ความสัมพันธ์ในคณะทำงานและการจัดการความรู้ของโครงการก่อสร้างในประเทศไทย
ภาคที่ 2: การศึกษากระบวนการจัดการความรู้และ
กรอบบันไดสามขั้นเพื่อบรรลุถึงการบริหารจัดการโครงการอย่างมีประสิทธิภาพ

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

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บทคัดย่อ

การศึกษาความสัมพันธ์แบบเครือข่ายในคณะทำงานโดยใช้โปรแกรม UCINET ในบทความภาคที่ 1 นั้น ได้รับแรงบันดาลใจจากปัญหาที่เกิดจากโครงสร้างแบบแยกส่วนของคณะทำงานพัฒนาโครงการก่อสร้าง บทความในภาคที่ 2 นี้จะได้กล่าวถึงปัญหาสำคัญอีกประการหนึ่งซึ่งเกิดจากขั้นตอนการทำงานที่มากมายที่ทำให้ประสิทธิภาพในการพัฒนาโครงการลดลง การแก้ไขปัญหาด้วยกระบวนการการจัดการความรู้ เป็นอีกแนวทางหนึ่งที่จะช่วยเพิ่มประสิทธิภาพในการพัฒนาโครงการโดยเฉพาะอย่างยิ่งในประเทศไทย โดยเริ่มจากการสัมภาษณ์ผู้แทนองค์กรที่มีบทบาทอย่างสูงในการพัฒนาโครงการที่พักอาศัยเชิงพาณิชย์ขนาดใหญ่ในย่านธุรกิจใจกลางกรุงเทพมหานคร ให้ประสบความสำเร็จเมื่อเร็ว ๆ นี้ โดยใช้ชุดคำถามมาตรฐานเกี่ยวกับกระบวนการการจัดการความรู้ขององค์กร ข้อมูลดังกล่าวจะนำไปวิเคราะห์โดยใช้แบบจำลองการแปรสภาพของความรู้ (knowledge conversion model) โดย Nonaka และ Takeuchi (1995) ผลจากการวิเคราะห์แสดงให้เห็นถึงประสิทธิภาพในการจัดการความรู้ในระดับปานกลาง อันสืบเนื่องมาจากการขาดความรู้ความเข้าใจเกี่ยวกับศักยภาพในการก่อให้เกิดประโยชน์ขององค์ความรู้ บทความชิ้นนี้ยังได้นำเสนอกรอบการปฏิบัติสามขั้นตอน โดยเริ่มจากการจำแนกผู้ที่เป็นหลักในการพัฒนาโครงการ การเสริมสร้างความสัมพันธ์แบบเครือข่าย

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และการปรับปรุงความสามารถในการจัดการความรู้ขององค์กร
เพื่อเพิ่มประสิทธิภาพในการพัฒนาโครงการโดยรวม

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.

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 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 degree centralisation. The second level of network relationship belonged to individual project member including centrality, clustering coefficients while the third level of relationship like cliques, ego network and brokerage was at subgroup level.

This second part article is about the organisational knowledge management in selected projects that is composed of two core activities knowledge creation and transfer as another significant approach to improve learning difficulties in order to increase the construction industry's competitiveness. It also includes the proposed three-stage framework to improve network relationship and the effectiveness of knowledge management.

2. Definition of knowledge

Knowledge is information or data structured into a meaningful composite model that can be used in a predictive manner (Morris and 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.

3.   Knowledge creation and transfer

Knowledge can be created from activities in formal and informal communicative events within and between people (Fruchter & Demian, 2005). As suggested by Handy (1991), it can be achieved through the cyclical four-step wheel of learning (Figure 1).

