



FACTORS INFLUENCING CREATIVITY DISPOSITIONS OF INNOVATORS WITH PATENTS: A STRUCTURAL RELATIONSHIP MODEL

Weeraphol SAENGPANYA¹, Ratchaneekorn UPASEN²✉

¹*Faculty of Education, Chulalongkorn University, Bangkok, Thailand*

²*Faculty of Nursing, Chulalongkorn University, Bangkok, Thailand*

Article History:

- received 26 July 2023
- accepted 5 November 2023

Abstract. Innovators are considered of very importance person in the field of creativity due to their original products. The creativity disposition (CD) is as crucial an influence on their work, but little is known about factors that influence it. Therefore, this study explored the level of family autonomy support (FS), working autonomy support (WS), and motivation (MO) for innovation development and CD to estimate the impact of factors that influence the CD among innovators with patents. Stratified random sampling was used to obtain 243 samples of innovators who licensed patents with the Department of Intellectual Property, Innovations, Thailand during the 15 years previous to this writing. Measurement instruments consisted of one preliminary (demographic) questionnaire and four scales. Data were examined by Pearson product moment correlation and path analysis. Averages of FS and CD were found to be high, while averages of WS and MO were moderate. Consistency index statistics indicated that the developed model was consistent with the data. Study results indicated MO's important role as both a direct effect and as a mediator variable of FS and WS through CD. Directors of organizations should recognize and apply this finding to discover methods to enhance innovators with patents' CD.

Keywords: innovator, family autonomy support, working autonomy support, motivation, creativity disposition.

✉Corresponding author. E-mail: ratchaneekorn.u@chula.ac.th

1. Introduction

Creativity disposition (CD) plays an important role in innovation development because it is a behavior tendency closely related to a person's creation of innovative products (Berlin et al., 2016; Ochse, 1990). Innovators or innovation developer are considered very important to the field of creativity study because they produce something new in the real-life context. In Thailand, the innovators have classified according to their licensed patents into nine groups based on their products (Department of Intellectual Property Ministry of Commerce, 2020a; 2020b). Therefore, innovators are not only important to the interest in the field of creativity but also the driving development to enhance the nation's potential (Office of the National Economic and Social Development Board Office of the Prime Minister, 2017). The Studies that discover which variables influence innovators' creativity disposition may also able to fill the knowledge gap of creativity in woke places. This investigation focused on what factors shaping professional creativity, especially family autonomy support (FS), working autonomy support (WS), and motivation (MO) for innovation development.

The literature mentions that creativity disposition (CD) can contribute to individuals having both emotional and motivational characteristics to create new products (Lubart &

Mouchiroud, 2003). There are various factors influencing CD, including family autonomy support (FS), working autonomy support (WS) and motivation (MO). However, there is not clear the level of CD and factors influencing the CD in innovators with patents. Additionally, previous studies on the influence of family autonomy support (FS) on the development of various characteristics in individuals during childhood and adolescence have shown that FS affects a person's characteristics in various ways, including happiness (Ryan et al., 1994), initiative (Grolnick et al., 2002), and self-determination (Soenens et al., 2005). Furthermore, studies have also found that working autonomy support (WS) affects the initiative of individuals in organizations as well (Diliello et al., 2011) and recommend encouraging creativity through small groups and supervisors rather than promoting it more broadly. Previous research on individual motivation has found that a person's sense of autonomy is related to various factors, such as cognitive resilience (Grolnick et al., 2002; Deci & Ryan, 1987), the ability to maintain one's goals (Miquelon & Vallerand, 2008), and personal goals (Koestner, 2008).

However, it is still unclear at what levels of family autonomy support (FS), working autonomy support (WS), and motivation (MO) for the development of innovation influence the creativity disposition (CD) of innovators with patents who most of whom are adults and actively working. Furthermore, it remains unclear which types of motivation trigger them to develop their innovations and how this motivation affects their CD.

2. Research questions

2.1. What are the levels of creativity disposition (CD), family autonomy support (FS), working autonomy support (WS) and motivation (MO) for innovation development among innovators with patents?

2.2. What are factors that influence the CD among innovators with patents?

2.3. What is the structural relationship model, and what are the levels of the direct and indirect influence of factors on the CD of innovators with patents?

3. Objective of the research

3.1. To investigate level of family autonomy support (FS), working autonomy support (WS), and motivation (MO) for innovation development and Creativity disposition (CD) among innovators with patents.

3.2. To investigate the factors that influence the CD among innovators with patents.

3.3. To develop a structural relationship model and investigate the level of direct and indirect effect of factors on the CD of the innovators with patents.

4. Literature review and hypotheses

Structural relationship model (SEM) is the relationship model of variables representing how they are thought to causally connect to one another variables. The verification of relationship among set of variables in the developed model must be verified whether it is consistent with the data. Thus, the researchers propose the following hypothesis:

H1: The structural relationship model of creativity disposition (CD) among innovators with patents is consistent with the data.

