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Key knowledge factors in Thai construction practice

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Abstract

This research has mainly focused on the practice of knowledge management in Thai construction projects at the on-site work level. The main objective was to identify whether or not knowledge factors influence on-site execution of works. A combination of qualitative and quantitative approaches was employed. The focus group interview with 16 construction managers was conducted to gather in-depth information related to practice of project knowledge management. This data was used to develop the questionnaire to explore key knowledge factors. The questionnaire was sent to 103 participants in 70 construction projects in Thailand. The survey data were analyzed by factor analytic techniques to identify key knowledge factors influencing on-site construction works. The findings showed that there were six key knowledge factors: (1) visionary leadership, (2) reward or incentive, (3) collaboration, (4) trust, (5) information technology, and (6) individual competency or skills.

Keywords: Knowledge management; Knowledge factor; Thai construction practice; Construction manager; Construction project

1. Introduction

The construction industry, which is where the highest capital investment is made, is an intensely competitive business with a high risk and a low profit margin. It still encounters the issues of construction delays, cost overruns and delivery failures [2,4,16]. In Thailand and other developing countries, construction projects have inadequate and ineffective control strategies for project management problems. The operational modes of contractors are mainly based on sole ownership, headed by entrepreneurs lacking efficient expertise in construction management [4,17]. An individual's knowledge and experiences from preceding construction projects are important resources for subsequent projects because they facilitating innovative and interdisciplinary tasks [6,17]. At the end of any project, competencies and skills built up by the members of the project team should remain within the executing organizations and should be available for future projects. In current practice, when a project is completed, its project team members withdraw and disperse, meaning that existing knowledge can no longer be accessed. Project team members keep their knowledge and experience as individual knowledge, which they can use in future. Evidently, the most important factor inhibiting the successful completion of a construction project is the scarcity of skilled personnel at all levels especially supervisors [4,17]. However, most owners do not want to incur the expenditures of employing qualified professionals to compliment and enhance management competency.

Edum-Fotwe and McCaffer [9] reported that project managers in today's construction industry are facing a situation whereby the fundamental roles and functions they perform have witnessed a gradual shift in focus. To develop or maintain their professional competency and adapt to changing industrial environments, having adequate knowledge and skills are required and inevitable for practicing

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project managers during of the course of their training and experience [6,9]. The ability to manage and use the knowledge of the project team is becoming highly valuable. The use of knowledge in organizations has been increasingly seen as a basis for enhancing a competitive advantage [3,10,12]. Challenges therefore lie in the means of managing knowledge resources and capabilities, contributing to project success and sustained organizational competitiveness. Various studies show the value of knowledge management in improving both construction organization and project performance.

Previous research has found that organizational creativity is critical for improving organizational performance [10,13]. However, in the construction field, there is limited evidence showed that knowledge management improves either organizational performance or project performance. The study of knowledge management in construction projects is still in its infancy, particularly in Thailand. No Thai studies have investigated how construction companies use knowledge to improve their organizational performance or project team performance. What is lacking in the Thai construction industry therefore is a comprehensive understanding of important knowledge factors such as individual and organizational factors. This study objective is to identify key knowledge factors influencing on-site construction.

2. Background

2.1. Knowledge management in construction project

Knowledge is one of the most important resources for both managerial decision-making and the competitive advantage of any organization. Knowledge is information, which has been used and becomes a part of an individual's experience base and behavioral patterns [2,7,8]. Individuals however have a differing knowledge-based capacities and experiences thus leading to different problem solving processes and decision-makings. The emergence of information and communication technology has set in motion a new wave of knowledge management for industrial organizations, technology management, strategic management, and organizational theory.

Knowledge has a number of dimensions, including explicit, implicit, and tacit [12]. Tacit knowledge is associated with terms such as "skill," "know-how," "working knowledge," and "expertise" that are used to describe knowledge of the ability necessary to perform work. Learning that takes place through apprenticeships draws heavily on tacit knowledge. It has been connected with informal learning and organization learning. There are conceptual differences in tacit knowledge.

