The Roles of Enjoyment and Shared Goals as an Integration Mechanism between Transactive Memory System and Ambidextrous Innovation in Open Innovation Teams: An Exploratory Study on Cross-Field Student Team Contests

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***Abstract*–The development of an effective and efficient mechanism to approach ambidextrous innovation plays an important role in interdisciplinary learning. The mechanism under consideration is comprised of enjoyment and shared goals. Enjoyment makes teammates feel comfortable with regard to learning, and shared goals help them focus in the same direction. With the support of a transactive memory system, we attempted to verify relationships involving whether or not these two powerful roles of integration mechanisms enhance learning attitudes and lead teammates to both improve existing knowledge and acquire new knowledge and in turn, lead to the development of ambidexterity. Therefore, we adopted purposive sampling and received 36 responses from questionnaire surveys in the Promotional Program for Cross-Field Creative Scenario Value–Adding of the National Science Council in Taiwan. The results verified only that the role of enjoyment serves a function as a significant mediator between transactive memory systems and ambidextrous innovation.**

Key words: cross-field teams, transactive memory system, integration mechanism, ambidexterity

I. NTRODUCTION

Knowledge has been considered to be play a powerful role leading to firm ability to take control of the business world in the modern marketplace. Transactive memory systems gather together people with interdisciplinary backgrounds who have a shared understanding of "who knows what" by encoding, storage, and retrieval of new knowledge, such as knowledge creation and knowledge integration, in order to provide an effective and efficient method for developing new products, processes and services for the purpose of surviving in the current competitive business world. As we know, individual learning is no longer suitable for the present society. Determining a method by which to gather together people with experience with transactive memory systems in an environment that will help them enjoy sharing their specialties on the basis of shared goals in order to develop ambidextrous innovation has become an increasingly important issue. However, the completion of projects involving experts from different fields may require substantial time, and developing shared goals and helping teammates enjoy these projects play important roles that fortify the relationship between a transactive memory system and ambidextrous innovation. Therefore, interdisciplinary teams can develop new knowledge by exploring their own experiences with TMSs. The exploration processes may generate knowledge integration and creation. In addition, integration mechanisms deliver and shorten the processes of encoding, storage and retrieval of new products, processes and services. According to the discussion above, we discuss the relationship among transactive memory systems, enjoyment, shared goals and ambidextrous innovation.

II. LITERATURE REVIEW

A. Ambidexterity innovation

Cross-field teams provide an effective and efficient way to acquire ambidexterity [1]. An interdisciplinary team is equipped with abilities that lead to the discovery of exploratory and exploitative knowledge [2]. Therefore, cross-field team members with knowledge integration and creative abilities continuously improve technologies, applications and the market as a whole.

B. Exploratory Innovation

Radical innovation has been called "exploratory innovation", and includes searching for new knowledge, technologies, and products for existing markets. Interdisciplinary capabilities help members in regard to knowledge creation as a form of exploratory innovation [3]. Thus, the extent of exploration has been defined as knowledge creation. Danneels depicted exploratory innovation as being embedded with new knowledge and competences in order to develop new products, processes and services to satisfy the needs of emerging consumers [4]. We can therefore reason that developing new products, processes, and services for emerging markets can be defined as exploratory innovation.

C. Exploitative Innovation

Incremental innovation is another word for exploitative innovation, which is constructed on the basis of identifying and establishing existing knowledge, technologies, and processes [4]. Li and Chu defined the development of existing customers, markets, knowledge and skills for continuing improvement as incremental innovation [5]. We can thus reason that incremental innovation means to develop new products, processes, and service in existing market and technologies.

Owing to the literature mentioned above, we gain a further understanding that the abilities related to ambidextrous innovation rely on transactive memory system approaches that drive team members to participate in the processes of encoding, storage and retrieval in order to acquire both knowledge creation and knowledge integration.

