	T-statistics (*P*-value)	Path Coefficient	T-statistics (*P*-value)	Path Coefficient	T-statistics (*P*-value)
Age	-.003	.333 (.740)	.051	.989 (.323)	-.043	.539 (.590)
Gender	-.012	.098 (.922)	.046	.896 (.371)	-.017	.278 (.781)
Education	.048	.722 (.471)	.095	1.701 (.089)	.014	.226 (.821)
Rank	.022	.440 (.661)	-.065	1.201 (.230)	.059	.774 (.439)
Domain Skills	-.055	.513 (.609)	-.013	.158 (.874)	-.022	.205 (.837)
Adaptive Expertise	.471***	4.192 (.000)	.659***	8.823 (.000)	.156	1.420 (.156)
Career Adaptability					.349***	4.716 (.000)
R^2	**.120**		**.428**		**.202**	
SRMR	**.066**		**.060**			

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Based on a survey of R&D personnel, this study confirmed both the direct impact of adaptive expertise and the mediation effect of career adaptability. This study presents the following theoretical and practical implications.

Theoretical implications

To address the critical questions of why cognitive rigidities develop and how to deal with them, this study focused routine expertise as a cause of cognitive inflexibility while highlighting adaptive expertise as effective countermeasure of the problem. This research suggests that the automaticity of routine expertise causes fixation of mental models, creation of biases against unfamiliar ideas, and resistance against knowledge incongruent with existing knowledge. More importantly, this research emphasises metacognition as the core component of adaptive expertise to cope with the detrimental cognitive fixation and mental biases of domain experts in the innovation process. Innovators with high adaptive expertise will resist automatic and habitual decision-making, perform self-monitoring over the effectiveness of current methods and processes, and generate novel solutions to cope with technological and environmental changes.

For an analysis of adaptive expertise's impact on innovators' resistance against cognitive rigidities, this study investigated its direct effect on R&D personnel's career success and the mediating effect of career adaptability. R&D personnel are the core workforce to promote organisational creativity and innovation and they should overcome cognitive rigidities to develop high career adaptability and achieve career success. This study made the first attempt to show the role of R&D personnel's adaptive expertise in achieving high work performance, personal development, and career achievement. Furthermore, R&D personnel with strong adaptive expertise develop high career adaptability and can successfully adjust their career plans in accordance with changes in the work environment. Elucidating a critical path in which adaptive expertise leads to career success, this research highlights career adaptability, the competences to identify career opportunities and manage environmental factors to achieve career goals.

The analysis of adaptive expertise in this study is applicable to a variety of R&D and innovation contexts. Given the recursive and chaotic nature of new product development (NPD), adaptive expertise will help decision makers at various developmental stages, such as in-stage, review, and strategic decision stages, enhancing NPD adaptability and congruence with dynamic environments (McCarthy et al. 2006). The adoptive expertise of the top management team may significantly affect the corporate search for distal solutions, which could lead to unrelated diversification strategies to enter into new product markets different from existing ones (Sidhu et al. 2020). Furthermore, entrepreneurs with strong adaptive expertise can change their decision rules effectively and appropriately in accordance with the feedback from the environment, achieving high decision performance in dynamic and uncertain environments (Haynie and Shepherd 2009).

Practical implications

This study's research results offer a variety of critical insights for the HRM of R&D organisations as well as individual R&D personnel. This study advises R&D employees and innovators to understand not only how adaptive expertise overcomes cognitive rigidities, but also what career benefits it can bring about. This study advises individual innovators to develop adaptive expertise, which will improve career adaptability and eventually help achieve career success. The HRM of R&D organisations can adopt a policy to select employees with high adaptive expertise. In the process of selection, the questionnaire items in this study will serve as important material for identifying and assessing the adaptive expertise of applicants. Given the significance of effective career management programmes, this study advises HRM to develop programmes designed to educate and promote adaptive expertise (Kua et al. 2021). For the instructional frameworks specialised for adaptive expertise, education researchers have developed training approaches, such as the Star Legacy

Cycle, the Reflective Inquiry, and the Mast Adaptive Learner (Kua et al. 2021, 351–352), which will help the HRM of R&D organisations develop effective training programmes suitable for corporate innovators.

Limitations and future researches

Although this study presents a variety of novel insights, it still has numerous limitations to be complemented by future research. First, this research has cast a new light on the role and effect of adaptive expertise in the innovation process, and future research should advance this theoretical perspective by exploring ways to improve adaptive expertise. Researchers in education studies have identified various predictors of adaptive expertise not only in individual personalities but also in the characteristics of training, tasks, and learning climate in educational contexts (Bohle Carbonell et al. 2014). To identify more directly valid factors for R&D management, a new research direction is necessary to elaborate critical predictors of adaptive expertise in business and innovation contexts. Second, this research investigated the role and effect of adaptive expertise on R&D personnel' personal outcomes, but future research can examine its impact on the organisational level of creativity and innovation performance. Third, and finally, the empirical analysis of this research is restricted to R&D employees in South Korea. Enhancing the external validity of this research requires further empirical analysis in diverse national contexts to understand national cultural influences. Despite the limitations, this study proposes adaptive expertise as a new critical aspect of individual capability that future innovation studies can explore to overcome cognitive rigidities and improve creativity and innovation.

Acknowledgement

I would like to thank the kind research supports from Yang-Joong, Yun and Su-Gyeong, Kim. I also appreciate the kind considerations by Prof. James Fleck and the constructive comments from anonymous reviewers.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by JSPS KAKENHI: [Grant Number 18K01869.].

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