Tacit knowledge is an important element in work and workplace learning. Existing empirical research on tacit knowledge has been technologically driven; there is a need to explore the people dimension [21]. Recently, tacit knowledge has been recognized as an important phenomenon and its role in knowledge management has been explored. There are conceptual dichotomies of tacit knowledge. Polanyi (1966) explained tacit knowledge as "we know more than we can express." [21]. Polanyi's theory of tacit knowledge constitutes the starting point for much of the KM literature [15]. Polanyi's thinking was the belief that the only way really to know anything is through personal experience. The fundamental basis of truth is always faith or belief, and that true knowledge is never based on reason. Truth can be discovered by a responsible investigator who uses his creative imagination to find and reveal a hidden reality [11]. Polanyi's original conception of tacit knowledge was that tacit knowledge was not a separate category of knowledge but rather an integral part of all knowing. Tacit knowledge is not explicit knowledge internalized. It is inseparable from explicit knowledge since tacit knowledge is the necessary component of all knowledge [24].

In contrast to Polanyi's view, Nonaka and Takeuchi [19] classified human knowledge into two kinds. One, referred to as explicit knowledge, can be articulated in formal language including grammatical statements, mathematical expressions, specifications, manuals, and so forth. This kind of knowledge can thus be transmitted across individuals formally and easily. The other, which is a more important kind of knowledge, is tacit knowledge, which is hard to articulate with formal language. This more or less refers to personal knowledge embedded in individuals and involves intangible factors such as personal belief, perspective, and values. Nonaka and Takeuchi [19] suggest that tacit knowledge is increasing being "recognized as playing a key role in form growth and economic competitiveness" [14]. Although, there are different conceptual definitions of tacit knowledge, there is agreement on the difficulty of sharing tacit knowledge among groups and individuals. Experience is identified as being a main source of tacit knowledge creation [19,21]. At work, on-the-job training and informal learning are important means of knowledge acquisition [14]. Argyris [1] notes the contradictory duality of tacit knowledge suggesting it is both the basis of successful management, and of defensive routine.

In the construction area, tacit knowledge or competency is the implicit knowledge used by team members to perform their work through adaptation into their specific environments and scenarios [6,16,19]. It is knowledge that is encoded and difficult to diffuse. It is also hard to verbalize since it is expressed in action-based skills and thus, cannot be reduced to rules and recipes. Tacit knowledge is learned through extended periods of experience and repetitive performance of tasks, during which the individual develops the capacity to make intuitive judgments about the successful execution of construction project such as tasks. Tacit knowledge is vital to construction projects which can only learn and innovate by leveraging on the implicit knowledge of its members.

Despite being encoded, tacit knowledge can be and is regularly taught and shared. Nonaka and Takeuchi [19] stated that organizational knowledge creation is a process that amplifies the knowledge created by individuals and

crystallizes it as a part of a knowledge network. There are two sets of dynamics that drive the process of knowledge amplification: (1) converting between tacit knowledge and explicit knowledge and (2) moving knowledge among individuals, groups and also, at an organization level. Nonaka and Takeuchi [19] explained that the knowledge creation process is composed of four modes which are created through the interaction and conversion between tacit and explicit knowledge. The four modes are socialization, externalization, combination, and internalization (SECI model).

Project management skills consist of technical skills and personal skills. A technical skill is considered as the ability to use tools, techniques, and specialized knowledge to execute a method, process, or procedure. On the other hand, personal skills encompass attributes of leadership, negotiation, communication, and problem solving. In this context, leadership covers three main areas: project, technical, and team leadership. Many dimensions for communication by the project manager often require the skills of writing, speech, and listening. Finally, problem solving skills encompass a combination of problem definition and decision-making related to problems that have already occurred [9].

3. Research method

The research methodological framework follows five steps, which are: (1) pre-survey to identify of knowledge factors; (2) questionnaire design; (3) data collection; (4) data analysis; and (5) conclusion and discussion.