D. Transactive memory system

Lewis and Herndon defined a TMS as shared knowledge of "who knows what", and they separated the function of a TMS into three parts: differentiated knowledge, transactive processes, and dynamic environment [5]. Wegner defined TMS as an environment in which a group of members share the same cognitions in order to encode, store, and retrieve information, and he also addressed two components of TMS, which included TMS structure and transactive processes. He also suggested that TMS processes not only generate knowledge creation but also include knowledge integration [6]. Lewis at el. suggested that prior experiences help cross-field teams both transfer and acquire new knowledge [7]. However, integration mechanisms provide an effective and efficient method by which to join transactive memory systems and ambidextrous innovation. Owing to the literature mentioned above, we realized that TMS processes bring knowledge creation and knowledge integration to team members. Therefore, we proposed the first hypothesis as follows:

E. Integration Mechanism

There are numerous learning approaches available; however, we closely observed the cross-field teams utilized in this project and found that team members adopted enjoyment and shared goals in order to develop ambidextrous innovation. We discuss them as follows:

F. Enjoyment

Recently a large number of scholars have adopted motivation theory embedded with the Technology Acceptance Model (TAM). Davis explored user motivation and defined both intrinsic and extrinsic motivation [8]. Intrinsic motivation referred to behaviors related to voluntariness, and extrinsic motivation was regarded as behavior for the pursuit of rewards. Fun, play and enjoyment have been depicted as forms of intrinsic motivation in TAM research. Venkatesh defined intrinsic motivation as intrinsic pleasure and inner satisfaction [9]; therefore, Heijden added perceived enjoyment to his model and discovered that perceived enjoyment had an influence on internet user acceptance [10]. Brunner and Kumar described enjoyment as influencing attitude [11]. According to these reviews, in the processes of a transactive memory system, including decoding, storage, and retrieval, learning enjoyment and a pleasant environment drives the willingness of team members to learn new abilities. Therefore, the second and third hypotheses are as follows:

H2: Transactive memory systems have a positive influence on enjoyment.

H3: Enjoyment has a positive influence on ambidextrous innovation.

G. Shared goals

Holladay and Coombs defined a shared goal as a clear idea that makes team members want to work together [12]. House referred to team members from design, engineering, and management fields with shared goals to complete projects by the processes of decoding, storage, and retrieval of a transactive memory system [13]. Tsai and Ghoshal depicted shared goals as not only helping in regard to knowledge transferal and productive negotiations, but also as leading to shared opinions and a reduction in conflicts [14]. Richards suggested that sharing the same purpose can excite team members and lead to sustained improvements [15]. Quigley suggested that high-level goals lead to high levels of achievement. People with shared goals can construct effective and efficient methods by which to develop new products, processes or services [16]. Based on these previous studies, in this study, it is assumed that shared goals provide a shared purpose and plan of action that can lead team members to accomplish their goals. This leads to the following hypothesis:

H4: Transactive memory systems have a positive influence on shared goals.

H5: Shared goals have a positive influence on ambidextrous innovation.

III. METHODOLOGY

This section first briefly introduces the case and second, presents the research model and operational definition. A number of concepts are adopted from previous studies, and data is collected from cross-field student teams for the purpose of developing the questionnaire. We also discuss the sampling method used and give details regarding how the questionnaire was distributed and returned.

A. Case Introduction

The Promotional Program for Cross-field Innovation Value-added in Green Technologies is held by the National Science Council of Taiwan. This cross-field student team contest is intended to integrate the power of knowledge found in academic fields in order to develop new green or orange products and then to transfer the developed component, processes, and product knowledge to domestic firms in order to increase their competitive advantages. In the end, we developed seven prototypes this year, and we truly hope to transfer the acquired system knowledge, technologies, specifications, and business plans to local companies in order to help them to develop new products, processes or applications successfully.

B. Research Model

This study adopted the concept presented by Jansen [24] to generate a model with four major constructs (see Figure 1). The major independent variables are team communication, peer learning and transactive memory system, while the dependent variable is ambidexterity.

C. Research Model

This study adopts the concept presented in Jansen [17] to generate a model with four major constructs. The major independent variables are transactive memory system, enjoyment, and shared goals, while the dependent variable is ambidexterity. See figure 1.

