Relationship and Knowledge Management in Construction Projects in Thailand Part 2: The Studies of Knowledge Management Process and the Three-stage Project Development Performance Improvement Framework
ความสัมพันธ์ในคณะทำงานและการจัดการความรู้ของโครงการก่อสร้างในประเทศไทย ภาคที่ 2: การศึกษากระบวนการจัดการความรู้และกรอบบันไดสามขั้นเพื่อบรรลุถึงการบริหารจัดการโครงการอย่างมีประสิทธิภาพ

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Abstract

The study of network relationship using UCINET program in part 1 was inspired by the problematic fragmented structure of a construction project development team. In this paper, the multi-stage project development process as another key factor that underlies the construction industry's poor performance is addressed. Knowledge management is then proposed as another key solution to achieve the more effective project development in Thailand context. Based on Nonaka and Takeuchi's 1995 knowledge conversion model, representatives from key project members' organisations that developed recently complete large commercial residential projects in Bangkok central business area were asked in semi-structured interviews about organisational knowledge management process using a set of standardised questions. The outcomes show the moderate efficiency due to key project members' unawareness of knowledge potentials. A three-stage framework is also proposed to identify key project members, strengthen network relationship and improve organisational knowledge management capability to achieve the better project development performance.

บทคัดย่อ

การศึกษาความสัมพันธ์แบบเครือข่ายในคณะทำงานโดยใช้โปรแกรม UCINET ในบทความภาคที่ 1 นั้น ได้รับแรงบันดาลใจจากปัญหาที่เกิดจากโครงสร้างแบบแยกส่วนของคณะทำงานพัฒนาโครงการก่อสร้าง บทความในภาคที่ 2 นี้จะได้กล่าวถึงปัญหาสำคัญอีกประการหนึ่ง ซึ่งเกิดจากขั้นตอนการทำงานที่มากมาย ที่ทำให้ประสิทธิภาพในการพัฒนาโครงการลดลง การแก้ไขปัญหาด้วยกระบวนการการจัดการความรู้ เป็นอีกแนวทางหนึ่งที่จะช่วยเพิ่มประสิทธิภาพในการพัฒนาโครงการโดยเฉพาะอย่างยิ่งในประเทศไทย โดยเริ่มจากการสัมภาษณ์ผู้แทนองค์กรที่มีบทบาทอย่างสูงในการพัฒนาโครงการที่พักอาศัยเชิงพาณิชย์ขนาดใหญ่ในย่านธุรกิจใจกลางกรุงเทพมหานครให้ประสบความสำเร็จเมื่อเร็วๆ นี้

โดยใช้ชุดคำถามมาตรฐานเกี่ยวกับกระบวนการการจัดการความรู้ขององค์กร ข้อมูลดังกล่าวจะนำไปวิเคราะห์โดยใช้แบบจำลองการแปรสภาพของความรู้ (knowledge conversion model) โดย Nonaka และ Takeuchi (1995) ผลจากการวิเคราะห์แสดงให้เห็นถึงประสิทธิภาพในการจัดการความรู้ในระดับปานกลาง อันสืบเนื่องมาจากการขาดความรู้ความเข้าใจเกี่ยวกับศักยภาพในการก่อให้เกิดประโยชน์ขององค์ความรู้ บทความชิ้นนี้ยังได้นำเสนอกรอบการปฏิบัติสามขั้นตอน โดยเริ่มจากการจำแนกผู้ที่เป็นหลักในการพัฒนาโครงการ การเสริมสร้างความสัมพันธ์แบบเครือข่าย และการปรับปรุงความสามารถในการจัดการความรู้ขององค์กร เพื่อเพิ่มประสิทธิภาพในการพัฒนาโครงการโดยรวม

Keywords (คำสำคัญ)

Construction Industry (อุตสาหกรรมก่อสร้าง)
Project Development Performance (ประสิทธิภาพของการพัฒนาโครงการ)
Knowledge Management (การจัดการความรู้)
Knowledge Conversion Model (แบบจำลองการแปรสภาพของความรู้)
Network Relationship and Knowledge Management Improvement Framework (กรอบการปฏิบัติเพื่อปรับปรุงความสัมพันธ์แบบเครือข่าย และความสามารถในการจัดการความรู้)

1. Introduction

The first part article identified fragmentation and linear multi-stage project based development process as the two underlying factors that cause poor performance in the construction industry both in UK and Thailand. It also extensively explored fragmented relationship at three different levels to improve project development performance. Firstly, it was a set of overall network characteristics including reciprocity, reachability, geodesic distance and network centralisation. The second level of network relationship belonged to individual project member including out and in degree centrality, clustering coefficients while the third level of relationship like cliques, ego network size and density as well as brokerage[1] was at subgroup level.

This first section of this second part article is about the studies of two core activities: knowledge creation and transfer currently adopted in the organisational knowledge management practice in selected projects. A three-stage framework is then proposed to increase the construction industry's competitiveness through the better relationship among stakeholders and the more effective organisational knowledge creation and management. At stage 1, the number of key members of a project, level of engagement, as well as strength and satisfaction of relationship are identified and recorded. The outcomes can be used at stage 2 to plan the improvement of key network characteristics based on relationship analysis using UCINET software. As a result, the current network characteristics such as network size, density, reciprocity, reachability, geodesic distance, centrality and other measures that influence degree of collaboration and quality of relationship can be developed to support better learning. Inter-organisational knowledge creation, transfer and management practices in four stages, according to Nonaka and Takeuchi's (1995) knowledge conversion model, can then be evaluated for further improvement at stage 3.

