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Network structure, organizational learning culture, and employee creativity in system integration companies: The mediating effects of exploitation and exploration

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ABSTRACT

To maximize employee performance in today's increasingly competitive environment, companies must enhance individual creativity through the effective management of organizational network structures and learning cultures. This study is an empirical analysis of how firms should design these structures and improve individual creativity according to employees' working styles. We propose a research model that delineates the effect of organizational learning culture on working styles and creativity. For organizational social network structures, we measured degree centrality and structural holes. Employees' working styles were represented as either "exploitation" or "exploration." To validate the model, we collected questionnaires from 137 individual members of 25 recently organized teams in several large system integration companies in South Korea, analyzing the data using a structural equation model. We found that most constructs, with the exception of social network structure, positively influenced individual creativity. With respect to organizational network structure, degree of centrality had a significant effect on both exploitation and exploration.

1. Introduction

With intense competition in today's businesses, employees' individual creativity has become an essential factor in enhancing an organization's competitiveness and performance. Therefore, organizational cultures and creativity-enhancing structures have become paramount. Guilford (1950) stressed the importance of creativity and argued that its study is rooted in psychology. Since then, research on creativity has been conducted in several disciplines. Early studies tended to focus on creativity as an individual trait. However, investigations have now shifted to how contextual factors affect an individual's creativity (Perry-Smith & Shalley, 2003). In this paper, we studied contextual factors of creativity that have not received as much attention: social network structure and organizational learning culture.

Because of the development of digital IT devices (e.g., smart phones), we live in a smaller world in which information spreads rapidly around the globe (Lazer & Friedman, 2007), and people now recognize the inefficiency of working or studying alone. As the value of knowledge exchange through organizational networks has received more attention, researchers have begun to identify social network parameters that shape creativity in the workplace (Burt, 2004). Acknowledging that cognitive limits and biases may constrain creativity, studies have examined employees' social networks as possible sources of knowledge and creativity (Zhou, Shin, Brass, Choi, & Zhang, 2009).

Although the need to enhance creativity through the efficient management of an organization's network structure has increased and study culture has become more common, little research has been conducted in this area. Therefore, our research questions are as follows:

1. Can we maximize individual creativity according to an individual's working style by adjusting the network structure at the organizational level?
2. Does organizational learning culture affect creativity by influencing an individual's working style?

To address these questions, we carried out an integrated research study on individual creativity, including organizational learning culture and network structures. Our first purpose was to empirically analyze how we should design the network structure in an organization to increase individual creativity according to individual working styles. We used the concepts of centrality and structural holes as the knowledge network structure with respect to the social network, and used exploitation and exploration as individuals' working styles. Secondly, we analyzed whether organizational learning culture influenced individual working styles and

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creativity. Finally, we confirmed the multidimensional relationship of centrality and structural holes as the knowledge network structure variables with organizational culture, exploitation and exploration, and individual creativity. We also confirmed the validity of the hypotheses based on structural model verification, which describes how each factor relates to the others.

This study is presented as follows: In Section 2, we discuss the theoretical background and existing literature regarding individual creativity, exploitation, exploration, network structure, and organizational learning culture. In Section 3, we suggest a research model based on the theoretical background and propose a set of hypotheses. Section 4 presents the empirical evaluation of the research model and verifies it through the analysis of the research results. Section 5 addresses the limitations of the research and directions for future research.

2. Previous studies

2.1. Individual creativity

Guilford (1950) argued that the study of creativity is rooted in psychology. Creativity researchers have made an effort to understand why some individuals are more creative than others, and their studies have focused on the cognitive and motivational processes that explain individual differences in creativity (Perry-Smith, 2006), a complex concept that has been defined in several ways (Shalley, Gilson, & Blum, 2000). Typically, it is defined as an idea that is both novel and useful, such as the development of ideas about products, practices, services, or procedures (Zhou & Shalley, 2003). This definition has been incorporated in subsequent conceptual models. There have been many empirical studies on personal and contextual factors that strengthen or weaken employee creativity (e.g., Amabile, Schatzel, Moneta, & Kramer, 2004; Rodan & Galunic, 2004; Zhou, 2003). Our research focuses on personality traits, with a focus on the change in and interactions among factors that individuals face in their surroundings.