4.1. Creativity disposition

The creativity disposition (CD) is a tendency and/or pattern of creative behaviors that are significant and relevant to a person's creativity as it relates to innovative behavior or involves creation of an innovative product (Katz, 1993; Berlin et al., 2016). In addition, psychologists believe that the CD enables both emotional and motivational characteristics of individuals who contribute to creation of various products (Lubart & Mouchiroud, 2003). However, this does not mean manifestation of a highly CD signifies the ability to produce creative products in real life (Ochse, 1990). In fact, confirmatory factor analysis of Innovators' CD revealed eight key indicators: (i) openness to new knowledge and experiences; (ii) learning characteristics, curious and knowledgeable; (iii) preferences in thinking and problem solving; (iv) values and beliefs in novelty; (v) characteristics of creativity and work, like a free working atmosphere; (vi) characteristics of self-image, confidences in their abilities and intelligence; (vii) venture characteristic; and (viii) emotional and feeling characteristics, emotional sensitivity (Saengpanya et al., 2020). In addition, the innovation developer has a personal emotional character and a special personality with both common and specific characteristics that contribute to creation of work products in various fields (Saengpanya, 2005). The literature is convincing that the CD has a strong connection to a person's creative abilities, especially to expressions of innovation development, which include common and specific characteristics that contribute to innovation.

4.2. Family autonomy support for innovation development

Family Autonomy Support (FS) can be considered an important starting point for pursuing a range of activities. Besides contributing to people's basic needs, the family is also a source of varied behaviors. FS is a person's level of perception of the supportive environment a family provides, more specifically, the family's support of a member's autonomy. According to self-determination theory (SDT), the family is an important social context that affects a person's motivation (MO) to act in the world; especially for innovation development (ID), the manner or level and style of support affects a person's well-being, development, and goal functioning (Grolnick & Ryan, 1989; Joussemet et al., 2008; Koestner et al., 2006). Besides that, the family is of great importance to a person's adaptive health, including initiating ID work. Much research supports this (Wang & Dong, 2019; Zhao & Yang, 2021; Puente-Díaz & Cavazos-Arroyo, 2022; Shi et al., 2021; Soenens et al., 2005; Niemiec et al., 2006). For example, FS was found to be significantly associated with MO and positively associated with adaptation (Soenens et al., 2005), while the perceived level of parental support could predict happiness (Niemiec et al., 2006). In addition, adolescents who felt they had a close relationship with their parents were found to be automatically self-directed and were happier than adolescents whose relationship needs were not met (Ryan et al., 1994). In contrast, distortion of related needs was found to have a negative effect on automatic self-direction and health (Ryan et al., 1994).

In addition, some research has indicated a relationship between FS and creativity disposition (CD), especially the influence of interaction between mother and son: A child who interacts with a mother with a high control style writes fewer creative poems when working alone (Grolnick et al., 2002). These findings highlight the maternal style, the child's skill level, and the context in which autonomy is supported. From studies of related documents and literature, research hypotheses can be formulated as follows:

H2: FS has a positive relationship with MO.

H3: FS has a positive relationship with CD.

4.3. Working autonomy support for innovation development

Working Autonomy Support (WS) can play importance role for innovation development in the workplace. According to self-determination theory, the level of a person's self-direction is the starting point for motivation (MO) to take appropriate actions at different stages of life (Deci & Ryan, 2000; Grolnick et al., 1997). Here the influence of autonomy support from the head of the organization or from the working climate leads to a person's suitable attributes and, unexceptionally, innovation development.

In workplace autonomy support, three forms of support for creativity are group support, support from the supervisor, and support from the organization. Creative self-efficacy and creative self-awareness act as moderators of support in the group, and the supervisor's support significantly impacts creative perceptions. Previous research has revealed a strong relationship between the level of autonomy support and the person's relative performance in the organization, especially autonomy support from supervisors (Diliello et al., 2011). In Deci and Ryan's (1987) study, people with less stress and pressure showed more creativity and more intellectual flexibility, learned concepts better, and had more positive emotions, higher self-esteem, more trust, and better physical and mental health than a behavior control group.

In addition, study of the relationship between a creativity disposition (CD) and variables of struggle found that people with highly creative, problem-solving personalities struggled in striving for self-directed reasons and higher self-determination. In other words, this highly customized trait might help individuals discover their cognitive abilities and competencies (Sheldon, 1995). In conclusion, a person's WS has been positively correlated with the CD (Deci & Ryan, 1987; Sheldon, 1995; Diliello et al., 2011) and with MO (Joussemet et al., 2008; Grolnick et al., 2002; Deci & Ryan, 1987). Accordingly, we can formulate research hypotheses as follows:

H4: WS has a positive relationship with MO.

H5: WS has a positive relationship with the CD.

4.4. Motivation for innovation development as a mediator

Self-determination theory (SDT) explains that individuals' motives to do something depend on three psychological needs – for competence, relatedness, and autonomy. The need for competence means wanting to be able to do things, to have knowledge and expertise. Second, the need for relatedness means developing satisfying and stable relationships with others in society. Third, the need for autonomy or self-determination means self-initiative and control (Deci & Ryan, 2000). In addition, SDT describes a person's motivation on a self-determination

continuum from external to internal. Amotivation indicates a lack of intention to act or an absence of motivation. Amotivated people do not act or act without intention, just with movement. Amotivation includes lack of appreciation of what one does (Deci & Ryan, 2000) and not feeling the ability to do it or the expectation of obtaining desirable results.