2. Definition and Importance of Knowledge

Knowledge is information or data structured into a meaningful composite model that can be used in a predictive manner (Morris & Loch, n.d.). It can be interpreted and evaluated as intellectual capital or a valuable asset (Boisot, 1998) by cognitive ability in a contextual mental model (Parikh, 2001; as cited in Gupta & McDaniel, 2002). There are two types of knowledge. First, tacit knowledge is subtly created and maintained personally in the heads of individuals. The second type of knowledge is explicit knowledge that is captured, systematically sorted and stored to be conveniently accessed and transferred in secondary types of media including printed materials as well as electronic database.

As suggested in the Egan report, knowledge and integrated construction project development process can be seen as the crucial elements to achieve the better performance of construction project development. It is the fifth and the last driver of change[2] inspired by the manufacturing and service industry that encourages people to work interdependently in a safe and pleasant environment while continuing to learn to improve and develop their professional capability (Department of Trade and Industry, 1998). Similar recommendations can be seen in Achieving Excellence in Construction initiative introduced by the UK Office of Government Commerce (OGC) where good performance to create value for money in public sector construction projects can be achieved using knowledge. Committed and capable individuals'

[1] See definitions of network characteristics technical terms in glossary.

[2] The other four drivers chronologically listed are 1) *leadership* that is committed to achieve improvement and change 2) *customers' needs* have to be fulfilled by 3) *integrated processes and teams* to 4) *deliver high quality products* on time and to budget

leadership and management skills have to be consistently enhanced through collective learning to understand technical knowledge and a shared mental model through a series of projects (Egbu & Robinson, 2005).

3. Knowledge Creation and Transfer

Knowledge can be created from activities in formal and informal communicative events within and between people (Fruchter & Demian, 2005). At personal level, Handy (1991) suggested a cyclical four-step wheel of personal learning (Figure 1) from *question, theory, test* to *reflection* to achieve individual learning.

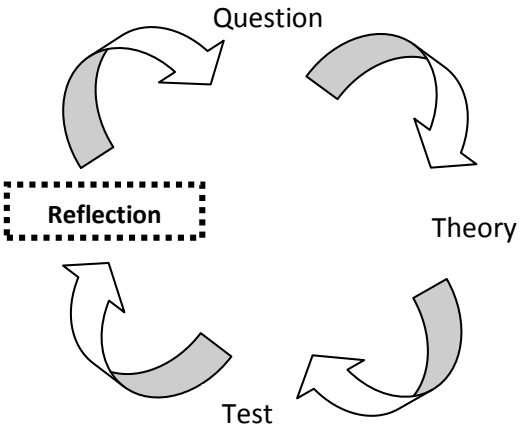

Figure 1. Wheel of learning. (Source: Handy, 1991)

The first step *(question)* often arises from an issue that deserves to be further explored. A relevant *theory* is then proposed as a potential solution. The collective social interaction/participation known as the histories of learning that includes an enquiry with the sources of first hand tacit knowledge is employed at the *test* stage. It is at the *reflection* stage that people involved can fully learn new knowledge from the immediate assessment and interpretation once the overall operation is completed or at strategic breakpoints of the continuous operation to make sense of the available data. The scope of reflection initially includes obvious problematic factors as seen in the *single loop learning* approach (Argyris and Schön, 1974). Governing variables that are the actual causes of the problems are not necessarily included. This limited scope of analysis is likely to cause learning disability since it does not encourage further exploration. Moreover, accumulated and unresolved causes of problems tend to create reverse effects known as *compensation feedback* that reduce the effectiveness of all proposed solutions. In order to achieve a sustainable problem solution, scope of analysis has to be extended to cover all causes of problem including the ones that seem irrelevant to create additional balancing feedback cycle. However, a new holistic view in the *double loops learning* might cause some delay to the whole process.

New organisational knowledge created via interpersonal communication is clearly explained in the widely regarded Nonaka & Takeuchi's (1995) progressive spiral four-mode knowledge conversion model (Figure 2). In this case, knowledge is treated

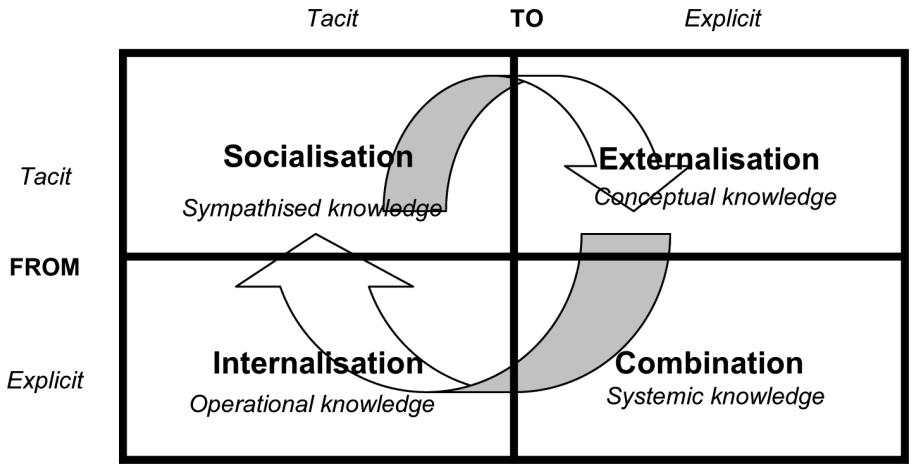

Figure 2. Four modes of knowledge conversion.
(Source: Nonaka & Takeuchi, 1995)

as organic assets with the potential to grow and switch between explicit and tacit forms throughout a project's life.

