

**Master of Science in Engineering**

**Construction Knowledge Management  
focusing on Acquisition Types**

**by**

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## **Abstract**

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There was a strong Knowledge Management (KM) boom among the Korea Contracting firms in the late 1990s and the early 2000s. For the last ten years, Contracting firms have developed Knowledge Management System (KMS) and operated learning organizations since they realized the significance of managing knowledge to gain a competitive advantage over rival companies in today's fast-paced business environment. These efforts seem to have paid off. But the difficulties in evaluating the effectiveness of KM strategy make it hard to improve contracting firms' KM strategy. This

paper investigates how major Korea contracting firm's employees exploit knowledge in construction sites to assess effectiveness of KM. It adopts the AHP (Analytic Hierarchy Process) methodology to carry out a survey on construction site employees' knowledge acquisition route and the CA (Correspondence Analysis) to investigate the differences in knowledge acquisition route depending on employees' project type, position (rank) and profession in their construction sites.

The study finds that there is correlation between the pattern of knowledge acquisition and employees' attributes that are rank and occupational type. The results of case study showed some interesting implications and it could be useful and basic information to set the KM strategy in contracting firms

**Keywords:** Construction KM, KM Strategy, Knowledge transfer process, Knowledge acquisition route

**Student Number:** 2012-22531

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# **Chapter 1. Introduction**

In late 1990s, Knowledge Management (KM) had emerged as a buzzword all over the world. Because many companies realized the significance of managing intellectual resource and capabilities explicitly to gain a competitive advantage over rival companies in today's fast-paced business environment (Zack 1999). But recently, on account of construction business recession, Interest in KM is waning in spite of the importance of KM. Thus, this study proposes a strategic approach for setting KM strategy in restricted investment environment to help contracting firms.

## **1.1 Research Background**

KM refers to “a systematic and organizationally specified process for acquiring, organizing and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work” (Alavi & Leidner 1999). The importance of KM had emerged due to the characteristics of the construction industry (eg. Project-based, labor -intensive, etc.), which lead to the KM boom among the Korea Contracting firms during the early 2000s.

Over the past 10years, the domestic contracting firms have pushed KM to accumulate company knowledge and take advantage of it effectively in a variety of ways, such as developing knowledge management system (KMS), operating learning organizations and so on. They carried forward KM

initiatives actively, focused on developing system having support of executives at the beginning. But recently, the initiatives are implemented on a reduced scale, such as making up for the weak points of the system and operating small learning organizations.

The fact remains that KM is important. But lack of explicit examples that demonstrate the success of KM and construction business recession is blocking investment in KM. Thus, strategic approach is needed for more effective KM.

The study propose a strategic approach to help contracting firms set a efficient KM strategy by analyzing knowledge acquisition routes of engineers in construction sites.

## **1.2 Research Objective and Process**

In the establishment of knowledge management strategy, companies want to take a strategy which could obtain maximum performance with limited resources. Recently, on account of recession in construction business, Korea contracting firms cannot afford to invest heavily on KM. Therefore, KM requires more strategic approach.

To devise an effective KM strategy, it is necessary to measure the effectiveness of the former strategy. We could evaluate the effectiveness by analyzing sales and changes in profit, but the characteristic of construction industry that is affected more likely by external environmental variables, such as construction business market environment, make it harder to appraise.

This research proposes a method to analyze knowledge acquisition routes of engineers in construction sites, which could be an alternative to assess current status of KM in contracting firm. Analyzing this result, the research suggests a strategic approach to establish an effective KM strategy.

The focus on practical aspects of KM leads to define knowledge as information which is integrated in our minds during which individuals understand and find a solution to a particular problem. In accordance with this reason, the target of this research is construction sites, where knowledge is applied and scope of knowledge is limited to construction-related knowledge (eg. Architectural, electrical, mechanical, civil, landscape) in the construction sites.

The research methods and process are as follows.