Motivation types range from external to internal, depending on the difference in degree of self-regulation (Gagné et al., 2010). The first type is *external regulation*, which has the least self-regulation and concerns the behavior of satisfaction from an external need or reward. The second type of external motivation is *introjected regulation*, which is behavior that arises from avoidance of guilt or anxiety, for instance, when a person does something just to avoid failure and maintain a sense of worth. Although such actions are internally driven, introjection behavior can still be an external motivation. A third type of external motivation is *identified regulation*, which is the range of behaviors that reflect appreciation of behavioral goals of acceptance or personal importance. The last type of external motivation, the most autonomous form, is *integrated regulation*, which occurs when the identified regulation is fully harmonized with itself. In other words, the person has evaluated the motivation, and it is consistent with the necessary values and needs. Actions of integrated regulation have strong internal motivation. However, integrated regulation is still an external motivation because it aims to obtain results rather than sustain intrinsic interest. Another type of motivation is *internal regulation*, in which the circumstances of any activity, as influenced by existing satisfaction, is highly independent and representative of self-regulation.

Studies have shown positive correlation among motivation for innovation development (MO) and creativity disposition (CD), such as cognitive resilience (Grolnick et al., 2002; Deci & Ryan, 1987) mental capacity to face and overcome obstructions, the ability to maintain one's goals and to work toward them (Miquelon & Vallerand, 2008), and personal goals (Koestner, 2008). Thus, research hypothesis can be formulated as follows:

H6: MO is positively related to the CD.

5. Methodology

5.1. Study design and setting

This study aimed to explore levels of family autonomy support (FS), working autonomy support (WS), and motivation (MO) for the development of innovation and the creativity disposition (CD) of innovators with patents, to develop structural relationship models, and to verify those models' consistency with the data. Descriptive research was conducted in nine groups of licensed patents, classified as (A) human necessity; (B) operation and transportation; (C) Chemistry and Metallurgy; (D) textiles and paper; (E) construction; (F) mechanical, light, heat, weapons, and explosives; (G) physics; (H) electricity; and (I) general patents – as recognized by the Department of Intellectual Property, Innovations, Ministry of Commerce (DIPI-MOC), Thailand.

5.2. Participants

This study's sample consisted of 243 Thai inventors who had registered patents of invention and innovation. The sampling used the suggestions of Hair et al. (1998), that is, this

study's parameters to be analyzed numbered 45, and so the number of participants should range from 5–20 per parameter. Stratified random sampling was used to allocate participants from the nine patent groups. For each group, innovation developers were randomly selected to participate based on the inclusion criteria. The researchers sent an official letter to the DIPI-MOC, Thailand to ask for a list of innovators from each group who had received a registered certificate of patents of invention and innovation. Innovators with patents are a group of individuals who can develop their own creative thinking into tangible products. This study focuses on creativity in real-life contexts and situations, which may be influenced by various factors in work-related settings. Patents serve as legal evidence of originality and protect unique inventions. They grant inventors the privilege of producing and selling their creations for a certain period of time. To qualify for a patent, the products must be new and distinct from existing ones, with a strong emphasis on solving technical problems. The creativity disposition of innovators with patents differs from that of the general group of innovators.

Participant recruitment was begun only after the office of the research ethics review committee for research involving human subjects approved the research proposal (Project number 088/62). Then researchers contacted innovators with patents by sending a letter of invitation to participate in the study. The letter also informed them about the research objectives, inclusion criteria for participation, data collection procedures, risk, and expected benefits. Participants had the right to decline or to participate. If innovators with patents were willing to participate in the study, they could send the letter and questionnaires back to the researchers. The inclusion criteria covered those who (i) had registered as holders of patents of invention and innovation from the DIPI-MOC, Thailand during the past 15 years (2003–2018) and (ii) were willing to participate in this study.

6. Research instruments

Instruments in this study consisted of two parts. The first part, the sample's demographic characteristics, was developed by the researchers and included types of patents, gender, age, income, level of education, and field of work. The second part included the family autonomy support for innovation development (FS) scale, the working autonomy support for innovation development (WS) scale, the motivation for innovation development (MO) scale, and the creativity disposition (CD) scale. All four instruments' items were rated using a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). Five experts examined and approved the instruments; they verified item consistency with content structure (index of item-objective congruence ranged from 0.6–1.00). Cronbach's alpha coefficients and confirmatory factor analysis (CFA) were described for each instrument. The four instruments' details are as follows.

The Autonomy Support Scale: The Family Support Scale

Applied from the Autonomy Support Scale by Powers et al. (2008), the FS scale was used to evaluate the level of autonomy support from the family for innovation development in inventors or innovators. The test was comprised of 12 items in two dimensions (autonomy support and controlling support). In the current study, the Cronbach's alpha coefficient was 0.94, and

CFA showed acceptable fit with the data (χ^2 (1, $N = 162$) = 1.60), $p = .21$, $\chi^2/df = 1.60$, CFI = 1.00 TLI = 1.00, SRMR = .00, RMSEA = .05).

The Work Climate Questionnaire: The Work Support Scale

The WS scale, based on the Work Climate Questionnaire (Baard et al., 2004), was used to evaluate the degree of the innovator's perception of autonomy support for innovation development from the organization, as measured by six items in one dimension (perceived autonomy support from supervisor). The scale's CFA was not analyzed, but the Cronbach's alpha coefficient for the current study was 0.93.