At the **socialisation** stage, multidisciplinary project participants are given opportunities to take part in activities to communicate and contribute their diverse skills and experiences known as *sympathised knowledge.* At the next **externalisation** stage, interpersonal contacts through dialogue and discussion among team members in an open and merit valued environment continue to transform sympathised knowledge into variation of ideas known as *conceptual knowledge.* It can be recorded using various types of media in explicit forms such as languages, metaphors, analogies, concepts, hypotheses and models. Moreover, the development of *organic schemas* that influence the development and articulation of personal cognitive issues including behaviour, ideas, values or emotions is also possible through retrospective reflection in the sensemaking process (Weick, 1995). As suggested by Wenger (1998), it starts from practice or physical engagement of a task that shares historical and social resources, frameworks and perspectives. It is the opportunity to negotiate and develop sense of *community* as the second schema (Hildreth, Wright & Kimble, 1999). *Meaning* and *identity*, on the other hand, help the development of individual's cognitive system through social participation. At the **combination** stage, *systemic knowledge* to serve particular purposes is created as boundary objects, prototypes or new technologies that effectively used to support communication among project members. *Operational knowledge* is internally developed as tacit knowledge at the **internalisation** stage from the application of systemic knowledge to complete the task. At the end of this stage, a new cycle can be started for a new assignment creating new knowledge that can be converted back and forth between tacit and explicit forms.

In construction, organisational knowledge creation can be initially explored in construction firms including architectural design offices who are working at different stages along project development process from predesign to building operation and maintenance. However, knowledge creation in project development scenario where a number of building professionals and specialists in building trade are involved also has to be explored.

4. Knowledge Management

Concept of knowledge management (KM) is to make required knowledge available for any specific purpose. Even though KM can be highly contextual, it can still be generalised in a five-stage progressive process from searching, capturing, articulating information to applying and learning (Construction Excellence, 2004) as seen in Figure 3.

Knowledge management process starts after the completion of a knowledge audit to identify the availability of tacit and explicit knowledge. Knowledge that is still required can be searched and captured

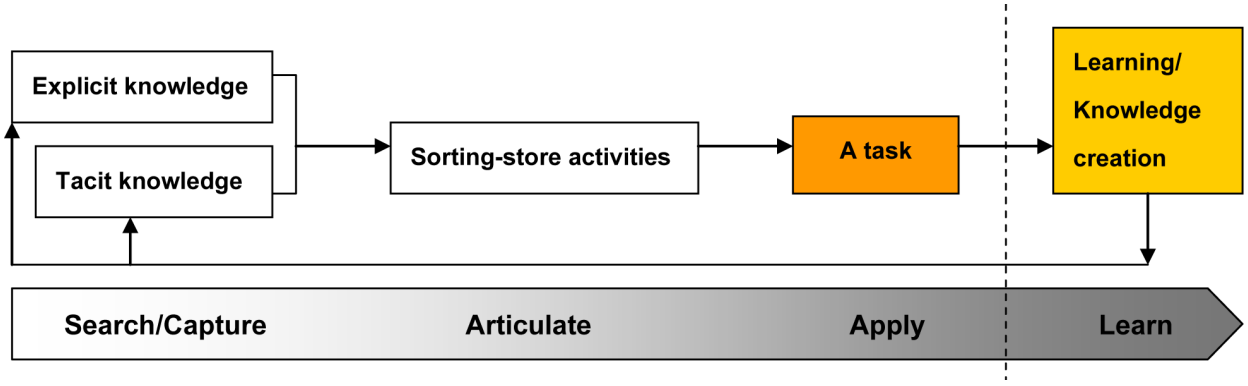

Figure 3. The comprehensive process of knowledge management. (Source: Adapted from Construction Excellence, 2004)

from various sources. Newly acquired knowledge has to be systematically sorted, articulated and fused with the existing one to be conveniently retrieved for applications. New knowledge can be eventually learned from retrospective reviews of the past experiences at the end of the process. The success of knowledge management relies significantly on supportive environment. At strategic level, the appointment of knowledge champions to oversee knowledge management activities suggests the organisation's profound understanding of knowledge management and the positive effects on project development performance. At operation level, project members should be encouraged to increase the level of commitment without excessive competition (Egbu & Robinson, 2005). Moreover, the choices of an appropriate project procurement system have to effectively facilitate the flow of knowledge.

Table 1. Selected project information and project members interviewed.