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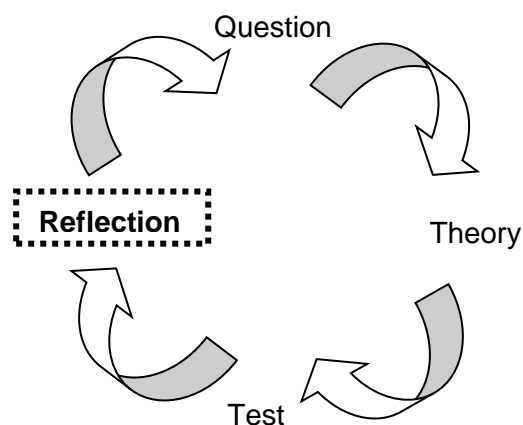
Source: Handy (1991)

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 is initially limited to tackle only obvious problematic factors as seen in the *single loop learning* approach introduced by Argyris and Schön (1974). In this case, governing variables that are the actual causes of the problems are not

included. 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 governing

variables. It can be seen as additional balancing feedback cycle in the *double loop learning* to create a

holistic view of the event even though it might cause some delay to the whole process.

Another theory that recognises the crucial role of interpersonal communication to create new

knowledge is the widely regarded Nonaka & Takeuchi's (1995) progressive spiral four-mode knowledge

conversion model (Figure 2). In this case, knowledge is treated as organic assets with the potential to grow

and switch between explicit and tacit forms throughout a project's life.

Figure 2: Four modes of knowledge conversion
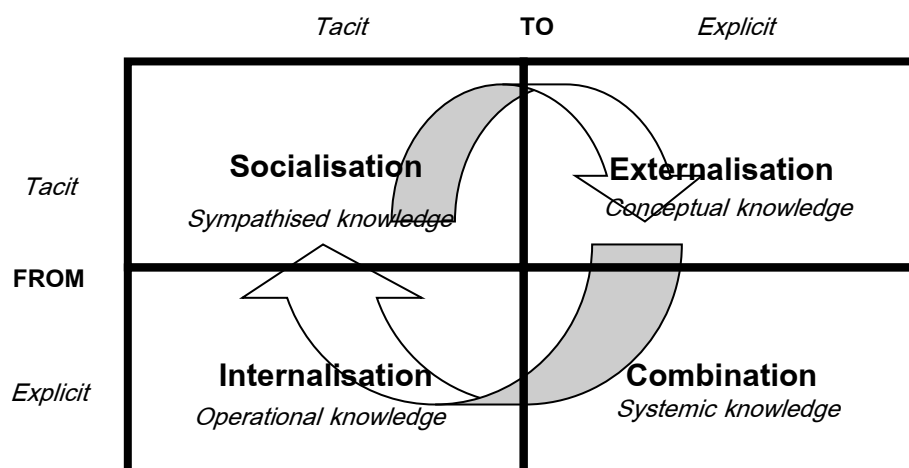

Source: Nonaka & Takeuchi (1995)

At the **socialisation** stage, multidisciplinary project participants are given opportunities to take part

in knowledge activities to communicate and contribute their diverse skills and experiences as well as a

mental model. As a result, *sympathised knowledge* is created. At the **externalisation** stage, interpersonal

contacts through dialogue and discussion among team members in an open and merit valued environment continue to transform sympathised knowledge into *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* 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.

4. Knowledge management

The 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.