The Revised-Motivation at Work Scale: The Motivation Scale

Adapted from the Revised-Motivation at Work Scale (Gagné et al., 2010), the MO scale was used to study levels at which innovators self-reported their MO to develop innovation or drive to create something. In addition, this scale also looked for how participants were motivated in innovative development. The MO contained 16 items in five dimensions [external regulation (social), external regulation (material), introjected regulation, identified regulation, and intrinsic regulation]. The Cronbach's alpha coefficient was 0.8, and CFA indicated an acceptable fit with the data (χ^2 (3, $N = 162$) = 1.74, $p = .63$, $\chi^2/df = 0.58$, CFI = 1.00 TLI = 1.00, SRMR = .01, RMSEA = .00).

The Creativity Disposition Scale

Developed by Saengpanya et al. (2020), the CD scale was used to explore innovation developers' level and dimension characteristics of creativity tendency behaviors. The scale had 27 items in eight dimensions: (1) new knowledge and experience exposure, (2) learning characteristics, (3) thinking and problem-solving characteristics, (4) values and beliefs, (5) creation and working characteristics, (6) self-image, (7) venture characteristics, and (8) emotional and feeling characteristics. In this study, the Cronbach's alpha coefficient was 0.95, and CFA indicated acceptable fit with the data (χ^2 (17, $N = 162$) = 15.74, $p = .54$, $\chi^2/df = 0.93$, CFI = 1.00 TLI = 1.00, SRMR = .02, RMSEA = .00).

7. Data collection

After the research proposal had been approved by the office of the research ethics review committee for research involving human subjects, the researchers collected data from December to April 2020. From that time until now, the results continue to reflect the creativity disposition of innovators who hold patents. Additionally, they also examine factors influencing their creativity disposition because human behaviour is influenced by both stable traits and environmental and situational variables (Runco, 2023). Creativity disposition refers to a person's behavioural tendencies that are relevant to creativity. It tends to be stable, enduring, and resistant to change once it has developed. Therefore, the data in this study remain relevant. Furthermore, these innovators are adults, and their creativity disposition is relatively mature.

Before that, however, the researchers sent an official request letter for information to the Director of the DIP, which permitted Thai inventors and innovation developers who had

registered invention and innovation patents during the past 15 years to participate in the study. The researchers then prepared innovators with patents' addresses based on the nine patent groups and distributed via post the demographic collection instrument and tests to 900 innovators with patents, of which 243 (27.0%) were returned. The collected and completed tests were then subjected to data analysis.

8. Data analysis

Before analysis, however, the researchers checked all the data to confirm its correctness and completeness. Basic data analysis was then performed using SPSS v. 27, including descriptive statistics for sociodemographic data (mean [M], percentage, and standard deviation [SD]). Coefficients of variation, skewness, and kurtosis were used to verify the data's normality. Verification of the CD's structural relation model among innovators with patents and evidence-based data was ascertained using structural equation analysis in the Mplus Program.

9. Result of the research

9.1. Demographic data

This study's 243 participants came from the nine classified groups of licensed patent holders (Groups A–I, as previously listed). Most participants were innovators with patents from Group A (18.52%), followed by Groups B and C (13.58%) each. Most participants were male (65.84%) and 51–55 years old (18.93%), followed by the group aged 56–60 (15.64%). As their highest level of education, most had a doctoral degree (25.93%), and were government employees (29.22%), followed by government officials (27.16%). Most had 26 years or more work experience and earned 55,001–70,000 Thai baht (16.46%) followed by 40,000–50,000 Thai baht (13.99%) monthly.

9.2. Level of FS, WS, and MO for innovation development and CD of innovators with patents

This study revealed that, overall, the average of FS and WS among innovators with patents was moderate ($M = 3.61$, $SD = 0.79$ and $M = 3.53$, $SD = 0.99$) as was MO ($M = 3.36$, $SD = 0.63$). However, the average CD was high ($M = 4.13$, $SD = 0.52$). Table 1 summarizes these results.

Table 1. Mean, standard deviation, coefficient of distribution, skewness, and kurtosis among the FS, WS, and MO for ID and the CD among Thai innovation developers ($n = 243$)

Variable	M	SD	CV (%)	Sk	Ku
Family autonomy support (FS)	3.61	0.79	21.94	−0.52	−0.04
Autonomy support (FS1)	3.95	0.82	20.62	−0.70	0.12
Controlling support (FS2)	3.28	0.89	27.26	−0.32	−0.17

End of Table 1

Variable	M	SD	CV (%)	Sk	Ku
Working autonomy support (WS)	3.53	0.99	28.06	-0.57	-0.16
Perceived autonomy support from director (WS1)	3.53	0.99	28.06	-0.57	-0.16
Motivation (MO)	3.36	0.63	18.84	-0.19	0.07
External regulation (social) (MO1)	2.73	1.05	38.59	0.08	-0.48
External regulation (material) (MO2)	2.28	0.98	43.06	0.41	-0.54
Introjected regulation (MO3)	3.43	0.98	28.47	-0.03	-0.71
Identified regulation (MO4)	3.96	0.82	20.73	-0.59	-0.09
Intrinsic regulation (MO5)	4.40	0.70	15.96	-1.50	3.55
Creativity disposition	4.13	0.52	12.63	-0.72	1.28
New knowledge and experience exposure (CD1)	4.30	0.66	15.38	-0.90	0.94
Learning characteristics (CD2)	4.38	0.62	14.14	-1.17	2.10
Thinking and solving problem characteristics (CD3)	4.17	0.58	14.01	-0.52	0.24
Values and beliefs (CD4)	4.16	0.66	15.74	-0.87	1.10
Creation and working characteristics (CD5)	4.22	0.53	12.66	-0.68	0.78
Self-image (CD6)	4.23	0.69	16.38	-0.67	0.09
Venture characteristics (CD7)	3.83	0.77	20.05	-0.22	-0.24
Emotional and felling characteristics (CD8)	3.78	0.79	20.95	-0.14	-0.45

Note: M = mean, SD = Standard deviation, CV = Coefficient of distribution, Sk = Skewness, and Ku = kurtosis.