(1) Redefine knowledge, by which apprehend characteristics of construction KM and strategy by the review of literature.

(2) Analyze characteristics of knowledge transfer process according to knowledge strategy classification.

(3) Propose a method to analyze knowledge acquisition routes, which could turn out basic data for setting the direction of strategy.

(4) Do case analysis and propose a strategic approach for KM in contracting firms based on the result of survey and analysis.

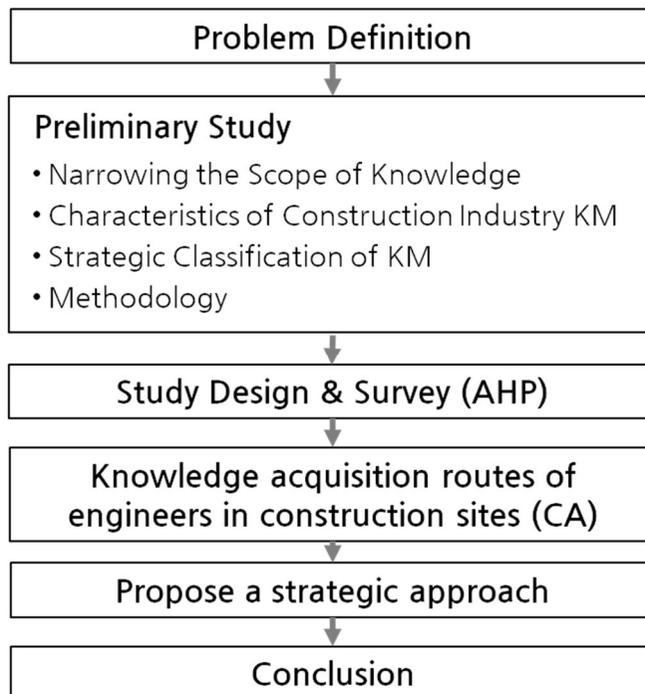


Figure 1-1 Research Process

## **Chapter 2. Preliminary Study**

Many researchers have defined knowledge diversely (Dretske 1981; Fahey and Prusak 1998; Huber 1991). Thus, knowledge has to be predefined before considering KM strategy to narrow the scope of knowledge for this study. In this chapter, after narrowing the scope of knowledge, we investigate the characteristics of construction industry KM and choose the strategic classification of KM, based on these characteristics of construction industry KM. And we propose a methodology for analyzing for knowledge acquisition routes of engineers in contracting firm.

### **2.1 Narrowing the Scope of Knowledge**

Definition of knowledge has mostly revolved around the relationship among data, information and knowledge. Although knowledge is universally accepted as authenticated information, Alavi & Leidner(2001) asserted that knowledge is personalized information which is embedded in the mind of individual. Because there is not an evident criteria to distinguish between information and knowledge, such as context, structure, accuracy or utility. This perspective on knowledge correspond with Fahey and Prusak(1998)'s and Tuomi(1999)'s. And Ruan(2012) suggested two preconditions for knowledge. First, knowledge only exist individual's brain and should be integrated and second, knowledge should be used to achieve a certain goal.

We agree with this view, but exclude information which is not integrated into employee's mind and not applied to solve a particular problem in a construction project, even though it is accumulated on the company's KMS in the light of practical perspective. Thus the study define knowledge as information which is integrated into one's mind in the process of understanding a particular problem and finding solutions, and applied to solve a problem. For this reason, investigation for knowledge acquisition route of engineers is carried out by survey methodology.

## **2.2 Characteristics of Construction Industry KM**

Construction industry has different characteristics in KM. First, construction industry is a project-based industry. Multiple stakeholders participate in a project during a relatively short period of time. So, members of a project team might be short of mutual social awareness, commitment to a common goal, shared performance norms, and equal liability for the outcomes (Mäkilouko, 2004).