Figure 3: The comprehensive process of knowledge management
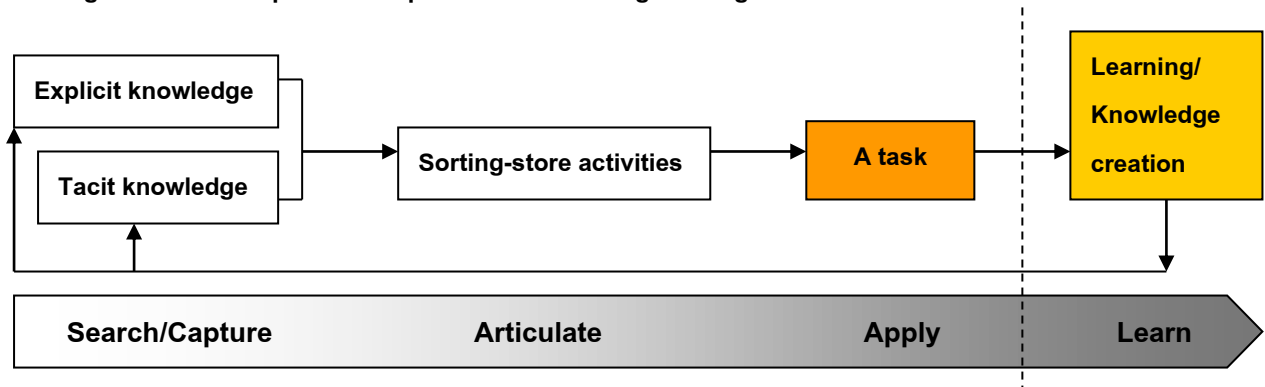
Knowledge management process starts after the completion of a knowledge audit to identify the availability of tacit and explicit knowledge. Knowledge that is still required can be searched and captured from various sources. Newly acquired knowledge has to be systematically sorted, articulated and fused 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 to permanently establish a knowledge culture. 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.

5. Knowledge management in selected projects at socialisation stage

According to 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 [1] [2] should be encouraged to participate in knowledge activities at *socialisation stage* such as education and training programmes to create tacit sympathised knowledge. The real practice by key members of project appraisal development teams collected from semi-structured interviews were as follow.

5.1 Client organisations

It was found that client's extensive connections with other team members played a very influential role in the knowledge creation and sharing. It was also the supportive environment that consistently nurtured two-way collaboration to encourage the creation of tacit sympathised knowledge. In Case L, there were socialising activities like continuous professional practice 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.

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1 Projects OTL and PMR developed by Case S1; projects LKS and LGN developed by Case R; projects YKT and SKV10 developed by Case S2, projects SUB and NTW developed by Case L; projects BKK and ADRS developed by Case A

2 Abbreviations were used to preserve research participants'' privacy.

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.

5.2 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 practicing in a team of two or three members working 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 create new knowledge and to strengthen connections among team members. In both HNT and PLN cases, formal and direct education and training were not seen as the main approach to improve architects' performance due to the lack of time. As creative agents, distinctive new ideas were always welcome in most organisations. However, extreme designs were unlikely to be fully accepted and implemented without proof of practicality to fulfill client's requirements. Fierce rivalry among fellow staff, on the other hand, was also not fully encouraged. Good performance was recognised and rewarded by bonuses and promotions. In some cases, newly enhanced knowledge from free trips abroad can be shared

by the awarded distinctive and long serving employees. Unfortunately, there was no direct collaboration with higher education or research institutes.

Knowledge management strategy and practice in foreign based 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, as suggested by SJL staff, due to work commitments. At WBT, 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. 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. Passive learning to get new ideas and inspiration was achieved by studying from publications, websites and other media.

5.3 Legal consultant and planning authority

Generally, in-house department of the established property development company performs basic legal administration. Only Case R 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. The widely encouraged

learning by doing was supported by an extensive collection of legal forms and agreements available from the company's database. Formal education and training were also organised at both local and international levels. Annual performance evaluation was based on information collected from every parties involved including head of departments and fellow team members.

Bureaucratic working process in the influential planning authority 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. Only certain employees who have closely collaborated with highly experienced heads of departments who are also knowledge champions would be able to learn from informal apprentice coaching. Moreover, performance-based incentive schemes to encourage good performance are not taken seriously. As a result, staff working in such a non-competitive environment has not been fully motivated to learn to achieve their full capabilities. The constant fear of poor career prospect has significantly affected knowledge sharing practices, job satisfaction and staff morale.

5.4 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 found 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 passive formal education and training programmes mainly to improve general business skills

like time management or effective meetings. Technical knowledge had to be learned from attending sessions organised by specialists or professional organisations. In Case A that vice president (VP) was an influential project manager and an attentive knowledge champion who oversaw every aspect of a property development project from start to finish, activities that promote socialisation and the creation of sympathised knowledge were even more effectively adopted.