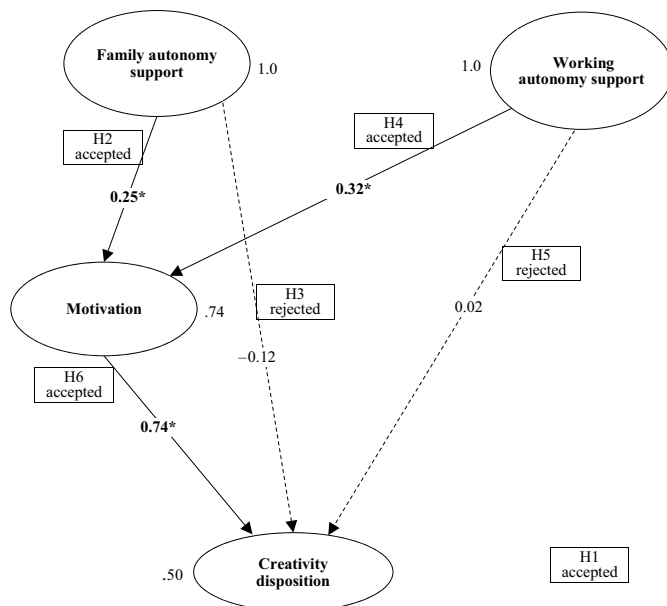
9.3. Developing the CD structural relationship model among innovators with patents

The structural relationship model for innovators with patents revealed two external latent variables (FS and WS) and two intrinsic latent variables (MO and CD), with 16 observed variables in the developed models. Validation of this structural relationship model revealed its consistency with the data, as follows.

The chi-square test ($\chi^2 = 105.76$, degree of freedom = 1.24, and $p = 0.06$) indicated no significant difference from zero, and so the hypothesis that the developed research model was consistent with the data was accepted (H1 accepted). The Comparative Fit Index was 0.988; the Tucker-Lewis Index was 0.983, both approaching one. The root mean square error of approximation was 0.032, and the based standardized root mean square residual was 0.043, both approaching zero.

For the influence level of FS and WS through the two intrinsic latent variables of MO and the CD, the variables in the model with direct effects were FS on the MO ($\beta = 0.25$, $p < 0.001$) (H2 accepted), WS on MO ($\beta = 0.32$, $p < 0.01$) (H4 accepted), and MO on the CD ($\beta = 0.74$, $p < 0.001$) (H6 accepted). Although FS and WS both directly impacted the CD, the effects were not statistically significant ($\beta = -0.12$, $p = 0.20$ and $\beta = 0.02$, $p = 0.86$, respectively) (H3 and H5 rejected).

Finally, FS and WS both significantly and indirectly affected the CD through MO ($\beta = 0.19$, $p < 0.001$ and $\beta = 0.23$, $p = 0.03$, respectively). Figure 1 shows these results.



Note: * $p < .05$; ** All coefficients were standardized. For the sake of clarity, measurement models and covariances among error terms are not shown.

Figure 1. Analysis of the structural relationship model of the CD among Thai innovators

Discussion and interpretation of results obtained

FS, WS, and MO for Innovation Development and CD Among Innovators with Patents

This study shows that the average FS was moderate. This latent variable showed a high level of some observable variables on autonomy support, but for controlled support, the average was moderate. Thus, Innovators with patents had a relatively high average of FS, especially in autonomy support characteristics, such as recognition of their talent, confidence in their jobs in innovation development, and listening to comments about their work. In addition, they were able to share their feelings and talk about their work with family members and others (Saengpanya, 2005).

Moreover, in skewness and kurtosis, distribution of latent and observed variables' scores were slightly skewed or above average, indicating that the majority of Innovators scored above the sample mean for this variable. In kurtosis, scores were flatter than normal curves only in the overall score and controlled support. Thus, this group's autonomy support was highly fragmented. The autonomy support score was slightly higher than normal, indicating that scatter scores were low.

The average WS among innovators with patents was also moderate, so the influence on innovation development of autonomy support from the organization was not as high, for instance, in providing innovation development options; in fact, supervisors' understanding, confidence, encouragement, and listening were minimal. This influenced employees' innovative

behavior, or, as previous studies have stated, supervisor support is related to the CD and innovative behavior (Saengpanya, 2018; Pojsupap, 2020). However, this variable was skewed slightly left, indicating the variable's score was higher than average among most innovative developers, while it was also flatter than the normal curve, indicating that WS was highly fragmented.