Second, construction industry is a labor-intensive industry. Labor-intensive characteristic gives project members greater autonomy in solving lots of problems which come up while carrying out project (Hobday, 2000). For this reason, without any conscious effort for internalization of each employee, employees keep on making the same mistakes which is distributed to prevent the recurrence of accidents recognized in other project over and over again. Thus the second characteristic of construction industry KM is the importance of internalization.

Third, construction industry features very competitive market environment for low profit (Carrillo & Chinowsky 2006). Because each stakeholder exerts themselves to maximize their profit at a given margin, it expedites a competitive atmosphere in the project.

On account of these characteristics, management of internalization efforts of each individual and knowledge transfer between the stakeholders is as important as construction of ICT(Information Communication Technology) system.

## **2.3 Strategic Classification of KM for Construction**

### **Industry**

Strategy is military word, which means a way to plan, organize, and conduct a battle for victory in a war. The word has wider application in the nonmilitary fields, such as business strategy to survive in a rapidly changing circumstance. Henry Mintzberg (1978) defined strategy as “a pattern in a stream of decisions”. If we add the necessity concept of strategy to this definition, company strategy is a consistent pattern or rule in a stream of decisions to achieve their goals.

The reason why companies need strategy is the limitation of resources which is available to gain and maintain a competitive advantage over rival companies in today’s fast-paced business environment. When it comes to construction industry, the significance of strategy becomes more prominent due to the very competitive market environment for low profit (Carrillo and Chinowsky, 2006). Companies’ KM strategy also has a strong influence on gaining and maintaining its competitive advantage since knowledge is strategic resource.

As shown in Table 1-1, KM strategies were presented in various ways. Each researcher proposes a dichotomous classification.

First, March(1991) considered the effect of KM, which is focused on exploration or exploitation, on organizational learning. Hansen et al.(1999) classified KM strategy into codification and personalization and emphasized the balance of the two strategy. Ho et al.(2011), meanwhile, categorized

strategy according to allocation of cost, which is investment to ICT platform or compensation of each individual's effort and shows the benefit and cost numerically for each case. Carrillo & Chinowsky(2006), Choi & Lee(2003), McElory(2003) suggest the classification of KM strategy according to knowledge carrier(IT or Human).

Table 1-1 Knowledge Management Strategy

Author	Strategy	Criteria
March(1991)	Exploitation	Knowledge adaptive process (Create or Exploit)
	Exploration	
Hansen etal. (1999)	Codification	Knowledge acquisition route
	Personalization	
Ho et al.(2011)	ICT platform	Allocation of cost (Game theory)
	Reward	
Carrillo(2006)	IT-centric	Knowledge carrier (IT or Human)
	HRM-centric	
Choi & Lee (2003)	System-oriented	
	Human-oriented	
McElory(2003)	First-generation	
	Second-generation	

As shown above, there are many classifications for KM strategy. But in this study, we would choose comprehensive classification which could reflect features of construction industry and construction site.

Management of internalization efforts of each individual and knowledge transfer between the stakeholders is important in construction sites, where a project is carried out relatively short period and knowledge exploitation is main process than knowledge exploration. Thus, strategic consideration is needed which is focused on individual's efforts and knowledge transfer between the stakeholders. For this reason, the study chooses the classification which categorized KM strategy into codification and personalization strategy. Codified record generally means systems or the record which is transferred by IT tools, but the term "codification" is focused on individual's efforts and time for codifying knowledge, and could include publications. Thus, the study follows the strategic classification of Hansen et al.(1999).

## 2.4 Analysis Methodology

As shown in Figure 2-1, this research applies Analytic Hierarchy Process (AHP) to conduct a survey and CA (Correspondence Analysis) to analyze result of responses.