5.5 Engineering companies

The opportunity for building engineers to create and manage new knowledge at the appraisal stage was also likely to be limited. It is because they are normally recruited to contribute their skills and knowledge at design development stage once schematic design is mainly settled by client and architect. Representatives from small local companies like VG, PAS and GMT concluded that, in their firms, 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 in GMT case were only put into practice at lunch breaks. There was also little competition in small teams that only a few members working long hours together. In medium scale companies like ATC and RKV, learning from doing under the supervision of a team leader/ knowledge champion was also adopted. Personal coaching in two-way apprentice sessions was extensively and constantly applied only in ATC case. However, there was no plan to encourage individual sharing.

The implementation of knowledge creation and management activities in large international engineering firms like ECLS and MH was not totally different from smaller practices. For example, meetings

were usually organised around free slots in ECLS project engineers' busy schedule. Coaching was extensively adopted between senior engineers as knowledge champions and novices. New knowledge can also be created by attending both internal seminars regularly organised by HR department as well as by participating in educational programmes organised by professional organisations including the Engineering Institute of Thailand (EIT), Engineering Council and other agents like building material suppliers. Social activities to encourage the formation of team spirit especially at operation level like bowling games, trips or festive parties in MH case were still not formally planned. In most cases, teamwork with minimum competition was very much encouraged. Good performance by hard working staff was appropriately recognised and rewarded through annual promotions, bonus and company shares in PAS case. Also, only new ideas that proved viable and applicable in the commercial context were implemented. Like architectural design companies, there was infrequent connection with higher education institutes.

6.   Knowledge management in selected projects at externalisation and combination stages

Information collected from interviews confirmed that negotiation and brokering at externalisation stage are two key activities that transform sympathised to conceptual knowledge. Team members adopted overlap connection (Figure 4) in discussion, argument and critique that does not require each of them to compromise their interests or change their identity. The newly created conceptual knowledge can be later captured, accumulated and transformed into explicit form to become systemic knowledge in project appraisal and associated documents at combination stage to support effective communication among project members.

Figure 4: Overlap connection

Practice A   **Practice B**

Overlapped area
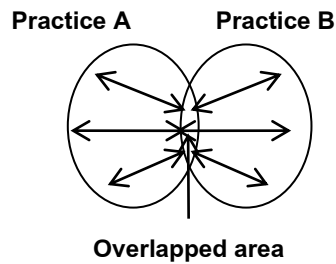
6.1   Client organisations

At externalisation stage, clients generally adopted overlap connection in both formal meetings and informal verbal communication. 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. Document management technology like Lotus Notes has been successfully incorporated in some cases. The information was subsequently analysed by customer relationship department and stored in the company's database system to be used in Case L later projects. In Case S1, however, the development of design database was not very successful 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.

6.2   Architectural design companies

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 are subsequently codified as explicit official documents that contain technical details for subsequent uses. However, the use of electronic media might not be fully effective in all cases without the efficient data

management system. Therefore, simple approach 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 badly executed concept, design or construction were posted with light-hearted comments that would not cause offences or conflicts. However, it was clearly noted by Case WBT that time available to produce explicit knowledge documents for future reference was usually limited.

6.3   Project management teams, legal consultant and planning authority

The nature of communication between project management team and building construction specialists using metaphors and analogies was similar to the one adopted by financial and investment departments. In ANO legal practice, the use of verbal and written language had to be in context to convey the exact meanings. Written documents like project progress report were stored to be searched, retrieved and passed on using the latest information technology. Verbal and written communications were also widely used by the planning authority working under Bangkok Metropolitan Administration (BMA). However, the scope of communication with larger number of people working on site was definitely more extensive.

