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INFLUENCE OF LEADER ON ORGANIZATIONAL LEARNING IN CONSTRUCTION TEAMS

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ABSTRACT: Organizational learning of construction team has been long addressed in the literatures, but the mechanism of learning and the influence of leader in the team still remain vague. This paper presents a computational model (OLT) depicting the mechanism and the influence of leader in a systemic way. The OLT model is a multi-agent system based on some eloquent propositions proposed in previous researches. The proposed model is preliminarily validated by some toy-problem simulations. In the OLT model, the leader is assigned as a project manager. The results show that a proper leader can effectively improve the learning process and the result-in performance, in which the team learning is mainly affected by both the leader and the majority in a team. Based on our findings, two propositions are concluded accordingly: (1) Learning of a team would be enhanced if a proper leader is assigned; (2) The effectiveness of learning would increase in a team, in which the members retain explorative attitudes.

Keywords: leader, followers, organizational learning in teams (OLT)

1. INTRODUCTION

In order to maintain competitive advantages and quality of products in the fast-paced construction industry today, construction teams need to adopt innovations, i.e. new methods, new procedure, new materials, new equipments and new team members…etc., and learn how to well utilize them as soon as possible. For example, an exterior-wall restoration project for a hotel was undertaken in Taipei of Taiwan at early 2003. In order to operate continually without disruption of operations for the hotel, this project was designed with high standards and a tight schedule. Due to specific requirement (work faster, but execute safer), the project manager decided introducing a new system, called *mast-climbing platform*, to replace the old one, *scaffold system*. However, the project manager did not sure how fast the team will perform accurately with the new system and hoped the team members can eventually catch-up by themselves. And it is too risky to leave this question on hopes.

Obviously, team can generate higher productivities if team members can learn the more know-how of technologies. But, learning takes time. Even though some researches provide insights for leaning time, i.e. learning curve [1], team managers still cannot estimate that exactly due to contingency differences [2]. Especially, time is crucial for current construction teams. Team managers have to systematically (not merely rely on hopes) consider how to speed-up team learning and carry out the new staffs smoothly if they decide to adopt ones. In this manner, the factors, which can improve and speed-up team learning, need be sorted out for practical using.

Many field-investigated researches in the construction industry have been focused on determining those factors within team-organization already. Tatum [3] and Nam and Tatum [4, 5] pinpoint organizational structure, culture and key individuals are three key factors that affect innovation launch and implementation for construction team. Barlow [6] investigates a complex offshore construction project in UK and concludes that time performance of the project was good while the management team considered how to improve team's learning ability before execution. Bossink [7] also distinguishes drivers which active on innovation diffusion at the trans-firm, intra-firm, and inter-firm level in the network of organizations in the construction industry. Interestingly, most of them highlight the importance of leader (or named key individual) effect during learning process. Notwithstanding the popularity of these researches, the mechanism of leader influence in team does not be examined analytically. How and how much does the leader influence team-learning process? The descriptive findings should be further examined with an accurate and analytical way.

Computer simulation is widely applied as a research method for organizational researchers in recent [8, 9]. Carley [10] proposes computational model can be a proper methodology to answer what-if questions in probing organization issues. Moreover, computational approach not only can access organization behavior and performance collectively (whole organization) but, more

important, can be a bridge to link organization members individually [11]. According to these advantages, the proposed model in this research, *organizational learning in teams (OLT)*, could be a suitable tool to answer the given research questions.

In this research, we take following steps to analyze the leader influence on organizational learning in teams. First, we recall some elegant propositions from researches of organizational learning and leader's characters. Second, we develop a computational model, OLT, based on selected propositions. Some validations are performed by a series of intellective simulations for what-if questions [12, 13]. Finally, the mechanism of learning is discussed according to simulation results.

2. RELATED WORKS

2.1 Organizational Learning

All organizations learn whether they consciously choose to do so or not [14]. Organizational learning is stemmed from individuals within organization [15, 16, 17] and can be observed in whole organizational performance, i.e. time, cost, productivity, quality, and so on. Learning curve is one of common formats to represent overall learning effect [1, 2]. In the construction industry, learning curves have been investigated by various case studies [18, 19, 20, 21]. In spite of the efforts worked on macro-performance, some micro-mechanisms of organizational learning behavior have also been examined for better understandings [2]. The conventional concept of organizational learning is viewed as routine-based, history-depended and target-oriented process [2]. Members receive some stimuli from mismatch between real outcomes and their expectations on works. They will seek ways to breakthrough and encode the inference from history into routines that adjust behaviors as time pass by in response to the changes. Based on this viewpoint, some micro-variables in organization, such as members' learning rates [22], turnover rate [23], influence of internal and external stress [24] and heuristic of single member [25], are well discussed.