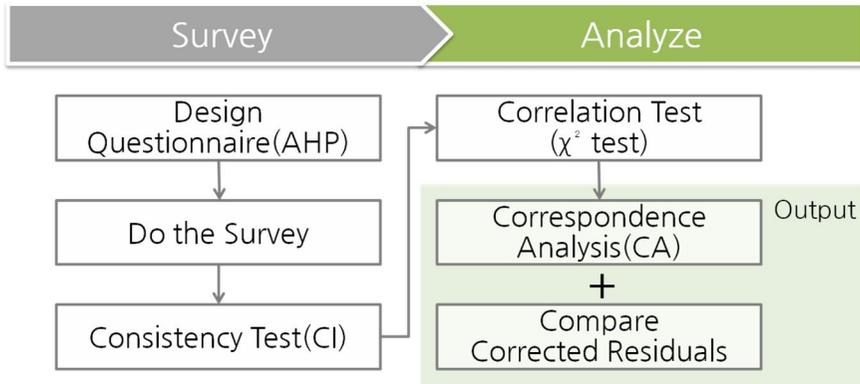


Figure 2-1 Methodology for analysis

AHP is a methodology which was developed by Saaty (1980) to calculate the importance of alternatives by hierarchical classification for a complicated system. One of the primary characteristics of AHP is pairwise comparison between the elements which affect decision making. This prioritizes alternatives and calculates relative weights of each alternative.

There are two reasons why the study applies AHP methodology. First, as mentioned before, it is up to knowledge recipient's judgment which distinguishes knowledge from information. Thus, it seems appropriate to survey the knowledge acquisition routes of knowledge recipients by questionnaires which have developed in line with KM strategy. Second, AHP has a Consistency Index (CI) by which we could verify the consistency of

questionnaires. Excluding returned questionnaires which are replied insincerely, we could get more reliable results.

The earlier studies on the knowledge acquisition routes did not classify the knowledge acquisition routes hierarchically. For example, Cross (2001) categorize them into 5 routes : people, PC archive, internet, K-base, and Others. In case of Fong & Kwok (2009), although they categorize based on KM strategy (Codification, Personalization), we could not check the relative importance of each route for each individual. Because, they asked five-point scales. Besides, it's hard to identify insincere respondents for 5-point scales questionnaires. Thus, the study applies AHP methodology to analyze knowledge acquisition routes hierarchically in line with KM strategy and by which calculate the relative importance of each routes and verify the consistency of responses.

After verifying responses, we analyze the relationships between respondents' characteristics (rank, occupational type etc.) and knowledge acquisition routes with CA methodology. CA methodology had developed respectively in France, Netherland, USA, Canada, Japan and so on. It turned out that each methodology which many countries had developed respectively were a same methodology due to the international exchange in late 1970s. CA is one of the principal component analysis with categorical data and it categorizes respondents based on the patterns of responses (Noh, 2008). The advantage of this methodology is graphical output that makes it easier to understand the results. The outputs of CA are a little different in accordance with the program used to analyze the results. In this study, we used Netminer

4 program, thus detailed method of analysis could be checked in Sten-Eric Clausen (1998).

# Chapter 3. Characteristics of Knowledge Transfer

## Process for each KM Strategy

Knowledge transfer process differs from route to route. To propose strategic approach for KM, it is necessary to understand the characteristics of each strategy. Figure 3-1 shows knowledge transfer process for each route.