No.	Selected projects	Developers	Number of units	Project value (m baht)	Project timeline	Project members interviewed											
						Client executive	User	Architect	Investment and financial consultant	Legal consultant	Project manager	Planning authority	Interior designer	Landscape designer	Structural engineer	M&E engineer	Professional organisation
1	OTL	S1	302	906	2004-2006	●						●					
2	PMR		Serviced apt: 138 Condo: 358	1,546	2003-2005	●											
3	LKS	R	165	1,600	2003-2005	●		● WBT		● ANO					● MH		
4	LGD		75	1,545	2004-2006	●		● SJL							● CWT	● ECLS	
5	YKT	S2	79	354	2003-2005	●		● ATP			● S2				● ATC	● VG	
6	SKV10		118	630	2004-2006	●		● PT									
7	SUB	L	155	N/A	2003-2005	●		● PLN							RKV		
8	NTW		294	N/A	2003-08/2005	●		● HNT									
9	BKK	A	580	2,500	2004-2007	●		● REP			● A				● GMT	● PAS	
10	ADRS		224	1,000	2005-2008	●											

5. Studies of Knowledge Creation and Management by Key Members of Appraisal Development Teams in Selected Projects

Based on Nonaka and Takeuchi's knowledge conversion model (1995), key members of 10 selected commercial residential projects in Bangkok central business area successfully developed by 5 established property development companies, as seen in Table 1, were asked to participate in semi-structured interviews about knowledge activities to achieve better project development performance in four ongoing stages from *socialisation, externalisation, combination to internalisation* while working on a project's pre-design stage.

5.1 At Socialisation Stage

Project members, at this stage, should be strategically encouraged to participate in knowledge activities such as education and training programmes to create tacit sympathised knowledge. It can be seen from data collected that knowledge management awareness has not been established in most cases. Therefore, systematic knowledge activities, only adopted for practical needs, have not yet been fully developed, planned and implemented. Employees were not encouraged to formally share new knowledge or compete for promotion that is likely to cause disintegration. Moreover, collaborations at this pre-design stage were not extended to include researchers and academics in higher education institutions as well as specialists at construction and post-construction stages. The outcomes can be elaborated in details as follow.

5.1.1 Client Organisations

It was found that client's extensive connections with other team members including users, legal consultant, project manager, planning authority, professional and research organisations as well as architects and engineers working on a project appraisal development played a significant role in knowledge creation and sharing. It was also the supportive environment that consistently nurtured two-way collaboration to encourage the creation of tacit sympathised knowledge. For example, in Case L, there were continuous professional practice development courses while in Case A, education and training programmes were formally organised by human resources department (HR). At the same time, informal meetings were also set up, like in Case S1, for team members to catch up and share updated information and experience with others in a friendly environment. Full involvement of top executives such as Chief Executive Officer (CEO) in Case A or Chief Operation Officer (COO) in Case R as a knowledge champion who settled any strategic disagreement significantly increased the level of project success. Interviews carried out with client executives in Cases A, S1 and S2 confirmed that the management's strong perceptions were the key to achieve knowledge creation and management. In Case A, all departments in the fragmented project management structure were unified by a vice president (VP) who was also a project manager. They were also constantly encouraged to produce new products that meet customers' fast changing requirements. In Case S1, assistant managing director (AMD) was an influential high ranked executive who oversaw the company's knowledge management strategy. However, the collaboration did not normally extend to construction and post construction stages. Only in Case R that construction material suppliers were included to procure the best price at the very early stage of project development.

5.1.2 Architectural Design Companies

All interviewed representations from local and foreign-based architectural design companies clearly supported collaborations with others at socialisation stage. However, in small scale local companies like ATP, HNT and PLN whose specialisation was small to medium size projects, organisational knowledge creation and transfer activities were limited. Except in ATP case where intensive coaching between the

highly experienced architect and junior members of joint venture firms was not fully implemented due to the satellite nature of practices, architects in other companies including PLN were able to learn from working in a team of two or three members on a project under the direction of senior architects who were also knowledge champions. Social activities such as frequent production wrap up parties, as seen in HNT case, were also used to strengthen connections among team members to create new sympathised knowledge. In both HNT and PLN cases, formal education and training were not seen as the main approach to support the creation of distinctive but practical new ideas that fulfill client's requirements due to the lack of time. In any case, fierce rivalry among fellow staff was not fully encouraged. Good performance was recognised and rewarded by bonuses, promotions or free trips abroad for long serving employees that also generate new knowledge to be shared. Unfortunately, there was no direct collaboration with higher education or research institutes.

Knowledge creation and management strategy at socialisation stage in foreign based architectural design companies was not widely different. Since they have to be working under strict local regulations, most of the firms including SJL and WBT have become corporate members of two architect representative organisations: the Association of Siamese Architects (ASA) and Thai Architect Council (AC). However, scope of socialised activities to create and transfer knowledge was still limited due to work commitments, as suggested by SJL staff. At WBT, for example, it was achieved through after work drinking sessions as well as Thursday movie screenings. Internal cross department collaboration was the more likely chance for the staff to learn. Old and new staff of SJL and WBT generally learned in two-way apprentice sessions supervised by senior architects who were also knowledge champions. Besides, new ideas and inspiration was achieved by studying from publications, websites and other media. More formal education and training activities at SJL were also internally organised. These sessions, in WBT case, were only available on Saturdays due to hectic work schedule.