3.1. Pre-survey

The purpose of the pre-survey was to gather input from construction experts to design the questionnaire in the second step. The pre-survey was conducted at construction sites in Bangkok and suburban areas by interviewing study participants and by site observations. The inclusion criterion for experts was a minimum of 20 years of working experience in the construction area. There were 20 senior construction managers qualified and selected to share their experiences. After briefing and discussion of the details of this study, of these experts, 16 senior construction managers voluntarily participated in the nominal technique of a focus group series of sessions [22]. They had extensive and eminent experience. The others opted to participate later in the personal interviews as they could not fully commit to the proposed schedules due to their own time constraints. The authors used the open-ended questionnaire for interviewing 16 construction experts during the first and second visits. Detailed descriptions were as follow.

3.1.1. First visit

The 16 experts responded to the open-ended questions almost similarly. Collected data were categorized. Five emerging themes determined through the use of interviews were collaboration, centralization, formalization, learning, and trustworthiness.

3.1.2. Second visit

All themes generated from the first interview were summarized and re-administered to the construction managers for confirmation and field notes were taken during this process. For the second visit, the researcher questioned the construction experts on activities that had an impact on knowledge factors in their respective construction projects. Thereafter, the researcher confirmed these responses by making direct field observations. The observation process involved actual observation of items that needed to be examined and recorded for better understanding of the construction context, and it also included noting of the environment around the observed areas. All the ideas generated by the experts were summarized into 52 brief statements which were further used to design the questionnaire.

3.2. Questionnaire design

Measurement was considered a crucial element in this step. Considering that only a few measures of knowledge management were readily available and adaptable to the Thai construction industry, the researcher had to develop an appropriate instrument or modify an existing one. For the purpose of this research, the questionnaire was designed to measure key knowledge factors used by a construction management team. The questionnaire was in a self-report format and used a five-point Likert scale for each item. The scale ranged from "1 = very low" to "5 = very high". The questionnaire consisted of two parts as follows:

Part I: this included questions related to demographic data of the respondents and characteristics of the construction firms.
Part II: this included a total of 52 items under four subscales which inquired on current practices and adaptation of knowledge factors in construction projects. The researcher validated the questionnaire's content by using content experts. The four subscales were:

1. *Measurement of organizational structure (18 items):* the respondents were asked to indicate the extent to which they perceived their visionary leadership, organizations' structure, roles, functions, etc.
2. *Measurement of corporate culture (24 items):* corporate culture, which is considered as one of the most important factors for successful of knowledge management, defines not only the value of knowledge but also places emphasis on its retention within an organization for sustainable innovations. The right culture facilitates the sharing of knowledge. The 24 items of culture factors measured communication, incentives or rewards, learning, knowledge networks, collaboration, and trust.
3. *Measurement of information and communication technology (ICT) infrastructure (5 items):* the infrastructure of ICT supports knowledge management and as such, respondents were requested to express their perception

of the extent to which the available and existing technology benefits team members on the construction site. Such benefits are with respect to the use of retrieved information and knowledge for decision-making and the ability to share the same with other team members.

4. *Measurement of individual (5 items):* the human factor is considered as one of the most influential factors that can impact project team creativity. Personal competence is vital to creating organizational knowledge during the execution of tasks. Technical and cognitive skills were the two dimensions of tacit knowledge perceived in construction team members. Where the technical dimension is defined as informal personal skills or know-how, the cognitive dimension consists of beliefs, ideas, values, schemata, and mental model.

3.3. Sampling frame and sample size estimate

The investigator obtained the roster of potential respondents who are members of the Thai Contractors Association under the H.M. The King's Patronage Directory 2004 and professional networks. Based on data analysis using factor analysis, no fewer than 100 individual per analysis were proposed [20]. Ratings as low as three subjects per variable are sometimes acceptable and another prospective 100 to 200 subjects are sufficient [20].

3.4. Data collection

The research study emphasized on the knowledge and experience utilized by construction engineers and therefore, to ensure the selection of a qualified sample, the total of 150 construction companies were invited to participate. Of this total, only 46 companies agreed to be involved in the study. The researcher asked these 46 construction companies to propose their construction projects as a case in point, to identify knowledge management practices. Some companies proposed one project and others proposed two. As a result, a total of 71 construction projects were selected to identify knowledge management practices. These 71 projects consisted of the following types of constructions: infrastructure – 57.7% (41), office – 15.5% (11), residential – 15.5% (11), and factory – 11.3% (8). Project managers and project engineers from these construction projects were given a brief description of the research study and its aims. The researcher then explained about the questionnaires prior to handing them over for a response. A total of 45 project managers and 58 project engineers completed this questionnaire.