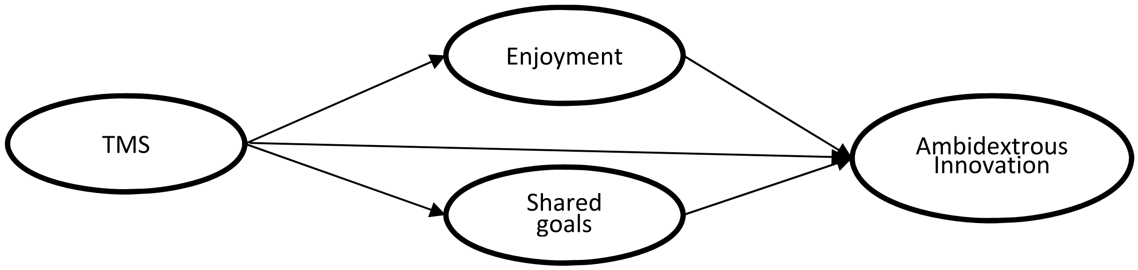

Figure 1.

D. Definition and Measurement of Constructs

We modified all of the measurements of transactive memory systems, enjoyment, shared goals, and ambidextrous innovation and abbreviated enjoyment as EJY, Shared goal as SG, transactive memory system as TMS, exploitative innovation as EI, and finally exploratory innovation as ER. First, we start with the transactive memory system from Wegner [6], while exploratory and exploitative innovation were derived from Jansen [17]; enjoyment came from Davis et al. [8], and the concept of shared goal came from Quigley et al. [16]. Five items were used to measure enjoyment; six items were used to measure shared goals, three items were used to measure the transactive memory system, and finally four items were used to measure exploitation innovation, and ten items were used to measure exploratory innovation in the ambidexterity construct. See Table 1.

TABLE 1. OPERATIONAL DEFINITIONS OF CONSTRUCTS

Operational Definitions
Enjoyment: Sources: Davis, (1989)seven-point Likert scale, seven-point Likert scale
EJY1. Participating in a cross-field team contest makes me feel happy. EJY 2. The processes of cross-field team learning are enjoyable. EJY 3. The orientation toward commercialization makes me feel hopeful. EJY 4. The integrated of interdisciplinary experiences makes me feel excited. EJY 5. The processes for interdisciplinary knowledge sharing make me feel accomplished.
Shared goal: Sources: Quigley et al. (2007), seven-point Likert scale
SG1. Members have the same vision to be the champion in the competition. SG 2. Members have the same vision to complete the assignments before the competition deadline. SG 3. Members have the same cooperative goal to acquire the commercializing team's ideas. SG 4. Members have the same vision to gain the opportunity to start a business. SG 5. Members have the shared vision to acquaint interdisciplinary partners with innovation. SG 6. Members share a consensus regarding the accumulation of interdisciplinary experiences related to innovation.
Transactive memory system: Sources: Wegner (1987), seven-point Likert scale
TMS1. I know my teammates' domain knowledge. TMS2. My teammates' domain knowledge is important to me. TMS3. I have the ability to learn other types of expertise.
Ambidexterity: Sources: Jansen (2006), seven-point Likert scale
EI1. Improve the functions of products. EI2. Make product processes more efficient. EI3. Improve existing business models. EI4. Improve existing technical solutions. ER1. The cross-field project is a brand new competition. ER2. Propose scenarios. ER3. Provide technical solutions. ER4. Develop a new business model. ER5. Make prototypes. ER6. Combine several technologies to develop new products. ER7. Adapt old technologies to new markets. ER8. Provide new service models for consumers. ER9. Develop new technologies.