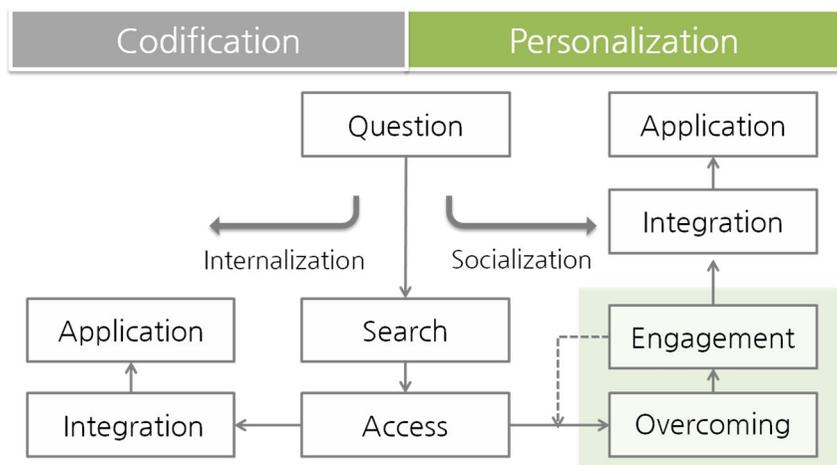


Figure 3-1 Knowledge transfer process for each route

Codification and personalization process is relevant to internalization and socialization, respectively. To be more specific, in case of knowledge transfer process through codified information, (1) the recipients search information to solve their problem. (2) It requires permission to access to the information. (3) If access to the information permitted, recipients integrate the information. (4) Finally, integrated information applied to solve the problem.

Meanwhile, in case of personalization, knowledge transfer process requires relational dimension. We added safety and engagement which Cross

(2001) suggested for facilitating knowledge transfer. When it comes to personalization, (1) the recipients search person who is supposed to know the answer. (2) It also requires permission to access to the person. (3) If access to the person permitted, the next step is relational dimension. Relational dimension is closely connected with organization. Safety means the knowledge transferred situation when recipients do not afraid of disregard from experts due to their ignorance. In this study we turned “safety” into “overcoming”. And engagement means that experts who are asked involve the problem solving. Engagement is important to form trust in the organization and this trust create a virtuous circle for sharing knowledge.

### **3.1 Codification Strategy**

Many companies have developed their KMS to exploit their intellectual property effectively. Electronic Knowledge Repositories (EKRs) is the most representative type of KMS (Kankanhalli et al., 2005). Codification strategy focuses on knowledge transfer through records which were published or stored on company server.

Codification strategy has some pros and cons. One of the advantages of codification strategy is its preservability. After an employee who has knowledge leaves the company, other employees exploit records by virtue of its preservability. And from the point of view of the company, company could diffuse the information which company wants employees to know in a short time. For this reason, many contracting firms have constructed KMS in Korea. But construction of KMS has limited impact on retrieval and sharing of tacit knowledge (Woo et al., 2004). And without performance metrics which incorporating individual's codification and sharing efforts, it's hard to expect employee to participate voluntarily on knowledge sharing(Carrillo & Chinowsky, 2006).

But we cannot expect successful achievement unless lots of information stored in the company is integrated into employees' mind and applied to solve the problem. Because employee who could be compared to an island in the sea of information would choose the route through which employee can get information at a minimum expenditure of time and effort. And it takes a long

time to acquire knowledge through codified record. That is why teachers are as important as quality of textbook.

### **3.2 Personalization Strategy**

Personalization strategy focuses on knowledge transfer through people. As mentioned above, the knowledge acquisition process of personalization is socialization process. The study applies concepts of social capital theory and social exchange theory.

Social capital theory posits that social capital provides a condition for knowledge sharing (Kankanhalli, 2005). In the past, capital means physical capital for elements of production. But the concerns for invisible capital came to the fore, human capital and social capital have emerged as an essential element of production. Human capital is an element of production which employees get the knack of work. It includes level of proficiency, knowledge, and health status etc (Schultz, 1961). Companies have made an effort to accumulate human capital through employing talented person and training. Putnam (1995) defined social capital as an organizational characteristic such as network, norm, and trust which facilitate cooperation in a mutually beneficial way.

Social exchange theory helps understand motivation of people when they participate in knowledge sharing. It posits that people behave in ways that maximize their benefits and minimize their costs (Molm 1997). Cost incurred in the form of opportunity cost and actual loss of resources during the social exchange (Molm 1997). Kankanhalli et al. (2005) asserted that trust as a social capital help alleviate the negative effects of perceived costs during knowledge

sharing and emphasized the significance of organizational culture which emphasizes trust.