Individual creativity can be divided into three categories. The first category is personal characteristics. For instance, Baer, Oldham, Hollingshead, and Jacobsohn (2005) concluded that creativity is enhanced in groups whose members have many siblings, small age gaps between siblings, and a balance between boys and girls. Some researchers have studied the relationship between creativity and motivation (Eisenberger & Aselage, 2009), positive and negative creativity and emotional states (Madjar, Oldham, & Pratt, 2002), and roles and effort (Hirst, van Dick, & van Knippenberg, 2009). The second category includes the contextual characteristics or circumstances that affect individual characteristics. Primarily, these include relationships among interested parties (Shin & Zhou, 2003), reward and appraisal (Eisenberger & Aselage, 2009), and group character (Hirst et al., 2009). The last category contains the interaction factors between situational traits and creative individuals. Some studies have suggested that creative acts occur during interaction processes, and are developed gradually through feedback. For example, Zhou and Oldham (2001) showed that individuals exhibited the highest creative performance when they expected a self-administered assessment. Also, Baer, Oldham, and Cummings (2003) divided workers into two groups—adaptive and innovative—and distinguished jobs as either complex or simple, studying employees' characteristics and the nature of their jobs affected creativity.

The increasing popularity and importance of social networks has attracted the attention of many scholars. For example, Baer (2010) found that individuals were most creative when they maintained idea networks with an optimal size (weak strength or high diversity). Zhou et al. (2009) showed that the optimal number of weak ties was related to elevated levels of creativity only when individuals placed little importance on conformity, a personal trait likely to coincide with reduced levels of openness. However, few studies have focused on the complex interplay between an individual's personality and his or her social network (Baer, 2010). Therefore, we introduced the concepts of degree centrality and structural holes with respect to social network, and examined how they affect creativity through subjects' working styles—either exploitation or exploration.

2.2. Exploitation and exploration

March (1991) defined exploitation and exploration as follows: "Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution. Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation." Thus, he categorized exploitation as "the use of already known" and exploration as "the pursuit of new knowledge."

March (1991) emphasized that business performance may depend upon the use of exploitation and exploration despite the implicit trade-off relationship between the two factors. Similarly, previous studies have found that a strategy that balances exploitation and exploration positively influences organizational performance. For example, Katila and Ahuja (2002) showed that when exploitation and exploration were used simultaneously, the effects on new product development were positive. He and Wong (2004) also found that the same strategy positively influenced sales growth. However, other researchers have produced conflicting results. Bierly and Daly (2007) regarded exploration and exploitation as separate constructs, showing that pursuing both simultaneously negatively affected performance.

Some researchers have used these constructs as independent variables to analyze corporate performance. Rosenkopf and Nerkar (2001) investigated the domain and overall influence of exploration on technological evolution within or across organizational or technological boundaries and distinguished between different exploration types. Nerkar (2003) investigated the effects of temporal exploitation and exploration on later knowledge creation, showing that balancing current knowledge with that acquired over the long term is important in influencing new knowledge. Further, Ahuja and Lampert (2001) examined the effect of exploratory strategies on the number of breakthrough inventions by a firm over time.

Other studies have considered exploitation and exploration as dependent variables. For example, Benner and Tushman (2002) studied the influence of process management on both types of innovation. When firms conduct many process management activities, exploitative innovations outstrip exploratory innovations. Network researchers have investigated the effects of social capital and network structure on exploration and exploitation. "Social capital" indicates the potential benefits that individuals derive from interpersonal relationships (Adler & Kwon, 2002), including the diversity of information and perspectives provided by others. At the heart of the notion of social capital is social network analysis (Brass, Galaskiewicz, Greve, & Tsai, 2004), which assumes that individuals do not exist in isolation but are part of a network of relationships (Zhou et al., 2009).

Vanhaverbeke, Gelsin, and Duysters (2007) researched the influence of direct or indirect ties on exploration and exploitation, and also examined redundant or non-redundant ties between firms regarding technological exploitation and exploration using data from technological alliances. Several other studies have focused on the relationship and processes of exploitation and exploration from the perspective of social network structure (e.g., Lazer & Friedman, 2007).

2.3. Social network structure

In sociology after the 1930s, network theory was an outgrowth of social network theory, and research was conducted to measure the characteristics and patterns of social relationships in individuals' personal lives and social organizations (Burt, 1992). Recently, scholars have also coined the term "social capital" to refer to potential benefits that individuals derive from relationships with others (Adler & Kwon, 2002). One such benefit is the diversity of information and perspectives provided by others. At the heart of the social capital notion is social network analysis (Brass et al., 2004), which begins with the assumption that individuals do not exist in isolation but are the part of a network of social relationships (Zhou et al., 2009).