Average MO was moderate, and among the observed variables, intrinsic regulation had the highest average, at a high level, followed by identified regulation, introjected regulation, and external regulation (social), while external regulation (object) had the lowest level. Thus, Innovators' MO tends to arise from internal MO types. Reasons for developing innovation included "because it was fun, exciting, and more interesting than 'work,'" due to other forms of external MO, such as needing acceptance or compensation.

An overview of skewness and kurtosis showed that introjected regulation, identified regulation, and, particularly, intrinsic regulation had a somewhat left-skewed distribution. Thus, innovation developers' MO tended toward internal MO (Baard et al., 2004; Saengpanya, 2005). The left skew indicated that Innovators scored higher than the sample's average for these three variables that influence individuals toward innovation development. Meanwhile external regulation (social) and external regulation (object) both had slightly skewed distribution.

The CD average was high overall, and all observable variables of this latent variable also had a high average. Skewness was slightly left, indicating that Thai innovative developers had a high CD, especially in learning characteristics, which were at the highest level. This indicates that innovation developers like to learn or to study their interests and that they spend time studying by themselves because of their curiosity and the desire to be a sage. They search for answers, even when getting a clear answer is difficult. This finding is consistent with previous psychological studies that creators are curious (Rice, 1970; Bernard, 1972; Malakula, 1974; Saengpanya, 2005) and showed that the majority of Innovators scored higher than average for all observable variables of the CD.

Development and Validation of the CD Structural Relationship Model Among Innovators with Patents

The developed model and the data were consistent (H1 accepted). Thus, the model is suitable for explaining the covariance or the influence of variables in the structural relationship model of the CD among innovators with patents. Interesting points are discussed below according to the pertinent hypotheses.

Study results showed H2 and H4 to be acceptable: FS and WS significantly and directly affected Innovators' MO, but these influences' sizes were not high. This confirms previous psychological studies that found positive correlation between MO and the FS and WS variables (Joussemet et al., 2008; Grolnick et al., 2002; Deci & Ryan, 1987), possibly because they form an autonomy-supportive environment (Standage et al., 2003; Pojsupap, 2020) where results can stimulate, promote, or hinder a person's motivation. Autonomy is a fundamental human need that relates to experience in innovation, for example, feelings, choice, willingness, and the desire to decide for oneself (Deci & Ryan, 2000).

However, results found that FS and WS variables did not directly influence the CD; thus, H3 and H5 were rejected. These results were inconsistent with previous studies that reported

positive correlation between these variables and the CD (Deci & Ryan, 1987; Sheldon, 1995; Diliello et al., 2011). Possibly, the subjects in this research were innovators with specific specialties, who differed from more general groups in previous studies. However, consideration of the structural relationship's model found that FS and WS variables significantly but indirectly influenced the CD and MO.

Another interesting result was that only the MO variable significantly and directly affected the CD, with relatively high positive influence on innovators with patents' CD (H6 accepted). This finding might confirm the continual variation: If innovators with patents had increased MO, that might increase the CD as well, especially internal regulation which is innovative development with more curiosity, interest, and fun than external regulation. This finding was consistent with previous studies on the positive relationship between MO and the group of CD variables, such as cognitive resilience, emotion, stress, and pressure/positive emotion (Grolnick et al., 2002; Deci & Ryan, 1987; Brown & Ryan, 2003; Deci & Ryan, 1987; Sheldon, 1995; Joussemet et al., 2008), which found positive correlation of self-determination variables with variables in adversity intelligence, such as attachment to one's goals, tolerance of work toward goals (Miquelon & Vallerand, 2008), and personal goals (Koestner, 2008). In addition, this finding evidences the influence of MO and some psychological traits, such as exposure to new knowledge and experiences (curious personality). That innovators have doubts and thirst for knowledge often makes them enthusiastic knowledge seekers. They are open to various experiences, interested in new and mysterious things, and have a self-directed learning personality.

10. Conclusions

This study's results provide evidence for MO as a critical transmission factor influencing innovators with patents' CD. In other words, if an innovator with patents experiences high levels of FS and WS, it may increase the CD; MO is thus the mediator of these two variables. This finding suggests that persons involved in human resource development promoting the CD, for instance, teachers, professors, educators, managers, and policy makers, should understand the factors of the CD and how they are mutually influential. This research should likely be applied to enhance the level of the CD by promoting FS, WS, and MO because the only directly influential variable is MO, which has a relatively high level of positive influence. Therefore, fostering MO should aim to create internal regulation, leading to innovation by challenging, compelling, and satisfying the person's curiosity: The higher the MO, the higher the CD.

In addition, the research suggested that FS and WS do not directly influence the CD, but indirectly influence MO toward the CD. Therefore, this relationship demonstrates MO's influence as a key mediator variable of FS and WS to the CD. The CD's mechanism of origin is indirectly influenced by FS in development of innovation, that is, by the level of a person's feelings about the family experience, such as acceptance, participation, discussion, inquiry, hearing, emotional support, time-giving, choice, care, and so on. In turn, this is influenced by FS in development of innovation, which is an in-house experience with a supervisor's

support, such as acceptance, understanding, encouragement, assurance participation, discussion, questioning, hearing, emotional support, and giving time, options, and attention to the innovation development of people in the organization. such experiences then mold a person into choosing to participate in the innovation development process, which is further transmitted to the person's MO and ultimately to the CD. MO is the level of awareness about the stimulus to initiate or undertake an activity regarding work in innovation.