Personalization is important in setting KM strategy on account of social capital which is accumulated on the relationship between individuals. Without the social capital which alleviates perceived costs company should compensate employees' efforts and time directly. If company ceases to compensate for their effort for knowledge sharing, the sharing of knowledge also stops. But knowledge transfer through socialization process has some disadvantages. First, if companies do not manage false information in circulation, it could cause serious economic losses. Second, when a employee leaves the firm, knowledge which the employee has leaves, too.

The difference between codification and personalization strategy is social capital. Adler (2001) asserts that high level of generalized trust<sup>1</sup> in the community or network facilitates knowledge sharing. But it lacks persuasion on the assumption that people behave in ways that maximize their benefits and minimize their costs. The argument of Johnson (1999) that identification such as shared value, membership in the organization create a context for prosocial behavior by attracting the attention for collective interests which come together with the individual's own interests.

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<sup>1</sup> Putnam (1993) defined generalized trust as trust which exists in the generalized action that is not in the relation between particular individuals but in the social unit.

## **Chapter 4. Study Design : Classification of Knowledge Acquisition Route**

The study shows that knowledge transfer process varies with the KM strategy in chapter 3. Employees' knowledge exploitation is dependent on which strategy would company choose. Thus classification of knowledge acquisition route of engineers in construction site according to KM strategy and investigation of current status could be helpful for setting KM strategy. The results of analysis for knowledge acquisition routes by surveying could be a base line data for setting the strategy. Because, (1) the KM strategy which companies choose shows intention of the company and it induces employees to a routes from which company wants them to acquire. And, (2) it is suitable to survey for this research since knowledge does not exist outside of an agent. Thus, the study completed a questionnaire to investigate knowledge acquisition routes of engineers in construction sites in line with KM strategy.

In this chapter, we classified knowledge acquisition route of engineers in construction sites into codification strategy and personalization strategy. The applied assumptions of classification are as below.

(1) People acquire knowledge from the people who have a competitive advantage in knowledge asset

(2) All the time and effort individual put into transferring knowledge requires intrinsic or extrinsic compensation.

(3) People behave in ways that maximize their benefits and minimize their costs when it comes to knowledge acquisition.

(4) Socialization process forms social capital between individuals.

(5) As a social capital, trust alleviates perceived costs for knowledge sharing.

(6) In case of knowledge acquisition through the external company, the employee of the external company provides their information in ways that maximize their profit.

The assumptions above are based on social exchange and capital theory in chapter 3, and considering these theory and assumptions, we categorized knowledge acquisition route of engineers in construction site as shown Table 4-1.

Table 4-1 Classification of Knowledge Acquisition Route

Level 1		Level 2	Abbreviation
Inside	Recorded Information(IR)	Electronic information	IRE
		Publication & Hard copy	IRP
	People(IP)	Same project	IPS
		Other project	IPO
		Head Office & Laboratory	IPH
	Outside	Recorded Information(OR)	Electronic information
Publication & Hard copy			ORP
People(OP)		Subcontractor	OPS
		Other Contracting firm	OPC
		Other Experts(ie. academia)	OPE

As shown table 4-1, we categorize knowledge acquisition route into two categories which are inside of company and outside of company. By classifying into in and outside firms, it is possible to find the location of knowledge competitiveness. And we could also check on which route is main to get knowledge in construction sites. Meanwhile, level 1 is categorized into 4 categories to verify consistency index.

At level 2, we categorized record into electronic information and publications regardless of in and outside firms. But in case of people, we categorized differently. People of inside firm are categorized into same project, other project, and head office to check knowledge transfer patterns (distributed KM, centralized KM). And people of outside firm are categorized into subcontractor, other contracting firm, and other experts in consideration of internal and external rivalry relationship.

In case of Recorded information, it requires lots of time and efforts to codify. If employees in the firm carry out this codification, the efforts to codify and opportunity costs which emerged from difficulties to concentrate on the work would be cost elements.