5.1.3 Legal Consultant and Planning Authority

Generally, in-house department of established property development companies perform basic legal administration. Only Case R exceptionally employs ANO, an international legal consultant, to achieve a higher standard of customer services. From the interview, ANO's management strategy was to avoid aggressive actions that usually cause internal conflicts. Planned organisation-wide internal meetings led by knowledge champions were utilised to create stronger bonds among independent departments. Formal education and training were also organised at both local and international levels. It is supported by the company's extensive database of legal forms and agreements that staff can consult as part of the widely encouraged learning by doing. Annual performance evaluation was based on information collected from every parties involved including head of departments and fellow team members.

Working process adopted by the influential but bureaucratic planning authority in Bangkok Metropolitan Administration (BMA) made it hard to adopt and develop an effective knowledge creation and management strategy. Due to the routine application of passive problem solving, meetings were only set up to find quick solutions to problems rather than the more effective preventive strategy. In the process, only certain employees who worked closely with heads of departments through informal apprentice coaching. would be able to learn who are also knowledge champions, Moreover, existing incentive schemes to encourage good performance are not taken seriously. As a result, staff working in such a non-competitive environment and constant fear of poor career prospect has not been fully motivated to learn to achieve their full capabilities.

5.1.4 Project Management Teams

On a day to day basis, there were various

occasions like formal meetings as well as informal lunch breaks for members of S2 project management team to meet and socialise. As a result, the best solutions for a project can be learned in a supportive atmosphere where ideas, comments and requests were extensively valued. Direct coaching was also extensive and constantly used even though the role of knowledge champion, normally performed by influential figures, was not clearly identified. HR department only organised formal education and training programmes mainly to improve general business skills like time management or effective meetings. Specialised or technical knowledge had to be learned from specialists or professional organisations in specially organised sessions. In Case A that vice president (VP) was an influential project manager and an attentive knowledge champion from start to finish, activities that promote socialisation and the creation of sympathised knowledge were even more effectively adopted.

5.1.5 Engineering Companies

The opportunity for building engineers to manage a project's new knowledge creation strategy at the appraisal stage was also likely to be limited. It is because they are recruited to contribute their skills and knowledge later at design development stage once schematic design is mainly settled by client and architect. Moreover, representatives from small local companies like VG, PAS and GMT concluded that organisational knowledge creation and management strategies were not systematically planned. In most cases, learning was mainly achieved by doing assigned jobs under senior staff supervision. Due to the busy schedule, casual social gatherings that promote knowledge sharing were only put into practice at lunch breaks as in GMT case. There was also little competition among members of a small team working long hours together. In medium scale companies like ATC and RKV, learning by doing under close supervision was also adopted. However, coaching in two-way apprentice sessions was only adopted in ATC case. Moreover, there was no plan to encourage individual to share knowledge.

In large international engineering firms like ECLS and MH, organisational knowledge creation and management activities were not totally different from smaller practices. For example, meetings were usually organised around free slots in ECLS project engineers' busy schedule. Coaching, on the other hand, was extensively adopted between senior engineers as knowledge champions and novices. New knowledge can also be created by attending seminars regularly organised by HR department as well as educational programmes organised by professional organisations like the Engineering Institute of Thailand (EIT), Engineering Council and building material suppliers. Social activities to encourage team spirit like bowling games, trips or festive parties in MH case were arranged occasionally. Like other smaller cases previously mentioned, teamwork with minimum competition was very much encouraged. Good performance by hard working staff was appropriately recognised and rewarded. In PAS case, it was the company's shares. Like architectural design companies, only new ideas that proved applicable were implemented. Connections with higher education institutes for new knowledge and technical supports were infrequent.

5.2 At Externalisation and Combination Stages

Information collected from interviews confirmed that negotiation and brokering, the two key activities that transform sympathised to conceptual knowledge at externalisation stage, are mainly as liaisons using overlap practice. Even though it was convenient to do so since each member did not need to compromise their interests or change their identity, this approach did not truly support the team's integration to create a body of knowledge in the long run. On the contrary, it might even have increased the problem of boundary paradox (Quintas, Lefrere & Jones, 1997) by not allowing the free flow of information to keep the organisation knowledge base and intellectual

capital. The newly created conceptual knowledge can be later captured, accumulated and transformed into explicit forms as project appraisal and associated documents to become systemic knowledge that can be passed on among project members at combination stage. However, there was no effective way, other than short personal summaries, to develop systemic knowledge and the personal organic schemas: meaning, community and identity.

5.2.1 Client Organisations

At externalisation stage, formal meetings and informal verbal communication were both equally adopted. Metaphors, analogies and hypotheses based on experiences in previous projects were extensively used to clarify the ideas. Written documents were the primary form of systemic knowledge at combination stage. They have been successfully managed using document management technology like Lotus Notes in some cases. The information was subsequently analysed and stored in the company's database system to be used by customer relationship department like in Case L. However, the development of design database was not very successful, as suggested in Case S1, due to the unique one-off nature of architectural design. There are also too many factors such as building regulations, design codes, aesthetic values and marketing strategies to be summarised into a set of design standards.

5.2.2 Architectural Design Companies

For an architect, communication via negotiation and brokering with people in various fields using metaphor, analogy and concept are crucial at both project appraisal and design development processes. Details of discussions have to be quickly turned into explicit forms of official documents with technical details for subsequent uses due to limited time available. However, the use of electronic media might not be fully effective in all cases without the efficient data management system. Therefore, simple approaches to encourage learning such as a public notice board known as 'Wall of Shame' used by SJL can be equally effective. In this case, photographs that clearly display substandard executed concept, design or construction were posted with light-hearted comments that would not cause offences or conflicts.