3.5. Description of sample demographics

Table 1 summarizes the descriptive data of the characteristics of all 103 participants. They generally represented a cross-section of the country in terms of age, gender, education, engineering discipline, and years of experience. The age of the construction engineers ranged from 31 years to 63 years with a mean age of 40.46 years (SD = 6.96). Most participants were male ($n = 101$, 98.1%). Years of experience in engineering ranged from 10 to 40 years ($M = 17.16$, SD = 6.66). The majority of the sample had a bachelor's degree ($n = 77$, 74.8%). Finally, civil works represented the most common discipline ($n = 66$, 64.1%).

Table 1
Demographics data of the study participants ($n = 103$).

Variables	*M*
Age (in years)	40.46 (SD = 6.96)
Years in current company	7.49 (SD = 5.65)
Years in experiences	17.16 (SD = 6.66)
Education	
Bachelor's	77 (74.8%)
Master's	26 (25.2%)
Position	
Project engineer	58 (56.3%)
Project manager	45 (43.7%)
Primary discipline	
Architectural	3 (2.9%)
Structural engineer	12 (11.7%)
Civil engineer	66 (64.1%)
Mechanical engineer	12 (11.7%)
Electrical engineer	6 (5.8%)
Others	4 (3.9%)

Note: *M* = mean, SD = standard deviation, excluding education, position, and primary discipline present in (%).

3.6. Data analysis

The SPSS 11.5 program was used to analyze the data and testing for the *psychometric properties of the questionnaire*. Pett et al. [20], recommended that the researcher examine the correlation matrix closely for item consistency and also to identify items that are either too highly correlated ($r \geqslant 0.80$) or not correlated sufficiently ($r \leqslant 0.30$) with one another. If items were too highly correlated, they had a problem with multicolinearity and the researcher may consider dropping one or more of the highly correlated items from the analysis. If the item was not correlated strongly enough, there will not be much shared common variance thus potentially yielding too few items. Correlation matrix and multicollinearity testing were carried out. There were a total 47 items remaining under four subscales.

Exploratory factor analysis with item analysis was used to examine the construct's validity and the reliability of the questionnaire. The Cronbach's alpha of each item and of all items were computed to examine the reliability of the instrument. A higher cutoff of 0.7 was used because the instrument was newly developed. All constructs had reliability higher than the 0.7 cutoff alpha values, ranging from 0.7 to 0.9. As suggested by the cutoff, the questionnaire demonstrated an acceptable reliability for each subscale, supporting the use of this questionnaire in a Thai construction project. The performance of the questionnaire at the

group level was done by item analysis technique, including the examination of item-to-total correlations. Seven items for knowledge factors relating to item-to-total correlation less than 0.4 were dropped [13,20].

Factor analysis with Varimax was performed to identify key knowledge factors and check the unidimensionality among items. Each variable was measured by multi-item constructs. One approach for determining the numbers of initial factors is to select only those factors with eigenvalues >1.00. This means that these factors would account for more than their share of the total variance in the items [20]. Items with factor loading value <0.5 were deleted [13,20]. There were 4 items with factor loadings <0.5 for the knowledge factors.

4. Naming the key knowledge factors

Table 2 presents the rotation of six knowledge factors under four subscales: visionary leadership, corporate culture (*reward or incentive, collaboration, trust*), information communication technology, and individual competency. The first factor, *visionary leadership*, emphasized on clear and/or written policies, as these are considered crucial to guide the construction team members to promote a culture of learning and knowledge sharing. The second factor, *reward* or *incentive,* was characterized by a higher weighting on monetary incentives. The third factor, *collaboration*, indicates the degree of willingness to collaborate. The fourth factor, *trust* as reciprocal faith in other members was perceived to be significant among team members. The fifth factor, *information and communication technology* (ICT) was regarded as a facilitative tool to capture and access knowledge in the real time. IT facilitates accomplishing the benefits of increasing information technology development in response to shorter product cycles and also helps to speed up decision-making in a project team. It is also a well known fact that information technology strongly supports improved communication. The sixth factor, *individual competency or skills,* includes the set of skills necessary to perform construction work effectively.