2.2 Leader Influence

The leader influence in organization has been addressed for a long time. For example, Greene and Schriesheim [26] conclude the leadership can benefit group arousal and cohesiveness via a longitudinal investigation. Levine and Moreland [27] conclude that the role of leader in an organization can facilitate critical activities carried out successfully. Whereupon the concept is developed, we interpret a *leader* is a role who is officially or unofficially empowered by team members and responsible to guide other's behavior.

Recently, many researches have started to identify leader influence on learning in the construction industry since the population of construction innovations is increased dramatically [28]. Except for owner's demand, technological ability and effective implementation, Nam and Tatum [4, 5] also address proactive leadership as an additional factor besides the above mentioned three key factors for successful innovation. Barlow [6] proposes that presence of a champion is crucial in promoting and distributing organizational learning from an empirical study of partnering construction project. Mitropoulos and Tatum [29] conclude that the technical champions are critical individuals who can absorb the risks and drive the changes. Bossink [7] also pinpoint the leadership is positive for participating in innovative projects in the construction industry. Moreover, Blayse and Manley [30] in their reviewing paper also indicate the leadership from given position is important for organizational learning in the construction teams.

Thus, summing up these descriptive evidences gives a good point of departure for us to explore the mechanism of leader influence on organizational learning in teams.

3. RESEARCH METHODOLOGY

This paper is to present a computational model for analyzing and predicting leader influence on organizational learning in teams. In this model, we define *a team as a set of members (agents) in a specific structure executes a sequence of tasks via technologies in order to achieve the goals.* For example, a construction team may be composed of many members, i.e. cement subcontractor, to complete tasks, i.e. floor and wall, via different technologies, i.e. high strength cement, to build a new building. This concept is similar to what has been adopted by many previous researches, e.g. Carley's turnover model [23], Carley and Lin's model [24], Jin and Levitt's VDT model [31].

The OLT model is developed employing MASON, an environment of multi-agent system [32]. The settings of the model, such as interactions of agents, learning mechanisms, are modeled based on eloquent propositions of previous researches. All the simulations are made up covering some key variables, including agents, tasks and structure. Team is operated via them in order to achieve its goal. And agents will learn to improve their skill competences during team operation. The relationship between basic variables of OLT model is presented in Figure 1. The details of variables are explained below.

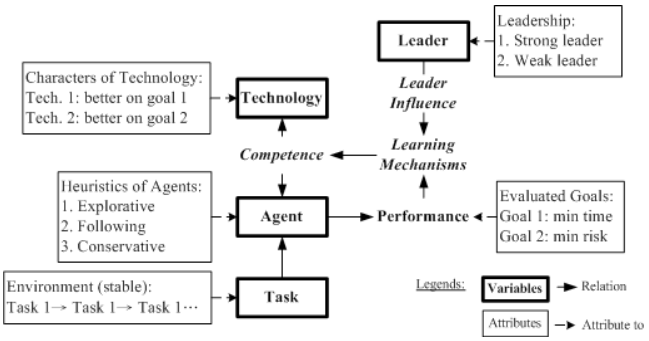

Figure1. Basic concept between variables in OLT model

In OLT, the agents are assumed boundary rational and have bounded memory [33]. They cumulate experience with limited abilities (depicted using a learning rate) and lost them as well (depicted using a forgetting rate). Due to the diversity of team composition, different agents have

different working heuristics [25, 27], which guide the agents' behaviors. To simplify our illustration in the OLT model, we choose three types of agents: explorer (new-staff driven and aggressive), follower and conservative. *Explorers* (also called *Inventors* or *Entrepreneurs*) prefer adopting novel things and act aggressively (the α in Figure2) [4, 34]. On the contrary, *Conservative*s behave in an opposite way preferring to stick on what is existing or familiar with [2]. *Followers* have no specific preferences but follow the majority.

In this study, agents choose in between two kinds of *skills*, new and old ones, to complete *tasks*. Either skill is relatively better in certain perspectives of performance regarding quality, time or/and budget. Agents show their preferences according to their heuristics. Once the result-in performance and their heuristics are matched, they feel rewarding and enhance the according competence (see the relation between agents and performance in Figure1).