5.2.3 Project Management Teams, Legal Consultant and Planning Authority

The nature of communication between project management team, legal consultant and planning authority also using metaphors and analogies, was similar to building construction specialists. However, scope of communication in project management team that includes a large number of people working on site was definitely more extensive. In ANO legal practice, the use of verbal and written communications had to be in context to convey the exact meanings. Project progress reports were stored to be searched, retrieved and passed on using the latest information technology.

5.2.4 Engineering Companies

Like most of building construction specialists including architect, verbal communication was the main approach to pass on ideas, metaphors, analogies and concepts especially in small companies like VG and PAS. All larger companies can truly make use of electronic media such as emails to convey abstract ideas as well as to manage general project information. However, quality and quantity of such information were still not at the highest standard. For example, written documents were not regularly produced as a medium to create new tacit knowledge. As seen in Case CWT that there was only a project handover report based on a two-day liability assessment at the end of the twelve-month warranty period for the team to reflect and learn. In Case GMT, only a selected collection of correspondences was kept due to the lack of time and encouragement. Only inconclusive technical information was available for future reference in Case MH. The capacity of lessons learned, therefore, can

only be indirectly seen or measured from the number of errors detected in contractors' feedback.

5.3 At Internalisation Stage

The short period of time available for reflection of the past experience at the end of a project before the team is dissolved has become a significant barrier to achieve the effective learning. However, feedback from each project was generally studied in a time consuming process at the end of a project development to form a body of tacit operational knowledge. Moreover, single loop as well as double loop thinking approach was adopted by key project members while working on a task in different scenarios as follow.

5.3.1 Client Organisations, Project Management Teams, Legal Consultant and Planning Authority

Even though it was agreed in client organisations and project management teams that double loop thinking approach was the ideal learning process. The capability to provide quick problem solutions such a limited time made single loop thinking approach popular among operation staff and executives as seen in Cases S1 and A. However, in legal practice like ANO, only double loop thinking that considers all relevant factors was adopted. On the contrary, BMA's planning consent department mainly employed single loop thinking. In the long run, it is expected that the inability to learn would eventually affect the BMA's capacity to cope with new issues in planning control using tacit operational knowledge.

5.3.2 Architectural Design Companies and Engineering Companies

Scope of reflection adopted by small and large architectural design and engineering companies were not considerably different from other project members. In the field of architecture, foreign-based companies like SJL, WBT and PT usually opted for double loop thinking with occasional application of single loop thinking to create the best possible building design. In Case WBT, the preference of double loop learning was inspired by the carefully analysis of relevant parties' comments and feedbacks showing the effects of bad building design, short-sighted construction management and low level of users' satisfaction. Local design-oriented architectural companies like HNT, PLN and REP also preferred the more conclusive double loop thinking. However, the single loop approach that provides fast problem solution was never neglected in any cases. All local and foreign based structural and mechanical & electrical engineering companies mainly employed double loop thinking approach while working on a project.

6. The Proposed Three-stage Framework to Improve Project Development Performance

Based on the studies of network relationship characteristics in part 1 article and knowledge creation and management practices in this article, a three-stage framework (Figure 4) is proposed to improve potential to learn from other network members to achieve the more efficient knowledge management leading to the better performance in project development.

Stage 1: The identification and engagement of stakeholders

It is important that existence of key stakeholders, levels of their engagement and collaboration in a project development have to be initially identified by all stakeholders. As seen in Table 2, the existence of key stakeholders' engagement can be recorded in a binary system where 0 means non-existence and 1 means existence. At the same time, a 5-level Likert scale where low scores suggesting weaker ties or low satisfaction and vice versa is also used to study the quality of such engagement in terms of strength and satisfaction.

The information can be used to extend the scope of stakeholders' involvement. Key stakeholders who have not yet been fully involved in the task have to be included. For example, independent financial