E. Sample and procedure

More than one hundred teams participated in the scenarios; however, only less than twenty four teams survived to the feasibility stage, and in the end, we only selected seven prototypes this year. Therefore, we attempted to determine if the seven surviving teams in the prototype stage acquired ambidextrous innovation abilities. We first interviewed the team leaders who joined the Promotional Program for Cross-Field Creative Scenario Value–Adding in order to generate the framework. Second, the data were collected from the 36 students in the cross-field student teams that survived to the prototype stage. There were only 18 experienced students in the pilot study to ensure consistency and to eliminate semantic and syntax biases. The survey took place from September 1st to 30th in 2013, with a total of 63 questionnaires mailed and receipt of 36 valid responses, with a 57% response rate. The majority of the respondents were as follows: 31 people were from engineering departments; 1 person was from a management department, and 4 people were from design departments.

IV. ANALYSIS AND RESULTS

A. Exploratory Factor Analysis

The criteria for proving validity and reliability were as follows: factor loading >0.5, eigenvalue >1, KMO >0.5, communality >0.5, Cronbach's alpha >0.6, and item-total correlation >0.6. Ambidexterity was used as a dependent variable and was composed of both exploitative and exploratory innovation, which were modified by Jansen [20]. We preserved ER7 and ER9 (α=0.83) from exploration and EI1, EI2, and EI3 (α=0.71) from exploitative innovation because these items fit the requirements mentioned above. Independent and mediating variables: based on the literature review, we modified and developed three items to measure the transactive memory system. We kept all three items (α=0.72) because they fit the requirements mentioned above. We used five items to measure enjoyment. We eliminated EJY1 and EJY2 because the factor loadings for these items were less than 0.6 (α=0.86). We used three items to measure shared goals (α=0.87). We also assessed the inter-correlation among the items, the results for which are shown in Table 2.

TABLE 2. EFA RESULTS

Construct	Items	Factor Loading	KMO	commonality	accumulation	Alfa	C.R. (>0.6)	AVE (>0.5)
Transactive Memory System	TMS1	0.77	0.56	0.59	65.96%	0.72	0.84	0.65
	TMS2	0.90		0.82				
	TMS3	0.74		0.55				
Enjoyment	EJY3	0.91	0.69	0.83	78.55%	0.86	0.94	0.84
	EJY4	0.92		0.84				
	EJY5	0.82		0.67				
Shared goal	SG1	0.88	0.71	0.78	80.08%	0.87	0.92	0.79
	SG4	0.92		0.86				
	SG5	0.87		0.75				
Exploitative Innovation	EI1	0.71	0.57	0.50	64.42%	0.71	0.84	0.64
	EI2	0.89		0.80				
	EI3	0.79		0.62				
Exploratory Innovation	ER7	0.92	0.5	0.86	86.05%	0.83	0.91	0.84
	ER9	0.92		0.86				

TABLE 3. INTER-CORRELATIONS AMONG THE ITEMS (N=159)

	Mean	S.D.	TMS	Enjoyment	Shared goal	EI	ER
1. TMS	5.90	0.58	1				
2. Enjoyment	5.94	0.77	0.52*	1			
3. shared goal	5.45	0.94	0.07	0.13	1		
5. Exploitation	5.64	0.79	026	0.37	0.61**	1	
6. Exploration	5.47	1.29	0.32	0.66**	0.45	0.31	1

Note: * P<0.05, **P<0.01, *** P<0.001; S.E: Standard error

The results show the items' factor loading values to be between 0.77 and 0.92, with all items higher than 0.5; KMO values ranged from 0.5 and 0.71, and alfa values were higher than 0.7. The CR values ranged from 0.84 to 0.94, and the AVE values ranged from 0.64 to 0.84.The results are shown in Table 2.

The convergent validity of a construct can be assessed based on the requirement that the composite reliability should be higher than 0.6, and the average variance extracted should be higher than 0.5 [18].

According to the results listed in Table 2, the values of convergent validity for each construct are higher than 0.6, while those for the AVE are higher than 0.5. Hair indicated that the square root of the AVE either should be higher than that of the constructs of all co-variances or correlation coefficients [19]. The constructs show good discriminant validity because the diagonal values shown in Table 3 are all higher than the co-variance coefficients. See Table 4.