In this view, a social network as social capital consists of centrality (closure view related to network density) and structural holes (non-duplication and low constraints). The closure view emphasizes the positive effects on a normative environment of dense, cohesive ties. Such ties facilitate trust and cooperation among individuals (Coleman, 1988) and, in turn, afford benefits such as the exchange of information and knowledge. Structural holes theory (Burt, 1992) claims that benefits from social capital result from brokerage opportunities, in that individuals who span structural holes can access diverse information. Recent studies on the "small world network" have shown that these two views are complementary (Schilling & Phelps, 2007), indicating that organizations should include a mixture of closure and bridging ties.

Other researchers have examined the relationship between network structure and organizational performance. Balkundi and Harrison (2006) compared social network structures between leaders and followers, examining their positive or negative effects on task effectiveness. They found that stronger solidarity among members of an organization yielded better task performance. Reagans and Zuckerman (2001) focused on changes in performance according to members' diversity.

Much research has been performed on how network structures such as degree centrality and structural holes—the main focus of this research—affect individual creativity and organizational performance (e.g., Nerkar & Paruchuri, 2005; Soda, Usai, & Zaheer, 2004; Tsai, 2000). A group with high-level centrality can increase its accessibility to high quality information, thereby using the knowledge and behaviors of other organizations more easily (Tsai, 2000). Nerkar and Paruchuri (2005) found that structural holes offer organizations greater access to varied information and knowledge, and organizations that expand these structural holes enhance performance by holding more social capital than organizations without such characteristics. Moreover, structural holes are positively related to current project performance, and the density related to past integration is also closely linked to improving current performance (Soda et al., 2004).

2.4. Organizational learning culture

According to culture theory, the reality of culture is created through social interactions among individuals within society. The application of organization theory to social culture theory has led to the concept of organizational culture, which is important for business success, but is difficult to measure. Organizational culture is composed of widely shared values, symbols, behaviors, and assumptions, and dictates how organizational tasks are performed.

Organizational learning is the driving force that makes a business profitable by leading employees to acquire knowledge and develop innovative ideas. Organizational learning is particularly significant in today's workplace, where employees may change jobs frequently or hoard knowledge because they feel that sharing it could be detrimental to their own success. Therefore, organizational learning culture can be interpreted as the integration of organizational learning and culture.

From previous research on creativity and organizational culture, Andriopoulos (2001) suggested five constructs as factors that affect organizational creativity: organizational climate; leadership style; organizational culture; resources and skills, and the structure and systems of an organization. Open flow of communication, risk-taking, self-initiated activity, participative safety, and trust and respect for the individual are regarded as the subcomponents of organizational culture. From this, we can deduce that a particular aspect of organizational culture, such as trust, must be developed to encourage participants to actively obtain information.

3. Research model and hypotheses

We first developed an individual model comprised of contextual factors (degree centrality, structural holes, and organizational learning culture) and working styles (exploitation and exploration; Fig. 1). This model assumes that degree centrality and structural holes have positive effects on individual creativity through the mediating effects of exploitation and exploration. Moreover, the model presumes that organizational learning culture influences individual creativity, either directly or indirectly through work styles.

Exploitation and exploration have been common themes in recent studies investigating organizational adaptation to environmental changes (Gupta, Smith, & Shalley, 2006). Theories regarding exploitation–exploration are potentially useful for understanding the creative process because they incorporate past success as a factor in the propensity to explore new ideas (Audia & Goncalo, 2007). Lazer and Friedman (2007) argued that exploitation is related to how information diffusion influences performance, whereas exploration is related to information diversity's effects on performance. Further, using social network theory, Perry-Smith and Shalley (2003) studied the association between the context of social relationships and individual creativity. They suggested that members with stronger connections to the external environment are more often exposed to varied viewpoints and thoughts, and therefore, more easily produce creative ideas. Song, Nerur, and Teng (2007) used degree centrality and structural holes in their study of the effect of network structure on a working unit's creativity. Structural holes in particular imply that the benefits of an individual's information depend on how many chances s/he has to make contact with unduplicated connections (Burt, 1992). Thus, to measure structural holes, we measured the range of duplicated information using the network's constraint variables. Based on existing literature, we proposed the following hypotheses:

Hypothesis 1. Degree centrality positively influences exploitation.