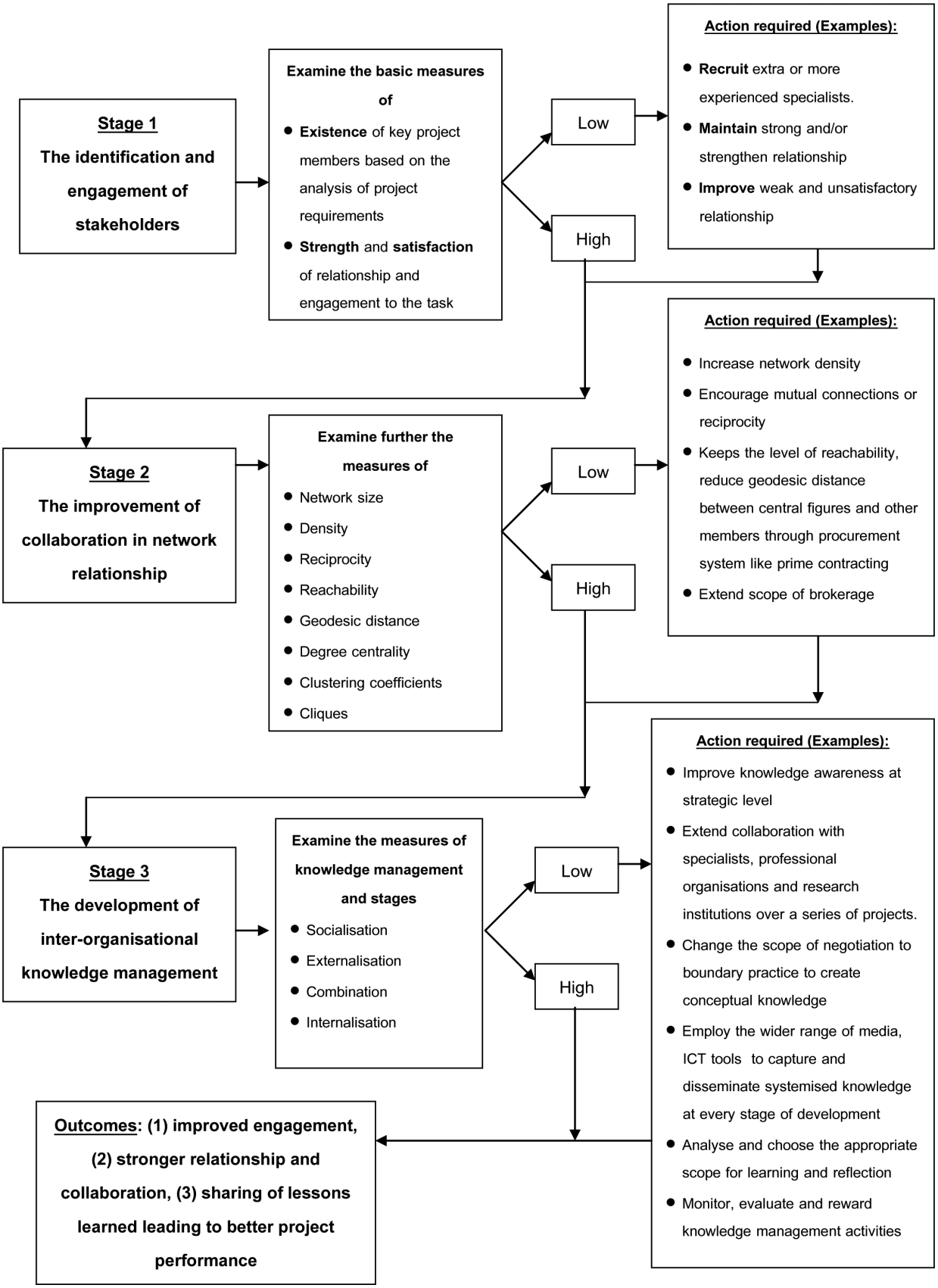

Figure 4. The proposed three-stage framework to improve relationship and inter-organisational knowledge management activities.

Table 2. A data collection sheet on existence, strength and satisfaction of relationship in a project.

Project	Key project members	Non existence	Existence	Degree of strength					Degree of satisfaction				
				Low		Medium		High	Low		Medium		High
A	1. Client executive	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	2. User	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	3. Architect	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	4. Investment and financial consultant	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	5. Legal consultant	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	6. Project manager	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	7. Planning authority	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	8. Interior designer	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	9. Landscape designer	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	10. Structural engineer	☐ 0	☐ 0	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	11. M&E engineer	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
	12. Professional organisation	☐ 0	☐ 1	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

consultants should be included at the early appraisal development stages to provide impartial views on project investments and returns. Contributions from potential end users have to be extensively procured to support the company's database to accurately specify the ever-changing functional requirements and preferences. Specialists in building codes as well as environmental impact assessment (EIA) should also be employed to support architects and engineers to work effectively with the planning authority. Interior and landscape designers as well as equipment and material suppliers who are usually recruited at the later stage should be consulted earlier to create the most effective functional space. Connections to professional representatives and research organisations could also be valuable to provide the most up-to-date knowledge and innovation to be used in architectural design and construction. At the same time, weak and moderately strong links have to be strengthened while unfavourable state of satisfaction also has to be improved.

Stage 2: The improvement of collaboration in network relationship

At this stage, information on stakeholders' level of engagement from stage 1 is used to develop

measures or plans to further improve the team's collaboration through a set of network characteristics identified by UCINET network relationship analysis software. First of all, current network density can be measured using the number of members participated in activities divided by the figures of the full network capacity (a network size of 12 members in this case). In order to create a strong, reciprocal and well connected network, level of network density by encouraging the higher degree of participation and collaboration has to be improved as high as the full value of 1. The most appropriate project procurement system can then be chosen to form a mutual constructive collaboration that promotes knowledge sharing among key members and their ego networks. The effective choice would also increase the level of reciprocity, reachability and node clustering coefficients. At the same time, geodesic distance or the shortest knowledge transfer path between members can be reduced. Project manager with the highest level of out degree centrality could be encouraged to perform the role of knowledge champion more effectively. On the other hand, architect who had high level of in degree centrality could become a source of technical contributions that can be conveniently reached by others.

Stage 3: The development of organisational knowledge management

Once key network characteristics are in place, inter-organisational knowledge management strategies and applications are the next to be developed to increase the team's learning capability. Based on the spiral four-stage Nonaka & Takeuchi (1995) knowledge conversion model, a strategy, first of all, has to be formulated at socialisation stage to create sympathised knowledge. Organisation structure and culture have to be studied to reveal the mechanism that supports the creation of new knowledge. At the second externalisation stage, knowledge sharing activities have to fully endorse the formation of conceptual knowledge. Effective approaches including technology available have to be carefully chosen to capture and transform conceptual knowledge to systemic knowledge at the third combination stage. Finally, at internalisation stage, scope of reflection adopted by people involved has to support the creation of operational knowledge.