B. Results of the Research Model

The model was examined for multicollinearity, and the VIF value were found to be far less than 10. The results of the hierarchical regression are as follows: There were four steps used to examine the relationship between the transactive memory system and ambidextrous innovation in the integration mechanism. Step 1: Examine the relationship between transactive memory system and ambidextrous innovation. The results indicate that the transactive memory system had no influence on ambidexterity (β=0.36, p>0.05), as can be seen in Table 4. Therefore H1 is not supported.

Step 2: Examine the relationship between the integration mechanism and ambidexterity. This study individually examines enjoyment and shared goals with regard to ambidexterity. The results show that enjoyment (β=0.61, p＜0.01) and shared goals (β=0.63, p＜0.05) also positively influence ambidexterity. The details are given in Table 4.

Step 3: Examine the relationship between the transactive memory system and ambidexterity in the integration mechanism. After adding enjoyment and shared goals with the transactive memory system, only enjoyment exhibited a significant influence on ambidexterity (β=0.02, p>0.05 β=0.32, p＜0.01), as shown in Table 5.

Step 4: Examine the relationship between the transactive memory system and the integration mechanism, with separate regressions carried out among the transactive memory system, enjoyment, and shared goals to examine the mediating effects. The results show that the transactive memory system positively and significantly influenced enjoyment (β=0.52 ， p＜0.05); however, it exhibited no significant influence on shared goals (β=0.07, p>0.05), as shown in Table 6.

TABLE 4. TEST FOR DISCRIMINANT VALIDITY

	CD	TV	COM3	EI5	ER
1. Enjoyment	(0.91)				
2. TMS	0.52*	(0.80)			
3. Shared goals	0.13	0.07	(0.89)		
4. Exploitative Innovation	0.37	0.26	0.61**	(0.80)	
5. Exploration Innovation	0.66**	0.32	0.06	0.22	(0.92)

TABLE 5. RESULTS OF HIERARCHICAL REGRESSION

	(Ambidexterity) Model 1	Model 2	Model 3
Intercept	***	***	***
TMS	0.36	0.32**	0.02
Mediator			
Enjoyment		0.61**	
Shared goals			0.63*
Adjust R^2	0.07	0.41	0.34
R^2change	0.13	0.45**	0.38**

Note: *p＜0.05，**p＜0.01，***p＜0.001

TABLE 6. REGRESSIONS OF COMPETENCE DIVERSITY WITH REGARD TO THE INTEGRATION MECHANISM

	Enjoyment	**Shared goals**
intercept	***	***
TMS	0.52*	0.07
Adjust R^2	0.22*	-0.06*

Note: *p＜0.05，**p＜0.01，***p＜0.001

TABLE 7. THE RESULTS FOR THE HYPOTHESES

	Hypothesis	Results
H1	Transactive memory systems have a positive influence on ambidextrous innovation.	Not supported
H2	Transactive memory systems have a positive influence on enjoyment.	Supported
H3	Enjoyment has a positive influence on ambidextrous innovation.	Supported
H4	Transactive memory systems have a positive influence on shared goals.	Not supported
H5	Shared goals have a positive influence on ambidextrous innovation.	Supported

The results of these four steps show enjoyment to have partial mediating effects. The results show that H2, H3 and H5 are supported; however, H1 and H4 are not supported. We thus conclude that a transactive memory system has no influence on ambidexterity, while the hypothesis suggesting that enjoyment mediates the relationship between a transactive memory system and ambidexterity in cross-field student teams is partially supported. The hypothesis suggesting that shared goals have no influence with regard to mediating the relationship between the transactive memory system and ambidexterity in cross-field student teams. The results for the five hypotheses are listed in Table 7.