Hypothesis 2. Structural holes positively influence exploitation. (Constraints negatively influence exploitation.)

Hypothesis 3. Degree centrality positively influences exploration.

Hypothesis 4. Structural holes positively influence exploration. (Constraints positively influence exploration.)

In research related to organizational learning culture and creativity or performance, Yang and Cheng (2010) studied the effect of structural and positional embeddedness on project team creativity depending on the team's climate of innovation from the viewpoint of network embeddedness. Eisenberg (1999) explored cultural variables related to the creativity of rewards, and analyzed how

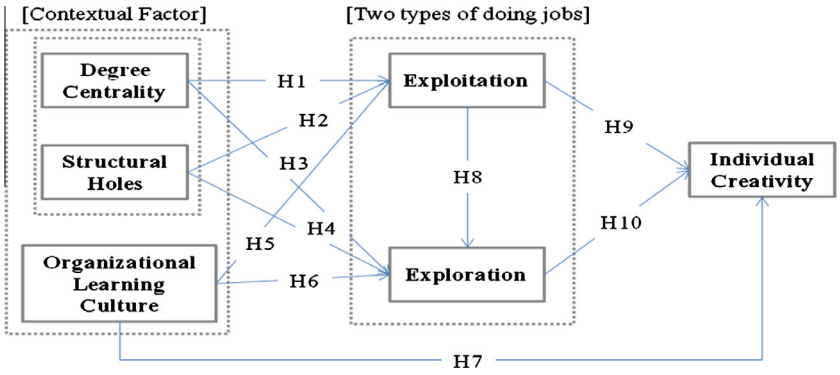

Fig. 1. Research model.

the influence of the incentive was dependent on organizational culture. He found that the organizational culture that members recognized affected the creativity of that organization. We concluded from these studies that organizational learning culture affects individual creativity, or organizational creativity and performance. Therefore, we proposed the following hypotheses:

Hypothesis 5. Organizational learning culture positively influences exploitation.

Hypothesis 6. Organizational learning culture positively influences exploration.

Hypothesis 7. Organizational learning culture positively influences individual creativity.

Audia and Goncalo (2007) divided creativity into two concepts, divergent and incremental, which they explained in relation to exploration and exploitation, respectively. It is natural to assume that exploration and exploitation activities are related to creative activity and, thus, to individual creativity. Therefore, we proposed the hypotheses presented below:

Hypothesis 8. Exploitation positively influences exploration.

Hypothesis 9. Exploitation positively influences individual creativity.

Hypothesis 10. Exploration positively influences individual creativity.

4. Experiment and results

4.1. Data collection

The purpose of this study was to test an individual creativity model. Because creativity is important in all aspects of information technology (IT) development, we surveyed members of proposal project teams in the largest system integration (SI) companies in South Korea. SI companies conduct business by integrating, operating, maintaining, and repairing customers' systems. They submit proposals to clients, who review them before selecting the firm most suitable for their needs. Due to this bidding process, fierce competition exists among companies as they try to win contracts by presenting more creative and differentiated proposals than their competitors. However, proposal project teams in SI companies generally operate for periods of only one week to one month. By selecting participants in this industry, we ensured that we included people who engage regularly in rigorous creative activity.

In order to test our research model, we developed a questionnaire to measure degree centrality, structural holes, organizational learning culture, exploitation, exploration, and individual creativity, combining them into an individual creativity model. Survey questions about each construct were modified and developed to fit the research questions, for which reliability and validity have been demonstrated in the literature (see Table 1).

Because our research employed a questionnaire that was originally written in English, we used a back-translation procedure. Back-translation is the process of translating text that has already been translated into another language back into the original language. It is used and recommended most frequently as a method to assess translated works by comparing and contrasting the back-translation with the original (Brislin, 1980; Harkness, 2003). We created Korean versions of all measures with a commonly used translation–back-translation procedure (Brislin, 1980). After the survey items of each construct were translated from English into Korean, 2 PhDs in business administration with a good command of both English and Korean back-translated into English the items written in Korean. Finally, using a Likert scale that ranged from "1" (strongly inconsistent) to "5" (strongly consistent), 10 employees working in SI companies—the research target—evaluated the consistency of meaning between the text of the original English survey and that of the two bilinguals' back-translation. The translation quality was measured as the average of the raters' marks for each survey item: 4.0–5.0 was considered to be an "exact translation"; 3.5–3.9 was judged a "relatively exact translation"; 3.0–3.4 indicated a "doubtful translation"; and below 3.0 was considered to be an "inexact translation." Finally, the validity and comprehensibility of the survey items derived through those processes were confirmed by 2 professors, 2 PhDs in business administration, and 4 PhD students.