Table 3. Selected commercial development projects for framework testing.

Selected projects	Project purpose/ location	Client organisations	Architect	Project manager	Civil engineer	M&E engineer	Land area	Project value (m Baht)	Project timeline
LS	40-key resort hotel/Hua Hin 144 miles south west of Bangkok	FLJ	AGL	FLJ	Dr Suthas	K Meng/ K Meow	4 Rai or 0.64 hectare	200	2004-2006
TS	39-key boutique hotel/central Bangkok by Chaopraya river	SC	BDS	DS	ACS	ACS	7 Rai or 1.12 hectare	800	2006- April 2011
OW	131-unit mid-tier serviced residence development/central Bangkok (Sukhumvit area)	BC	SD	BC	WA	ACS	NA	300 to 600	Mid of 2008 to end of 2009

The framework was then tested on three new build commercial development projects in Thailand (Table 3). Comments from six key project members in shaded boxes, based on a list of interview questions, suggested that the framework is a valuable tool to identify relevant stakeholders, relationship between project members and knowledge management activities. Information from the implementation of the framework can be used to form specific action plans to facilitate the improvement of project development performance. For example, at stage 1, Information collected from the client and architect of the LS project clearly shows noticeable existence of strong relationship between client, architect and other project members. Each of them (except project engineer) was involved strongly (rated 5 out of a 5-level Likert scale) with seven out of a total of eleven other key stakeholders. However, some key members such as project manager as well as professional organisations were not included at this stage because the tasks could be performed effectively by clients. In order to improve relationship and knowledge management practices, strong existing relationship between key stakeholders has to be maintained. Weaker links with project engineers have to be strengthened by the early inclusion of all building engineers at the project appraisal development stage to be able to efficiently share and use technical knowledge. At the same time, relationship with other project members like real users, technical specialists such as investment and legal consultants as well as a dedicated project manager have to be established. This will help to capture the views of all relevant stakeholders leading to better decisions.

7. Conclusion

It can be seen from the articles that strong network relationship among key project members and efficient knowledge management especially at appraisal development stage are the two complementary factors that lead to the better performance of a construction project development. Part 1 clearly showed how certain network characteristics can speed up or hinder the flow of information to create and transfer new tacit and explicit knowledge. The lack of direction of inter-organisational knowledge management practices was clarified in part 2. A three-stage framework, therefore, was introduced to systematically explore the current relationship and knowledge management practices in order to properly address problems and develop appropriate action plans to achieve a more successful project development. Knowing who the key players are in order to bring out the best contributions from the extended range of stakeholders has to be completed at stage 1. Closer and stronger relationship has to be achieved at stage 2. Introducing the more integrated project procurement systems can be one of the approaches to improve some weak network characteristics.

At stage 3, awareness and true understanding of knowledge potential to improve project development performance are the core values that need to be strategically established. Knowledge activities at all four stages of knowledge conversion model can then be effectively planned and implemented. Firstly, the opportunities to establish extended cooperation have to be strategically available at socialisation stage to encourage the creation of sympathised knowledge. At externalisation stage, collaborators have to be more closely involved in discussion and negotiation to create the more comprehensive conceptual knowledge and, at the same time, develop each project member's cognitive characteristics. Systemic knowledge can be better captured at combination stage with the more conclusive use of media. Suitable scope of reflection, either quick but superficial single loop approach or slow but profound double loop approach, has to be adopted by all project members at internalisation stage to build up operational knowledge. Led by strong leadership and readily available resources and technology, extensive learning among members of network relationship can be established to consistently create a well-managed body of knowledge to be used in future projects.

Glossary

Network size is the number of people involved in project development.

Network density is the proportion between the present ties compared to all possible unique pairs of ties among key members.

Reciprocity shows the potential of knowledge transfer among project members through the proportion of project member pairs with reciprocated ties or mutual connections to all the possible pairs.

Reachability suggests the existence of paths that can be traced from source to target no matter of how many other members were in between.

Geodesic distance shows the number of relations that information can be effectively passed on in the shortest possible path or the simple walk from one project member to another.

Network centralisation is a network's variance in percentage compared to a same size star network recognised by its complete centralisation. High figures suggest a high concentration in a network with a few numbers of smaller groups.

Out degree centrality is the sum of sending connections from one project member to others. Members who have the most out degree tend to be the most influential member in a network.

In degree centrality is the sum of receiving connections from project members. Members who have the most in degree tend to be the most prominent member in a network.

Clustering coefficient suggest the average densities of all members' local adjacent neighbourhood that affects the efficiency of inter-organisational knowledge transfer and management.

Cliques are groups of project members who have all possible direct ties and create a maximum complete subgroup.

Ego network size of a project member is calculated from the number of one-step out nodes in project member's neighbourhood.

Ego network density is the number of present ties divided by the number of all possible ties.

Brokerage score suggests the number of pairs not directly connected in a project member's ego network. A high number means it is very likely that a broker is needed to perform one of five categories of combination from coordinator, gatekeeper, representative, consultant, and liaison to create links among members.

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