V. DISCUSSION AND CONCLUSIONS

A. Transactive memory system and Ambidexterity

Interdisciplinary team leaders bring together people from fields related to design, engineering, and management to provide their expertise, technical solutions and business plans in order to complete projects for the Promotional Program for Cross-field Innovation Value-added in Green Technologies. We used the case involving Sprinkle to explain. The first designer came out with an idea for a desalination shower system as a scenario, which represented years of experience with transactive memory systems. Then, discussing sub-systems including a solar system, a desalination system, and a pump system, the desalination shower system was constructed and represented cross-field team work in the form of exploitative innovation. The original design required two solar panels, but the engineers suggested that there might be serious problems with regard to electric shortage, so another two panels were added to generate sufficient power for the pump and desalination system. In order to develop clean water, we used a trial and error process to evaluate different desalination systems. In the end, we chose CDI as the equipment used to desalinate sea water. In order to develop the business plan, we browsed tourist bureaus to find the top ten beaches in the world and the correct number of tourists in order to predict the potential market. The business plan also included market segment, target, positioning, strength, weakness, opportunity, threats, price, product, promotion, place and five forces to develop short term and long term strategies; therefore, we viewed the prototype as a product of ambidextrous innovation. In order to provide more details, we offer the following examples: From our perspective as system engineers, first, the interaction with cross-field team members allowed us to acquire new knowledge from different domains, such as design concepts and methods for writing business plans. Second, we were able to entrench existing knowledge into the team domain, such as the knowledge related to changing the requirement for two solar panels into four solar panels relative to the issue of voltage and the provision of specifications. It was mentioned earlier that individuals having experience with transactive memory systems and the related abilities may develop abilities related to exploratory innovation and knowledge of exploitative innovation, or they can also be viewed as knowledge related to ambidextrous innovation

B. Integration mechanism of enjoyment, shared goals between TMS and ambidexterity

Individuals teammates in cross-field teams possess different levels of experience related to transactive memory systems. This results on their relying on teammates from other domains to gain the knowledge related to such experience, and it was proven that TMSs have a significant influence on enjoyment but not on shared goals. However, determining a method by which to reduce the time required for new product development is a critical issue. Enjoyment resulting from TAMs was verified to be an important construct to change attitudes, and shared goals were also proven to serve a mediating role by Jansen [17]. According to our observations, enjoyment makes teammates more willing to share their domain knowledge in order to complete prototypes. During the processes of knowledge sharing, teammates also learn other skills or acquire domain knowledge, such as abilities related to design, the logic and system thinking from the field of engineering or the capability to analyze business plans, and we defined this as ambidextrous innovation as proven in this study. In addition, shared goals can also lead teams to work in the same direction and lead them to devote their unique abilities toward the completion of prototypes in a short time, as was also verified in this study.

Integration mechanisms may shorten the time necessary for the development of new products, processes, and services. Enjoyment, one of the integration mechanisms discussed herein, exhibited a significant partially mediating role between the TMS and ambidextrous innovation. First, we reason that teammates regard making prototypes and commercialization as their final goals. As we know, the project for making prototypes is a yearlong program. The time required to go through the difficult development processes leading from scenarios, assessing technical feasibility, writing business plans to the building of prototypes is substantial, so teammates may feel exhausted after dealing with the difficulties they have encountered in the feasibility stage, or they may suffer from frustration related to the trial and error process. Such challenges may cause them to give up on this program. Therefore, arousing and maintaining their interest and contributing to their enjoyment in regard to problem solving in order for them to last to the prototype stage becomes an important issue to consider. Second, asking different major experts to work together for a year may seem like an impossible mission. However, it is necessary to design an interesting learning program that leads to a highly heterogeneous team enjoying participation in this project. For example, a lecturer feeling a sense of achievement with regard to knowledge sharing because of helping teammates acquire domain knowledge or aiding them with having positive experiences related to interdisciplinary integration can provide opportunities to develop cross-domain friendships. Finally, the happiness and sense of achievement related to the completion of prototypes is owed to the cooperation and collaboration of cross-field teams. These are the driving forces that make team members eager to learn from TMSs in order to integrate and create knowledge leading to both exploitative and exploratory innovation. However, shared goals were not found to have a mediating effect between transactive memory system and ambidextrous innovation.

C. Research Limitations and Future Research

The number of respondents was a limitation in this research. If we had more respondents, the model might have performed better. Moreover, constructs such as peer learning, coaching, and heuristic learning toward ambidextrous innovation could be added to compare with TMS in future studies. Finally, integration mechanisms such as communication and coordination could be considered in future studies as well.

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