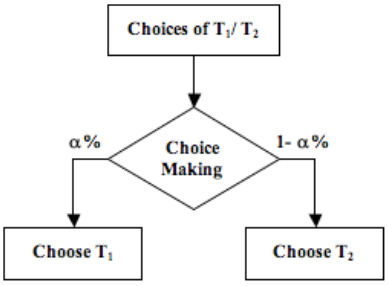

Figure2. Probability inset of choices on technologies

In OLT, agents learn skills and enhance their competences via two designated mechanisms, (1) learn skills by repetitions due to historical learning [1, 2] and (2) enhance their competence because of rewarding by heuristics matching, while agents' skills and competences would decreasingly lose (forgetting or unlearn) if these mechanisms are interrupted somehow.

In presented OLT model, a formal or informal leading position in a team is shown using two *team structures*, flat and wheel [35, 36]. As shown in Figure3, in a flat structure, agents always make their own choices, on the other hand agents' choices are mostly affected by the *key agent* in a wheel structure. The key agent here is interpreted as a leader, a senior member or a technological champion who will officially or unofficial affect others, just like the project manager of a team. In OLT, agent's choices upon skills are described in probabilities, and that is influenced by the present of key leader as:

$$\text{Probability}_{\text{with leader}} = \text{Probability}_{\text{origin}} \pm \Delta \qquad (1)$$

in which, Δ show the influence of the leader. If the type of leader coincides with his/her team members, such as a explorative leader works with members of explorers, the influence is enhanced by adding, otherwise subtracting a Δ is for those unmatched cases. And the influence of the leader Δ is calculated as:

$$\Delta\,(\%) = \sigma.\ \ \Omega\,(\%) \qquad (2)$$

where σ is a weight number that can reflect different contingencies and/or "cultures" [37, 9]. Ω is a number showing an extreme case predetermined in OLT.

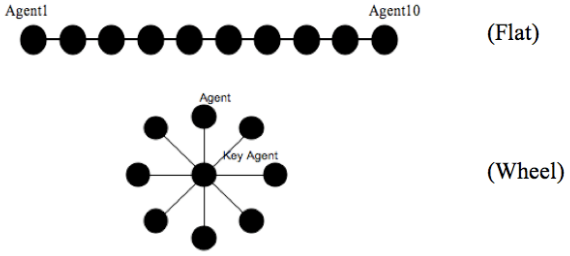

Figure3. Flat and wheel structures.

4. SIMULATIONS

4.1 Sensitivity Studies

Results of OLT simulations are shown on two indicators: the competence of new skill and the competence of old skill. The number from 0.0 to 1.0 to is to represent the level of agent's familiarity and capability to the skills, in which 0.0. is totally incapable to handle while 1.0 is full competent of the designated skill. In our preliminary setting, 0.3 and 0.9 are chosen to represent the starting levels of new and old skills, respectively, for all the agents. Our results are to show the growing enhancement of competence by 100 repetitions of practices.

Prior to proceeding target simulations, the OLT model is first examined by straightforward testing of three single-agent situations, and all the testing results show reasonable tendency reflecting particular heuristics of the three types of agents. In the following, toy problems of multi-agents cases are to further validate the OLT model.

Two cases are of interest: (1) influence of majority in a team, and (2) influence of followers once there is a tie between explorers and conservatives. A flat structure is chosen as the background to examine the reasonableness of OLT simulations.

In the first testing, a portion of follower, 40%, with a portion 50% of explorers and conservatives as two cases showing the designated majority. Results in Figure 4 clearly demonstrate that the team tends to enhance the competence of new skill when explorers dominate as the majority of the team and the influence of conservatives is insignificant. And the team's tendency demonstrates the other way round once the dominant majority changes.

In the second testing, with equal portions for explorers and conservatives, the portions of followers vary from 20%, 40% to 80% to trace the increasing influence of followers. As shown in Figure 5, the three cases show a same tendency (shown as a broken line) enhancing both the new and old skills, nevertheless the oscillation along the tendency increases with the portions of the followers.