For exploitation and exploration, 6 and 4 measurement items were used, respectively, based on those used by Prieto, Revilla, and Rodriguez-Prado (2009) and Song et al. (2007). For organizational learning culture, a 7-question survey based on the work of Marsick and Watkins (2003) was administered. Finally, for individual creativity, we used 4 measurement items that were similar to those of Zhou and George (2001).

Variables related to the members' network structure were organized to identify the relationships among respondents. We used an egocentric approach to capture an individual's knowledge network by asking participants to write their own name and the names of the people with whom they worked. To understand the network structure of the team, we also asked about their cohesiveness and the frequency of their interactions. Some item definitions were

Table 1
Measures and items.

Construct	Item	Measurement items	Reference
Exploitation	ET1	I combine the existing valuable knowledge elements for carrying out the task	Prieto et al. (2009)
	ET2	I carry out the task by applying the existing competences related to products/services that are currently being offered	
	ET3	I apply the lessons learned in other areas of the organization in the task	
	ET4[a]	Lessons learned in other areas of the organization were put in operation	
	ET5	I carry out the task by using the in-company output (knowledge management system, etc.)	Song et al. (2007)
	ET6	I work by utilizing past experiences (including mine and those of other colleagues)	
Exploration	ER1	I am well-motivated to improve the field with which I was dissatisfied in the past	Prieto et al. (2009)
	ER2	I will create the new solution about the field with which I was dissatisfied in the past	
	ER3	I utilize the new knowledge and method in carrying out the task	
	ER4	From carrying out the task, new and utilizable knowledge and outputs are produced	
Organizational learning culture	LC1	In my organization, people are rewarded for learning	Marsick and Watkins (2003)
	LC2	In my organization, people spend time building trust with each other	
	LC3	In my organization, team/groups revise their thinking as a result of group discussion or information collected	
	LC4	My organization makes its lessons learned available to all employees	
	LC5	My organization recognizes people for taking initiatives	
	LC6[a]	My organization works together with the outside community to meet mutual needs	
	LC7[a]	In my organization, leaders continually look for opportunities	
Individual creativity	IC1	Among my colleagues and co-workers, I will be the first or nearly the first to try out a new idea or method	Zhou and George (2001)
	IC2	I usually find new uses for existing methods or existing equipment	
	IC3	I develop adequate plans and schedules for the implementation of new ideas	
	IC4	I suggest new and better ways to achieve goals or objectives	

[a] These items were eliminated from our study due to not satisfying thresholds of factor analysis.

converted into a questionnaire format because our situation was different from those in previous studies.

A professional research company conducted the survey. Because we were studying creativity in the employee environment of SI companies, the survey subjects were selected with respect to the human resource composition of such companies. Specifically, in 4 major Korean companies that compose 70% of the entire SI market share, the proportion of male to female employees is approximately 4:1 (see Table 2). Therefore, we approximated that proportion in our sample population. After interviewing many project team members, the research company selected participants who corresponded to the purpose of our research. To ensure content validity, they explained our survey's purpose and methods during an orientation session. They next interviewed all team members to explain the content of the questionnaire. In this way, we collected and analyzed completed surveys from 137 people comprising 25 teams. Table 3 describes the characteristics of the survey participants.

4.2. Reliability and construct validity

To verify the theoretical research model and hypotheses, we used UCI-Net 6.1 for the network analysis and SmartPLS 2.0 (Ringle, Wende, & Will, 2005) in the analysis of the structural equation model (SEM), which is part of the Partial Least Square (PLS) software. PLS is an SEM tool that uses a component-based approach for estimation, so it places minimal restrictions on sample size and residual distribution, and is especially useful in areas where there is weak theory and limited understanding of relationships among variables. PLS also allowed us to cope simultaneously with issues of construct measurement and the structural relationships among different constructs.