On the level of MO variables for innovation, these results have indicated the importance of internal MO and influencing a person's CD toward innovation, eventually leading to a patented invention. Hence, providing individuals with the opportunity to experience FS at home and WS in their organizations is important to the development of the CD.

Limitation of the research

We acknowledge a limitation in this study. This study only investigated some factors influencing creativity disposition. The further research should expand to other factors that may be related to the innovators with patent's creativity disposition.

Suggestions for further research

In the future, this study should be expanded to investigate another mediator influencing the CD. The study tested only MO as a mediator, but more variables might mediate the relationship between support and the CD. The possibility of additional factors influencing the CD should also be studied. Otherwise, the study should be expanded to other groups of innovators with patents, such as MO for developing work in other contexts, in a new generation of innovation developers, or in entrepreneurs. Additionally, researchers may use this model relationship of variables for creating programs to enhance people's CD, especially young innovation developers and entrepreneurs. Further studies might explore other relevant variables in preparing innovations for commercialization, in studying obstacles to the commercialization stage, and in finding methods to promote future innovation.

Acknowledgements

The authors would like to special thanks all participants, The Thailand Science Research and Innovation Fund, and Thinking, Disposition, and Mental Health-Research Unit (TDMH-RU), Faculty of Education, Chulalongkorn University.

Funding

This research has been supported by the Thailand Science Research and Innovation Fund Chulalongkorn University (CU_FRB65_soc (4) _004_27_04); and Thinking, Disposition, and Mental Health-Research Unit (RU68_003_2700_001), The Faculty of Education Research Fund (Fiscal year, 2018), Chulalongkorn University.

References

- Baard, P. P., Deci, E. L., & Ryan, R. M. (2004). Intrinsic need satisfaction: A motivational basis of performance and well-being in two work settings. *Journal of Applied Social Psychology*, 34(10), 2045–2068. <https://doi.org/10.1111/j.1559-1816.2004.tb02690.x>
- Berlin, N., Tavani, J.-L., & Beasancón, M. (2016). An exploratory study of creativity, personality and schooling achievement. *Education Economics*, 24(5), 1–50. <https://doi.org/10.1080/09645292.2015.1117580>
- Bernard, H. W. (1972). *Psychology of learning and teaching*. McGraw-Hill Book Company.
- Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, 84(4), 822–848. <https://doi.org/10.1037/0022-3514.84.4.822>
- Deci, E. L., & Ryan, R. M. (1987). The support of autonomy and the control of behaviour. *Journal of Personality and Social Psychology*, 53(6), 1024–1037. <https://doi.org/10.1037//0022-3514.53.6.1024>
- Deci, E. L., & Ryan, R. M. (2000). *Self-determination theory and character education*. https://selfdeterminationtheory.org/SDT/documents/2000_RyanDeci_SDT.pdf
- Department of Intellectual Property Ministry of Commerce. (2020a). *Patents and petty patents 17 July 2020*. <https://www.ipthailand.go.th/th/patent-005.html>
- Department of Intellectual Property Ministry of Commerce. (2020b). *Knowledge about patents – definitions 17 July 2020*. http://www.ipat.or.th/index.php?option=com_content&view=article&id=270:25-06-53&catid=46:aut2&Itemid=14
- Diliello, T. C., Houghton, J. D., & Dawley, D. (2011). Narrowing the creativity gap: The moderating effects of perceived support for creativity. *Journal of Psychology*, 145(3), 151–172. <https://doi.org/10.1080/00223980.2010.548412>
- Gagné, M., Forest, J., Gilbert, M., Aubé, C., Morin, E., & Malorni, A. (2010). The motivation at work scale: Validation evidence in two languages. *Educational and Psychological Measurement*, 70(4), 628–646. <https://doi.org/10.1177/0013164409355698>
- Grolnick, W. S., & Ryan, R. M. (1989). Parent styles associated with children's self-regulation and competence in school. *Journal of Educational Psychology*, 81(2), 143–154. <https://doi.org/10.1037/0022-0663.81.2.143>
- Grolnick, W. S., Deci, E. L., & Ryan, R. M. (1997). Internalization within the family: The self-determination theory perspective. In J. E. Grusec & L. Kuczynski (Eds.), *Parenting and children's internalization of values: A handbook of contemporary theory* (pp. 78–99). Wiley.
- Grolnick, W. S., Gurland, S. T., DeCoursey, W., & Jacob, K. (2002). Antecedents and consequences of mothers' autonomy support: An experimental investigation. *Developmental Psychology*, 38(1), 143–155. <https://doi.org/10.1037/0012-1649.38.1.143>
- Hair, J. F., Anderson, R. F., Ronald, L. T., & Black, W. C. (1998). *Multivariate data analysis* (5th ed). Prentice Hall International.
- Joussemet, M., Landry, R., & Koestner, R. (2008). A self-determination theory perspective on parenting. *Canadian Psychology/Psychologie Canadienne*, 49(3), 194–200. <https://doi.org/10.1037/a0012754>
- Katz, L. G. (1993). Dispositions as educational goals. *ERIC Digest*. <https://files.eric.ed.gov/fulltext/ED363454.pdf>
- Koestner, R., Horberg, E. J., Gaudreau, P., Powers, T., Di Dio, P., Bryan, C., Jochum, R., & Salter, N. (2006). Bolstering implementation plans for the long haul: The benefits of simultaneously boosting self-concordance or self-efficacy. *Personality and Social Psychology Bulletin*, 32(11), 1547–1558. <https://doi.org/10.1177/0146167206291782>
- Koestner, R. (2008). Reaching one's personal goals: A motivational perspective focused on autonomy. *Canadian Psychology/Psychologie Canadienne*, 49(1), 60–67. <https://doi.org/10.1037/0708-5591.49.1.60>
- Lubart, T., & Mouchiroud, C. (2003). Creativity: A source of difficulty in problem solving. In J. E. Davidson & R. J. Sternberg (Eds.), *The psychology of problem solving* (pp. 127–148). Cambridge University Press. <https://doi.org/10.1017/CBO9780511615771.005>
- Runco, M. (2023). *Creativity, research, development, and practice*. Nikki Levy.
- Malakula, P. (1974). *Personological correlates of creative productivity in Thai students* [Dissertation, University of Wisconsin]. University of Wisconsin.