6.4   Engineering companies

Negotiation and brokering activities among project engineers to develop problem solutions were not completely different from the approaches adopted by architects. In small companies like VG and PAS, verbal communication was the main approach to pass on ideas, metaphors, analogies and concepts. All larger companies can truly make use of electronic media such as emails and various forms of digital documents to convey abstract ideas as well as to manage general project information. However, quality and quantity of such codified information were still not at the highest standard. In Case GMT, for example, only a selected

collection of correspondences was kept for future reference due to the lack of time and encouragement.

There was only inconclusive written information available in some technical areas in Case MH.

7.   Knowledge management in selected projects at internalisation stage

7.1   Client organisations, project management teams, legal consultant and planning authority

From the interviews, it can be seen that both single loop and double loop learning approaches were adopted in most cases to learn and create tacit operational knowledge via reflection of the experience using systemic knowledge to complete the tasks. Even though it was agreed that double loop approach was the ideal learning process. The capability to provide quick problem solutions made single loop approach popular among operation staff and executives in client organisations, as seen in Cases S1 and A. Since limited time and range of activities were available to support effective reflection and learning. It was significantly harder to achieve the effective creation and management of new tacit operational knowledge. In legal practice like ANO, only double loop learning that covered all relevant factors was considered. On the contrary, learning approach adopted by BMA's planning consent department was mainly single loop. In the long run, the inability to learn eventually made it increasingly difficult to achieve the sustainable creation and management of knowledge in planning control.

7.2   Architectural design companies

The scope of reflection adopted by foreign-based and local architectural practices were not considerably different from other project members. Foreign-based companies like SJL, WBT and PT usually opted for double loop with occasional application of single loop learning to create the best possible building design. In Case WBT, the preference of double loop learning was inspired by the effects of bad building

design, short-sighted construction management and low level of users' satisfaction. Therefore, comments and feedbacks from relevant parties were always thoroughly analysed. Local design-oriented architectural companies like HNT, PLN and REP also preferred the more conclusive double loop learning. However, the single loop approach that provides fast problem solution was never neglected in any cases.

7.3   Engineering companies

All engineering companies employed both single and double loop learning approaches to form a body of knowledge that can be used in future projects. However, written documents were not regularly produced as a medium to create new tacit knowledge in either small or large companies. In Case CWT, 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. The capacity of lessons learned, therefore, can only be indirectly seen or measured from the number of errors detected in contractors' feedback.

8.   The proposed three-stage framework to improve relationship, organisational knowledge management and project performance

Based on key network characteristics influenced by relationship among team members as well as knowledge management practice by members of project appraisal development teams, a three-stage framework (Figure 5) is proposed to improve inter-organisational knowledge creation and transfer that eventually affect the overall project development performance.

Figure 5:   The proposed three-stage framework to improve relationship and inter-organisational knowledge management activities

Stage 1
The identification and engagement of stakeholders

Examine the basic measures of
- **Existence** of key project members based on the analysis of project requirements
- **Strength** and **satisfaction** of relationship and engagement to the task

Low

High

Action required (Examples):
- **Recruit** extra or more experienced specialists.
- **Maintain** strong and/or strengthen relationship
- **Improve** weak and unsatisfactory relationship

Stage 2
The improvement of collaboration in network relationship

Examine further the measures of
- Network size
- Density
- Reciprocity
- Reachability
- Geodesic distance
- Degree centrality
- Clustering coefficients
- Cliques

Low

High

Action required (Examples):
- Increase network density
- Encourage mutual connections or reciprocity
- Keeps the level of reachability, reduce geodesic distance between central figures and other members through procurement system like prime contracting
- Extend scope of brokerage

Stage 3
The development of inter-organisational knowledge management

Examine the measures of knowledge management and stages
- Socialization
- Externalisation
- Combination
- Internalisation

Low

High

Action required (Examples):
- Improve knowledge awareness at strategic level
- Extend collaboration with specialists, professional organisations and research institutions over a series of projects.
- Change the scope of negotiation to boundary practice to create conceptual knowledge
- Employ the wider range of media, ICT tools to capture and disseminate systemised knowledge at every stage of development
- Analyse and choose the appropriate scope for learning and reflection
- Monitor, evaluate and reward knowledge management activities