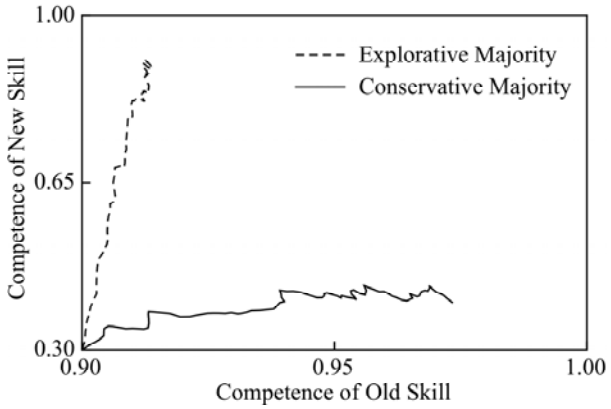

Figure4. Influence of majority in a team

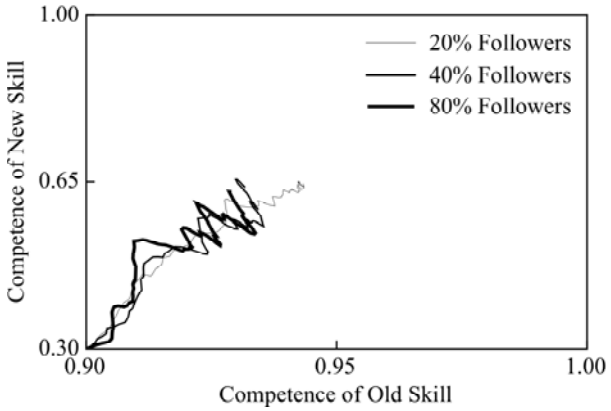

Figure5. Influence of followers in a team

shows the degree of insistency of his/her guidance toward team members. In this study, we simply categorize the insistency into two types: weak and strong, and represent the style using σ, weight factor, in equation (2). For instance, if a leader can effectively affect one half of his crew member's choice, his influence (Δ%) is as 0.5Ω% (σ is 0.5). Therefore, the tendency of the whole team would thus be influenced by 0.5Ω%.r. In the present case, we choose 0.5 and 0.1 to represent strong and weak leaders, respectively.

Previous two cases with a majority in team are re-examined by adding in a leader as wheel structure (with his/her type consisting or not consisting with the majority of the team). Learning of the team under cooperative or non-cooperative situations will be elaborated. Figure 7 illustrates a conceptual idea of the simulation, and 4 situations (Table 1) with a total 8 simulations are analyzed hereby.

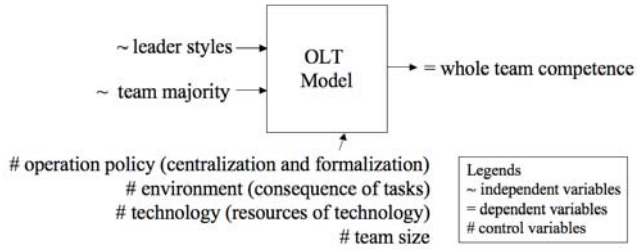

Figure 7. OLT Simulation

4.2 Leader's Influence

In order to test the influence of leader, a leader of specified "leader style" is assigned to a team. The style

Table1. Simulation Cases

Leader Style	Leader Type	Team Majority	Weight Number σ	Influence Δ
Strong	Explorative/ Conservative	Explorative/ Conservative	0.5	0.5Ω
			0.5	0.5Ω
Weak	Explorative/ Conservative	Explorative/ Conservative	0.1	0.1Ω
			0.1	0.1Ω

4.3 Results and Discussions

Figures 8 and 9 show the influence of leader on the organizational learning using OLT model. All the simulations are of wheel structure team (with a leader). Both cooperative and non-cooperative cases are depicted in the same figure with respect to a specific team majority.

By comparison with flat team, two interesting phenomena are observed. First is "*leader influence*" in cases of a leader leading big portion of un-cooperated members. For example, in testing of weak and strong explorative leader with conservative majority, as shown in Figure 8, only strong leader does influence team learning process from conservative to explorative (competence of new technology is improved 50%, from 0.4 to o.6). By contrast, weak leader does nothing for changing in this case. Similarly, reversed tendency (delay the learning) is also observed in testing of conservative leader with explorative majority (see SC leader in Figure 9).

Second phenomenon is that *"team majority"* dominates process and performance of organizational learning although a leader is assigned in cases of leading cooperated members. For instance, as shown in Figure 9, the explorative leader, whether strong or old one, enhances a little on learning with a team dominated by explorative majority. Alike, the results shown in Figure 8 indicate those conservative leaders' contributions on obstruction of learning is not significant with cooperated members (conservative majority).