- Miquelon, P., & Vallerand, R. J. (2008). Goal motives, well-being, and physical health: An integrative model. *Canadian Psychology/Psychologie Canadienne*, 49(3), 241–249. <https://doi.org/10.1037/a0012759>
- Niemiec, C. P., Lynch, M. F., Vansteenkiste, M., Bernstein, J., Deci, E. L., & Ryan, R. M. (2006). The antecedents and consequences of autonomous self-regulation for college: A self-determination theory perspective on socialization. *Journal of Adolescence*, 29(5), 761–775. <https://doi.org/10.1016/j.adolescence.2005.11.009>
- Ochse, R. A. (1990). *Before the gates of excellence: The determinant of creative genius*. Cambridge University Press.
- Office of the National Economic and Social Development Board Office of the Prime Minister. (2017). *Thailand twelfth national economic and social development plan (2017–2021)*. <https://www.nesdc.go.th/download/the-twelfth-national-economic-and-social-development-plan-2017-2021/>
- Pojsupap, T. (2020). Factors influencing innovative work behaviour: A systematic literature review. *MUT Journal of Business Administration*, 17(1), 197–221.
- Powers, T. A., Koestner, R., & Gorin, A. A. (2008). Autonomy support from family and friends and weight loss in college women. *Families, Systems, and Health*, 26(4), 404–416. <https://doi.org/10.1037/1091-7527.26.4.404>
- Puente-Díaz, R., & Cavazos-Arroyo, J. (2022). The influence of parental autonomy support on creativity self-concept in the context of business. *Creativity*, 9(2), 43–54. <https://doi.org/10.2478/ctra-2022-0011>
- Rice, J. P. (1970). *The gifted developing total talent*. Charles C. Thomas.
- Ryan, R. M., Stiller, J. D., & Lynch, J. H. (1994). Representations of relationships to teachers, parents, and friends as predictors of academic motivation and self-esteem. *Journal of Early Adolescence*, 14(2), 226–249. <https://doi.org/10.1177/027243169401400207>
- Saengpanya, W. (2005). The study of personal characteristics, creative process, and creative product: Case study of Thai eminent creators in the fields of science, art, and education. *Journal of Demography*, 21(1), 63–85.
- Saengpanya, W. (2018). *Psychology of learning and instruction*. Chulalongkorn, Thailand.
- Saengpanya, W., Upasen, R., & Keawkhosaba, S. (2020). Confirmatory factors analysis of the scale measuring creativity disposition of Thai innovators. *Journal of Educational Measurement. Mahasarakham University*, 26(1), 225–238.
- Sheldon, K. M. (1995). Creativity and self-determination in personality. *Creativity Research Journal*, 8(1), 25–36. https://doi.org/10.1207/s15326934crj0801_3
- Shi, B., Xing, Z., Yang, M., & Tang, C. (2021). How family's support of perseverance in creative efforts influences the originality of children's drawing during the period of COVID-19 Pandemic? *Frontier in Psychology*, 12, 1–11. <https://doi.org/10.3389/fpsyg.2021.600810>
- Soenens, S. B., Vansteenkiste, M., Luyten, P., Duriez, B., & Goossens, L. (2005). Maladaptive perfectionistic self-representations: The mediational link between psychological control and adjustment. *Personality and Individual Differences*, 38(2), 487–498. <https://doi.org/10.1016/j.paid.2004.05.008>
- Standage, M., Duda, J. L., & Ntoumanis, N. (2003). A model of contextual motivation in physical education: Using constructs from self-determination and achievement goal theories to predict physical activity intentions. *Journal of Educational Psychology*, 95(1), 97–110. <https://doi.org/10.1037/0022-0663.95.1.97>
- Wang, Z., & Dong, S. (2019). Autonomy as core of creativity and compliance: Moderated moderation model of maternal parenting behaviours. *Creativity Research Journal*, 31(1), 74–82. <https://doi.org/10.1080/10400419.2019.1577674>
- Zhao, X., & Yang, J. (2021). Fostering creativity thinking in the family: The importance of parenting styles. *Thinking Skills and Creativity*, 41, Article 100920. <https://doi.org/10.1016/j.tsc.2021.100920>