Table 2
Varimax rotated component matrix of knowledge factors ($n = 103$).

Naming	Items	Factor loading
Visionary Leadership (8 items)	Clear or written policies	0.680
	Culture to promote knowledge sharing	0.653
	Program to improve workers	0.644
	Strategic alliance	0.650
	Instantaneous and independent decision-making	0.501
	Formal training programs	0.637
	Informal individual development	0.512
	Attending seminars, symposia	0.633
Incentive or Reward (4 items)	Admire the team	0.671
	Value given to specialist	0.719
	Monetary incentives	0.722
	Non-monetary incentive promotion	0.601
Collaboration (5 items)	Degree of collaboration	0.548
	Supportive team members	0.641
	Helpful members	0.599
	Willingness to collaboration	0.615
	Voluntary suggestions about others' tasks	0.605
Trust (8 items)	Encouraged to ask external experts	0.551
	Willingness to accept mistakes	0.530
	Trustworthiness	0.662
	Reciprocal faith in other members	0.829
	Reciprocal faith in others' ability	0.788
	Reciprocal faith in others' behaviors to work toward organizational goals	0.675
	Reciprocal faith in others' and towards the organization than individual	0.754
	Relationship based on reciprocal faith	0.556
Information Technology (5 items)	IT support for collaboration	0.773
	IT support for communication	0.828
	IT support for searching and accessing	0.814
	IT support for simulation and intuition	0.731
	IT support for systematic storing	0.689
Individual Competency or Skills (6 items)	Using criteria for assessing performance	0.655
	Formal contacts or planning	0.647
	Applying the rules with flexible and adaptable capability	0.680
	Understanding others' tasks	0.820
	Communicating well with their groups	0.557
	Specialists on their own parts	0.645

Note: the above-listed factors will be elaborated in detail below in order to comprehend the concept behind each.

5. Discussion

5.1. Visionary leadership

The first factor, *visionary leadership* emphasizes clear and/or written policies with the highest factor loading of 0.680. Leadership skills are crucial in guiding construction team members towards promoting a culture of learning and knowledge sharing vision or policies which are accepted by all levels of team members and require much inspiration for its realization. A common vision is important for the construction team to surpass limitations of existing capabilities and to gain a competitive advantage by aiming for new markets. The project manager as a leader of a construction project must take the initiative in nurturing the knowledge management culture for knowledge sharing and creation. This can be realized if leaders clearly articulate the value of knowledge management initiatives or the knowledge management program.

Management of a construction project in the knowledge age is about managing tacit knowledge to increase the speed of innovation. The keyword associated with leadership which emerged in this study is "vision". The ability to inspire the team was required for high-level leadership skills. Project managers and project engineers should have leadership skills because their positions

demand the need for decision-making concerning project performance, particularly financial control and budgeting. Group leaders were basically selected based on the subcontractors. A good leader is required to be aware of the qualifications of their workers and their performances as well.

Visionary leaderships established strategic alliance and can be generally categorized under two themes: (1) a network of experts working in the same field but in different firms, such as subcontractors and friends. It was frequently noted that this group shared tacit knowledge to improve their work: (2) networks of experts from diverse backgrounds. These networks included random contact sources called on to identify potential collaborations. Networks and partnerships can support new products' development or new construction methods. For instance, by sharing of information between suppliers, subcontractors and the main contractor, a new technology for diaphragm wall construction could be shared and learned. Networks still provides a means of building trust and understanding, as well as spreading knowledge and intelligence.

5.2. Incentive

The second factor, *reward* or *incentive*, was characterized by a higher weighting on the monetary incentives (0.722). Organizations currently compensate employees based on the value and knowledge they add to the organization. Other employees get paid for skills, special skills, exceptional performance, and competencies. Almost every organization tends to 'buy' knowledge. They achieve this through two means: (1) hiring employees, putting the right man on the right job, and giving them wages based on the company's salary scale, and (2) employees are rewarded with higher salary based on the company's needs of their construction knowledge and special skills.