Meanwhile, the location of social capital which is accumulated during the socialization process comes into question in personalization. Insufficient social capital in the firm causes a hiatus in knowledge sharing among employees. So, it is important to divide knowledge acquisition routes into in and outside of the firm.

## Chapter 5. Case Study

In the previous chapter, we designed the study to investigate knowledge acquisition routes of engineers in a strategic aspect. In this chapter, we conducted a survey and analyzed knowledge acquisition patterns of engineers in construction site. In consideration of these results, we propose a strategic approach procedure for setting KM strategy and show the way to utilize the results.

### 5.1 Survey target

For the survey the study choose the contracting firm which has carried out company-wide KM. the firm is in the top five in contractor's construction capacity rank. Table 5-1 shows changes of focus that the firm has implemented for KM.

Table 5-1 Changes in KM focus

Year	Primary Focus
2002~2003	Development of construction Technology DB (Tacit Knowledge → Explicit Knowledge)
2004	Focus on work-site problems (Introduction of learning organization)
2005	Assignment of learning tasks according to the headquarter' s strategy
2006	Select & concentration Strategy

Thirty nine participants from six construction project sites that are three general building project sites and three apartment project sites are selected for the survey. The questionnaire was designed simple and it takes about 10 minutes to fill out. For improvement of understanding and user interface of the questionnaire, we conducted a survey tentatively targeting 6 engineers who are excluded when we analyze the results. And we tried to reduce the number of questionnaires which are filled out insincerely by explaining briefly prior to survey.

## 5.2 Analysis for Knowledge Acquisition Routes

The study analyzes knowledge acquisition routes of engineers in construction sites by AHP and CA. After we conducted a survey of thirty nine engineers, the number of questionnaires which consistency index (CI) was more than 0.1 was nine. In general, If CI is less than 0.1, the questionnaire is accepted as a consistent response. Thus, analysis was conducted only for thirty questionnaires.

CA was conducted using Netminer 4 program. Analysis for correlation between categories and chi-square test was carried out with SPSS program. The study analyzes differences according to the rank and occupational type of engineers.

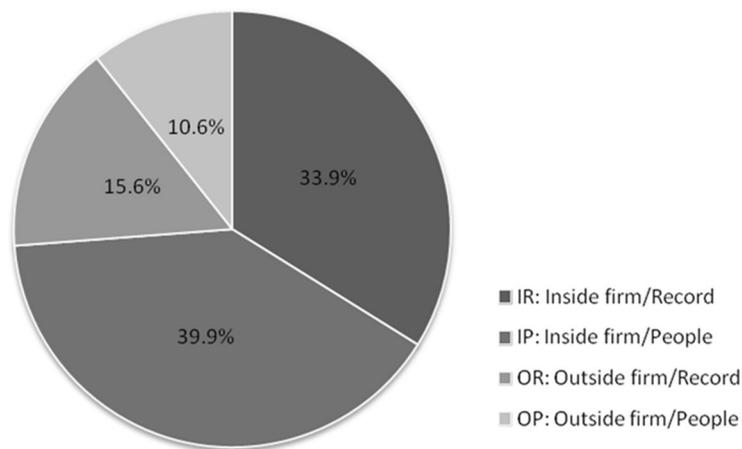


Figure 5-1 Knowledge acquisition ratio(%) for each route(Level 1)

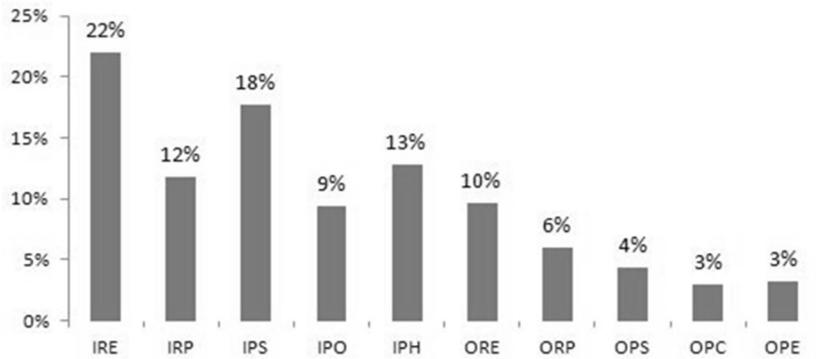


Figure 5-2 Knowledge acquisition ratio(%) for each route(Level 2)