We used an exploratory viewpoint to examine the effects the two working styles on individual creativity in the SI project teams' network structures and organizational learning cultures. Therefore, PLS analysis, which focuses on "causal-prediction," is more appropriate than other SEMs that focus on model fit. Specifically, PLS is a method of statistical analysis that uses principal component analysis (PCA), path analysis, and regression analysis. The loadings of the measurement items are interpreted through methods such as factor loadings of the PCA. The path of the model is interpreted as standardized regression coefficients of the regression analysis.

PLS is similar to LISREL in that it can simultaneously analyze the measurement and structural models. However, while LISREL uses maximum likelihood estimation of parameters, PLS uses least squares estimation. In the interpretation of results, LISERL uses goodness of fit indices of the structural equation model, such as AGFI, GFI, NFI, and CFI, while PLS uses composite reliability and *R*-squares. Although PLS does not provide a goodness-of-fit index, it demonstrates strong loadings, significant weights, high *R*-squares, and significant structural paths. A further difference between existing SEMs and PLS is that the latter aims to minimize the error of endogenous constructs, while LISREL uses parameter evaluation to determine the parameter in the covariance matrix that is correlated most closely with the observed matrix (Chin, 1998).

We analyzed reliability and validity to determine whether the questionnaire items matched our intent. Reliability measures internal consistency, while validity measures how accurately the target concepts are measured. In this study, we selected several items to measure each construct. We tested reliability with Cronbach's α to verify if multiple items within constructs violated the internal consistency of each item. As the reliability coefficients of

Table 2
The composition of male/female in main SI companies. *Source:* Financial report, the end of December, 2012.

Gender/No. of employees		Total	Company			
			S	L	C	P
Male	No.	20,135	9390	5188	3275	2282
	%	79%	78%	75%	82%	90%
Female	No.	5333	2613	1723	738	259
	%	21%	22%	25%	18%	10%
Total		25,468	12,003	6911	4013	2541

Table 3
Characteristics of respondents and teams.

Category		Number	Proportion (%)
Gender	Male	112	81.8
	Female	25	18.2
Age	19–29	19	13.9
	30–39	75	54.7
	40–49	35	25.5
	50+	8	5.8
Work experience	<5 yrs	33	24.1
	5–10 yrs	35	25.5
	10–15 yrs	38	27.7
	>15 yrs	31	22.6
Job level	Junior	45	32.8
	Advisory	72	52.6
	Senior	20	14.6
Total		137	100.0
Team ($N = 25$)		No. of members	Proposal period (days)
Average		5.5	52.2
Max		8	180.0
Min		4	6.0

Table 5
Discriminant validity.

	DC	SH	LC	ET	ER	IC
DC	NA					
SH	−0.337	NA				
LC	0.143	−0.016	0.817			
ET	0.135	0.008	0.302	0.785		
ER	0.240	−0.070	0.433	0.546	0.809	
IC	0.200	−0.187	0.467	0.568	0.599	0.819

Note1: NA: Not applicable.
Note2: DC (Degree Centrality), SH (Structural Holes), LC (Organizational Learning Culture), ET (Exploitation), ER (Exploration), IC (Individual Creativity).

all factors were greater than the generally accepted 0.7, we concluded that each measurement item had internal consistency (Hair, Anderson, Tatham, & Black, 1998).

We ensured the validity of our survey questions by using those verified in the existing literature. We also verified construct validity with an exploratory factor analysis of the surveyed data to test the uni-dimensionality of the multi-variables—which were constructed from variables extracted from the existing literature—and the variables' operational definitions. For the extraction of factors, we used PCA and varimax rotation. The extracted factors exceeded the general level of factor loading of 0.4 and eigenvalue of 1.0.

Conversely, measurement models can be evaluated by convergent and discriminant validity (Hair et al., 1998). Convergent validity can be evaluated by a construct's measurement item reliability, composite reliability, and average variance extracted (AVE; Fornell & Larcker, 1981). As the factor loadings in Table 4 show, all coefficients were greater than 0.6. Composite reliability and Cronbach's α were greater than 0.7, and AVE was greater than the standard 0.5 (Fornell & Larcker, 1981); thus, convergent validity was verified. Fornell and Larcker (1981) demonstrated that discriminant validity can be verified, when the square root of AVE about the particular concepts is greater than the correlation coefficient between those and other concepts. As shown in Table 5, our results confirmed that the square root of AVE was greater than the corresponding correlation coefficient (Gefen, Straub, & Boudreau, 2000).