Outcomes: (1) improved engagement, (2) stronger relationship and collaboration, (3) sharing of lessons learned leading to better project performance

Stage 1: The identification and engagement of stakeholders

In order to improve relationship and collaboration, it is important that the exact number of key project members who were involved in appraisal development has to be clearly identified. At this stage, the information on existence of relationship is recorded in binary system where 0 means non-existence and 1 means existence. Moreover, quality of relationship is also studied based on 5-level Likert scale with low scores suggesting weaker ties or low satisfaction and vice versa. The information can be used to extend scope of stakeholders' involvement and increase quality of relationship at stage 2.

Stage 2: The improvement of collaboration in network relationship

At this stage, existence and quality of relationship data from stage 1 is used to develop measures or plans to improve the team's collaboration. While weak and moderately strong links have to be strengthened to improve performance and satisfaction, missing links, at the same time, have to be reinstated. Other key project members who have not yet been fully involved in appraisal development process have to be included in appraisal development process. For example, independent financial consultant should be recruited at this early stage to provide impartial views on project investments and returns. Contributions from potential end users help the team to accurately specify the ever-changing functional requirements and preferences better than information from the company's database. 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 provide advanced knowledge and innovation to be used in architectural design and construction.

As a result, strong and reciprocal links can be created in a better connected network as reflected, firstly, in higher degree of *network density*. The most appropriate project procurement system can then be chosen to procure mutual constructive collaboration and knowledge sharing among key members and their *ego networks*. It can be seen from the increased 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. Out and in degree *centrality* can be used to promote each project member's current and potential capability of inter-organisational knowledge transfer. For example, 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.

<u>Stage 3</u>: The development of organisational knowledge management

In order to develop the more effective inter-organisational knowledge management strategy and application, current knowledge sharing and management practice among key project members at project appraisal development stage has to be analysed based on the spiral four-stage Nonaka & Takeuchi (1995) knowledge conversion model. As a result, a strategy has to be formulated to support knowledge management *process*. Firstly, knowledge sharing activities have to be formally endorsed at socialisation and externalisation stages. Effective approaches to capture and transform knowledge at combination stage have to be carefully chosen. At internalisation stage, scope of reflection has to support the creation of operational knowledge. Three other dimensions of knowledge management programme, suggested by Quintas (1997), also have to be explored in order to achieve the most effective knowledge management. Firstly, *organisation*

structure and culture have to be studied to reveal the mechanism that supports the creation of new knowledge especially via informal structure like Wenger's communities of practice (1998). *People*'s capability to create and transfer knowledge and *technology* that support knowledge management activities are the second and the third dimensions that need to be covered.

9. Conclusion

As seen from the articles part one and part two, network relationship among key project members and knowledge management at appraisal development stage are the two complementary factors that influence a construction project development performance. The part 1 article clearly identified how certain network characteristics can speed up or hinder the flow or exchange of information to create and transfer new tacit and explicit knowledge. The lack of direction of inter-organisational knowledge management practices is also vividly clarified in part 2. A three-stage framework was introduced to improve the current uneven state of network relationship and knowledge management. Closer and stronger relationship that brings out the best knowledge contributions from extended range of stakeholders has to be the first two stages. Effects from the wider scope of relationship under the fully integrated procurement systems will improve some aspects of 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 scope of cooperation at socialisation stage can be extended to encourage the effective creation of sympathised knowledge. Collaborators at externalisation stage can be more closely involved in discussion and negotiation to create the more comprehensive

conceptual knowledge and develop each project member's cognitive characteristics. Systemic knowledge

can be better captured at combination stage with the more conclusive use of media. Appropriate time and

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 the internalisation stage to build up operational

knowledge. Led by strong leadership and readily available resources including IT system, long term learning

can be established to consistently create a well-managed body of knowledge to be used in future projects.

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