Through the proposed model, OLT, the simulation results display different types of leader influences visually. Closer examinations on the mechanism of leader

influence on organizational learning in teams are explained more specifically: (1) learning of new-technology in a team would be enhanced if a proper leader is assigned and empowered in un-cooperated situation; (2) the effectiveness of learning would increase in a team with members employing explorative attitude in. Accordingly, the tradeoff on strategy using of role of leader for organizational learning in team in response to different contingencies can be considered by then.

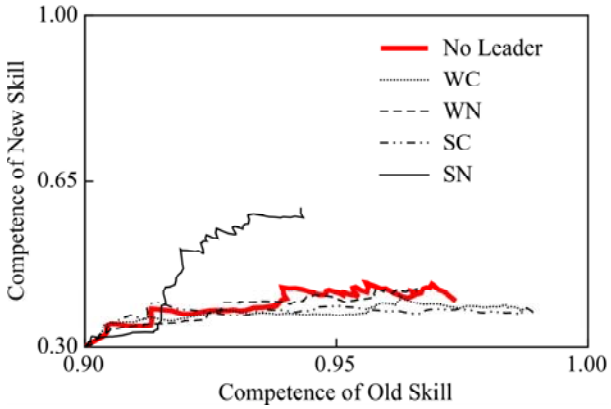

Figure8. Influence of a leader in a team with conservative majority *(WC: Weak leader with Cooperative team; WN: Weak leader with Non-cooperative team; SC: Strong leader with Cooperative team; SN: Strong leader with Non-cooperative team)*

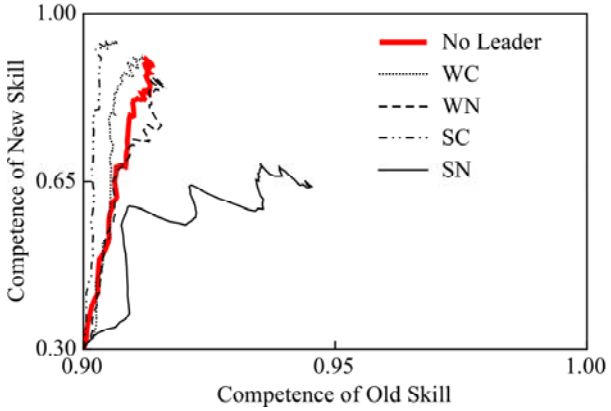

Figure9. Influence of a leader in a team with explorative majority *(WC: Weak leader with Cooperative team; WN: Weak leader with Non-cooperative team; SC: Strong leader with Cooperative team; SN: Strong leader with Non-cooperative team)*

5. CONCULSIONS

Organization theory suggests that no organization is best fit in all contingencies. Thus, how to design a learning organization or how to speed up organizational learning could be considered in perspective of organization design strategies, such as structural settings, member hiring, training or policy implementing.

Based on this point of view, several propositions can be concluded by this research:

First, the OLT research demonstrates *the effect of group diversity* on organizational learning in teams. Different kind of team members contributes different influence on learning. Notably, the portion of explorers (or conservatives in the other perspective) dominates the team learning for new skill (or old skill). Otherwise, high portion of followers would oscillate learning performance. These findings suggest that team managers need to understand their team compositions for better performance with different purposes, e.g. introducing a new skill for a project; braking the learning on superstitious skill [2].

Meanwhile, this research addresses the *leader influence* on different contingencies. At least eight scenarios are discussed. From simulations, leader in non-cooperative team have to gather more powers and authorities in order to change others' behaviors. By contrast, leaders merely facilitate team learning in cooperative situations. These results are partially consistent with previous researches [i.e. 3, 4, 5, 6, 7, 29, 30]. Thus, the fully delegated leader can be concluded as a crucial position *for changing* in a team. The leader is responsible to insist on his/her guidance. Some dilemmas in teams, such as choice conflicts, goal incongruence…etc., can be solved simply in this case.

The validation of OLT model is proceeding with a real case study, in which an architectural innovation [38] is implemented successfully. Through the validation, OLT simulation provides the insights for quantifying the numbers of team adaptation rates with different team compositions and different leader influences. The numbers can facilitate project managers in predicting performance in time, cost and quality. We will discuss that thoroughly in our next paper.

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