4.3. Hypothesis testing and interpretation

The results of the PLS were measured in R^2 values as well as the path coefficient's size, sign, and statistical significance (Hair et al., 1998). R^2 values represent the amount of variance explained by the independent variables, while path coefficients indicate the strength of the relationships between dependent and independent variables. To verify the significance of all paths, we carried out bootstrap resampling with 1000 iterations, the number recommended by Hair et al. (1998). Fig. 2 shows the results.

In our model, the R^2 values of all constructs were above the recommended value of 10% (Falk & Miller, 1992), providing strong support for the posited relationships among the constructs. The value of R^2 for individual creativity, the last dependant variable explained by all independent variables, was 48.4%, that of exploration was 39.7%, and that of exploitation was 10.2%. Table 6 summarizes the results of our hypothesis tests.

Table 4
Reliability and convergent validity.

Construct	Item	Factor loading	Initial eigenvalues	% Variance	Cronbach's α	Composite reliability	AVE
Degree centrality	DC**	1	1	1	1	1	1
Structural holes	SH**	1	1	1	1	1	1
Organizational learning culture	LC1	0.824	7.099	39.437	0.874	0.909	0.667
	LC2	0.736					
	LC3	0.773					
	LC4	0.798					
	LC5	0.790					
Exploitation	ET1	0.700	2.469	13.719	0.844	0.889	0.617
	ET2	0.738					
	ET3	0.713					
	ET5	0.756					
	ET6	0.705					
Exploration	ER1	0.631	1.153	6.406	0.823	0.883	0.655
	ER2	0.659					
	ER3	0.801					
	ER4	0.776					
Individual creativity	IC1	0.708	1.394	7.743	0.835	0.890	0.670
	IC2	0.706					
	IC3	0.723					
	IC4	0.776					

Note: Degree centrality and structural holes is a single item, respectively. Degree centrality was measured by in-degree centrality, and structural holes were by constraint.

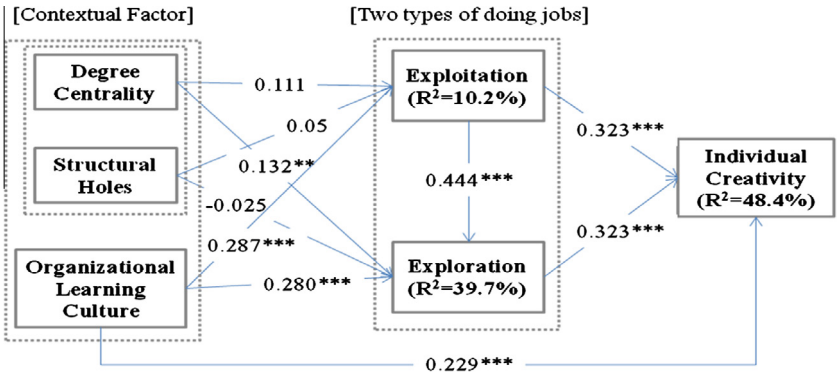

Fig. 2. Research model results: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Table 6
Results of hypotheses testing.

H-No.	Path name	Path coefficient	*t*-Value	Result
H1	DC → ET	0.111	1.386	Reject
H2	SH → ET	0.050	0.593	Reject
H3	DC → ER	0.132	2.108**	Accept
H4	SH → ER	−0.025	0.337	Reject
H5	LC → ET	0.287	2.763***	Accept
H6	LC → ER	0.280	3.990***	Accept
H7	LC → IC	0.229	2.711***	Accept
H8	ET → ER	0.444	6.549***	Accept
H9	ET → IC	0.323	3.332***	Accept
H10	ER → IC	0.323	3.643***	Accept

** $p < 0.01$.
*** $p < 0.001$.

We interpreted our results as follows. Hypothesis 1, which states that degree centrality positively affects exploitation, and Hypothesis 2, which states that structural holes positively affect exploitation (and that network constraint negatively affects exploitation) were rejected. Although team members had a high degree of centrality (number of close links) or high structural holes (controlling the flow of information and knowledge, or having the advantage of accessing information in multiple areas), the constructs did not have a significant influence on exploitation. This could be due to the characteristics of the survey. It may be that project members each have their own professional expertise and work on the projects is of a relatively short duration, so the network variables made through their relationships with other people did not significantly affect the use of existing knowledge.