5.3. Collaboration

Fostering linkages among the construction team members is one of the most important elements of developing any synergetic working team [23]. This simply brings about unity in diversity and involves practices and actions fostering collaboration and joint working. It also involves developing team working formats or supporting and encouraging cultures, in taking other cultures forward.

Personnel in construction teams help one another during the course of work (supportive team members weigh 0.641). Collaborations among them lead to positive knowledge exchange, loss of fear, and increased openness towards one another. It also helps members to developing a shared understanding at on-site projects. With project managers creating a sense of trust and belonging among the team, there is a tendency and willingness to collaborate. Such collaboration with team members is an essential element as it leads to the willingness to share knowledge, information and ideas.

5.4. Trust

It is easier said than done to connect tacit knowledge to explicit knowledge and to easily transfer the same among the members. Particular skills and experience involved in such a process do not present themselves in codified documentations. Thus, a simple form of communication is not effective. The instinctive resistance to change and the need for trust are considered important. Trust is one of the most valuable and vulnerable assets of any construction team. When team members trust one another, they can work through disagreements or conflicts, either in a personal or professional context. With trust, construction managers and team members work with a single purpose towards achieving positive construction performance. The trust in team members was seen to be defined as the reciprocal faith in one another to complete the task in the area of expertise (0.829), either by themselves or by assigning an appropriate person. Over a longer term, trust may be the most significant determinant of a construction team's success.

5.5. Information and communication technology

A broad array of IT solutions exists for archiving and retrieving information, supporting collaborations, and searching web-based engines for information. The results showed that cell phone systems were clearly an equally important enabler of communication (0.828), especially for the purpose of effective engineering management within different regions, between the construction site and the site office, and between on-site construction engineers and experts. Information technology facilitated the capture and access to knowledge in real time. The benefits of improving the information technology development are being equipped for shorter production cycles and to speeding up decision-making within the project team.

5.6. Individual competency

Competency is the set of skills that a construction manager can exploit to carry out a given task. Concentrating on individual knowledge (learning or utilizing), is the foundation of construction project success [5,6]. Items such as understanding each other's tasks were given the highest loading factor of 0.820. Such skills depend on the capability of individual specialists to sustain a meaningful and synergistic conversation with each other. These capabilities go beyond the mere social skills of tolerance of different perspectives to specific cognitive skills. Rather, knowledge management in construction projects recognizes the ability of individuals to utilize knowledge. Teams could utilize this knowledge (such as engineering and technical skills) even more than the specialists would on their own.

A project management team requires an expertise body of knowledge. Project team management skills are critical factors, which influence a product team's ability to acquire and utilize such knowledge in improving their probability

of success. Davenport [7,8] argued that successful management of the human factors are the key to achieving dramatic gains in knowledge development. Similarly, Dainty *et al.,* [6] suggested that effective knowledge transfer depends upon high skill and competence.

6. Conclusion

This research established that construction managers use key knowledge factors to improve project performance by construction managers. Thai construction managers are seen to emphasize individual competency or tacit knowledge. Their flexible thoughts and engineering techniques were elements of tacit knowledge fundamental to fostering knowledge management and creativity. The strength of knowledge management rests on the vision and aspiration of construction managers in applying creativity in on-site knowledge practices [18]. By having appropriate and attractive incentives, competent project teams were brought in to utilize and generate new knowledge in the form of problem solving. Making knowledge visible requires, the competency in using ICT to convert conceptual ideas and packaged knowledge into obvious activities must be inherent. ICT is seen to facilitate the knowledge creation process by capturing knowledge in real time and thereafter making it accessible for future use. ICT greatly benefits construction projects in that it speeds up the project team's decision-making process and thus shortens the product life cycle. The knowledge creation process is seen to facilitate the improvement of project performance. In conclusion, successful execution of construction projects requires project managers to consider the three important factors mentioned above.

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