Hypothesis 3, which states that degree centrality positively affects exploration, was accepted at the 99% confidence level, with a path coefficient of 0.13. However, Hypothesis 4, stating that structural holes would positively affect exploration (and network constraints would negatively affect exploration), was rejected. This shows that degree centrality had a more significant effect on exploration than did structural holes. Thus, to explore new knowledge actively, individuals did not control the flow of information in the middle (structural holes), but had many more connections among members (degree centrality).

Hypotheses 5, 6, and 7, which stated that organizational learning culture positively affects exploitation, exploration, and individual creativity, respectively, were accepted at the 99.9% confidence level, with path coefficients of 0.30, 0.28, and 0.23, respectively. Thus, the formation of an organizational learning culture positively affected exploitation and exploration, suggesting that this is an important factor in improving individual creativity.

Hypothesis 8, which proposed that exploitation positively affects exploration, was accepted at the 99.9% confidence level, with a path coefficient of 0.44. Therefore, we concluded that, in an environment that requires creativity, exploitation has a positive effect on exploration; team members first engaged in exploitation, and then implemented exploration based on exploitation.

Finally, Hypotheses 9 and 10, which stated that exploitation and exploration would positively affect individual creativity, were both accepted at the 99.9% confidence level, with path coefficients of 0.32 and 0.32, respectively. These results are similar to those of Audia and Goncalo (2007), who also found that both exploitation and exploration had significant effects on individual creativity.

5. Concluding remarks

This study investigated the: (1) effect of network structure and organizational learning culture on the work styles of exploitation and exploration; (2) direct influence of each on individual creativity, and (3) mediating effect of work styles on individual creativity. We found that most variables included in the model positively affected individual creativity. However, neither degree centrality nor structural holes had significant effects on exploitation. Degree centrality did significantly influence exploration, but structural holes did not. Thus, an organization's network structure apparently does not affect an individual's working style significantly.

First, the present research is valuable because existing studies have focused on self-reported constructs at the individual level (such as creativity-related characteristics, environment, and the rewards of interactions, personal characteristics, motivation, leadership, and creative atmosphere). Instead, our research introduced individual social networks at the group level into an individual creativity model, analyzing the effects of organizational learning culture and network structures on exploitation, exploration, and creativity; second, our results allow us to suggest strategies to help managers increase employee creativity by designing organizational learning cultures and network structures according to an individual's working style; finally, our findings suggest that the manager of the organizational culture should implement specific programs when developing techniques to increase employee creativity.

Our results offer the following implications for improving individual creativity. First, because the member with the highest degree of centrality in the network structure affects how employees conduct effective exploration, managers should establish network structures that delineate the rights and responsibilities of members who occupy the central position of knowledge creation and sharing. Moreover, managers should implement job training to provide more useful information for team members with high degrees of centrality. We also found significant effects of organizational learning culture on exploitation and exploration, as well as on the demonstration of individual creativity. Considering the fact

that we studied proposal project teams that worked together for relatively short periods of time, managers may increase creativity if they form an organizational learning culture equally quickly. Therefore, managers must demonstrate proper leadership in establishing the learning environment so that members can develop trust in each other and gain necessary knowledge and information rapidly. Third, exploitation positively influences exploration and individual creativity, and subsequently, exploration also affects individual creativity positively. Therefore, the knowledge circulation process, which consists of acquisition, creation, accumulation, and sharing of knowledge, must be combined with the cycle of exploitation and exploration, so that its synergistic effects can increase individual creativity.

In this study, we tested the effects of organizational learning culture, network structure, and individual working style on individual creativity. Our study is important in that we obtained and analyzed data from real businesses that emphasize creativity. However, our study has limitations that should be addressed in future research. First, due to the difficulty of collecting and measuring network structures, we used a small sample of 25 teams (137 people). In future research, the sample size should be increased and other creative surroundings should also be explored. Second, although various organizations have diverse types of network structures, we did not implement rigorous studies on the relationship between network structures and creativity in different organizations. The processes by which creativity emerges in different network types should be investigated as well.

Based on our results, we intend next to conduct a longitudinal study that will investigate organizational creativity and performance over time, taking into consideration creativity-related precedent variables, such as network structure and organizational environment; second, in subsequent research, in order to compare survey and other significant methods of data collection, we will use a more sophisticated simulation method that allows for analyzing more variables and organizational formats.

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