Figure 5-1 and 5-2 show the average of responses according to level of classification. It is easy to find that ratio of knowledge acquisition from recorded information (IR, OR) and people (IP, OP) are almost similar at one to one.

The result of this survey corresponds with the earlier one which was conducted by Fong & Kwok (2009) using five-point scale targeting the local contracting firms in Hong Kong. The result reaffirms that people is as important as recorded information as a route of knowledge acquisition in construction industry which places emphasis on field experience of employees.

Figure 5-3 shows the result of analysis according to the rank (position) of employees; staff (T1), assistant manager (T2), manager (D), deputy general manager (E1), general manager (E2). In case of Fig 6 which is illustrated by bar chart, it's hard to understand the meaning of the distribution according to the rank of employees. So, the study illustrates the distribution of knowledge acquisition routes using CA which shows configurational-coordinate on the

quadrant. And cross correlation analysis was conducted 95 percent accuracy level.

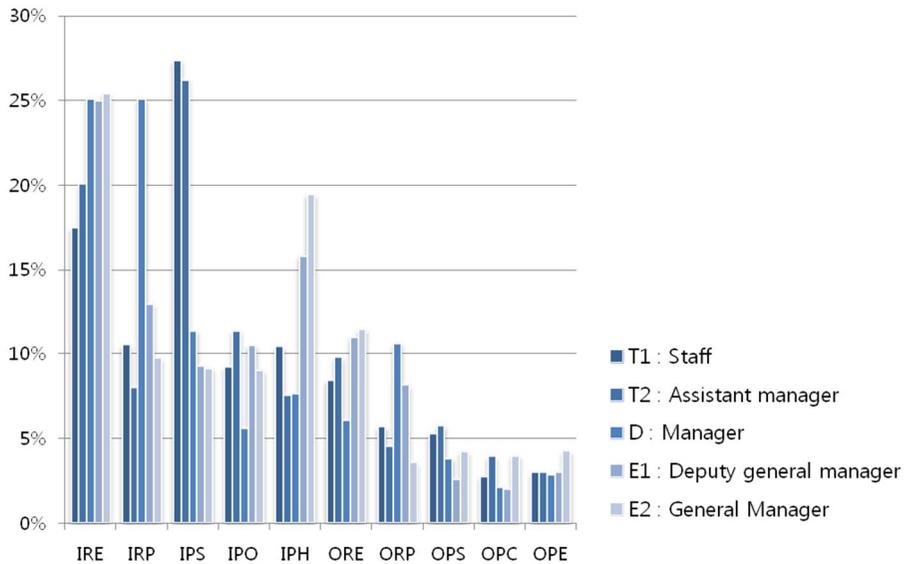


Figure 5-3 Knowledge acquisition ratio(%) for each rank (Level 2)

The result of CA could be valid when there is a correlation between the rank and knowledge acquisition routes. To verify the correlation between the two categories, we conducted chi-square test and the result shows that p equals 0.054 at level 1, 0.010 at level 2 respectively. It means that the result of CA is valid at level 2 according to the level of significance 0.05.

As shown in Figure 5-4, each rank of employees is spread throughout the quadrant. What is most interesting is that T1 and T2, E1 and E2 located in the same quadrant, respectively. Contracting firms have operated Career Development Program (CDP). When they operate CDP, they categorize

employees into training phase (T1, T2), deepening phase (D), and expert phase (E1, E2). The fact that the result of CA according to the rank of employees and CDP phases are similar shows that they are intimately related with each other.

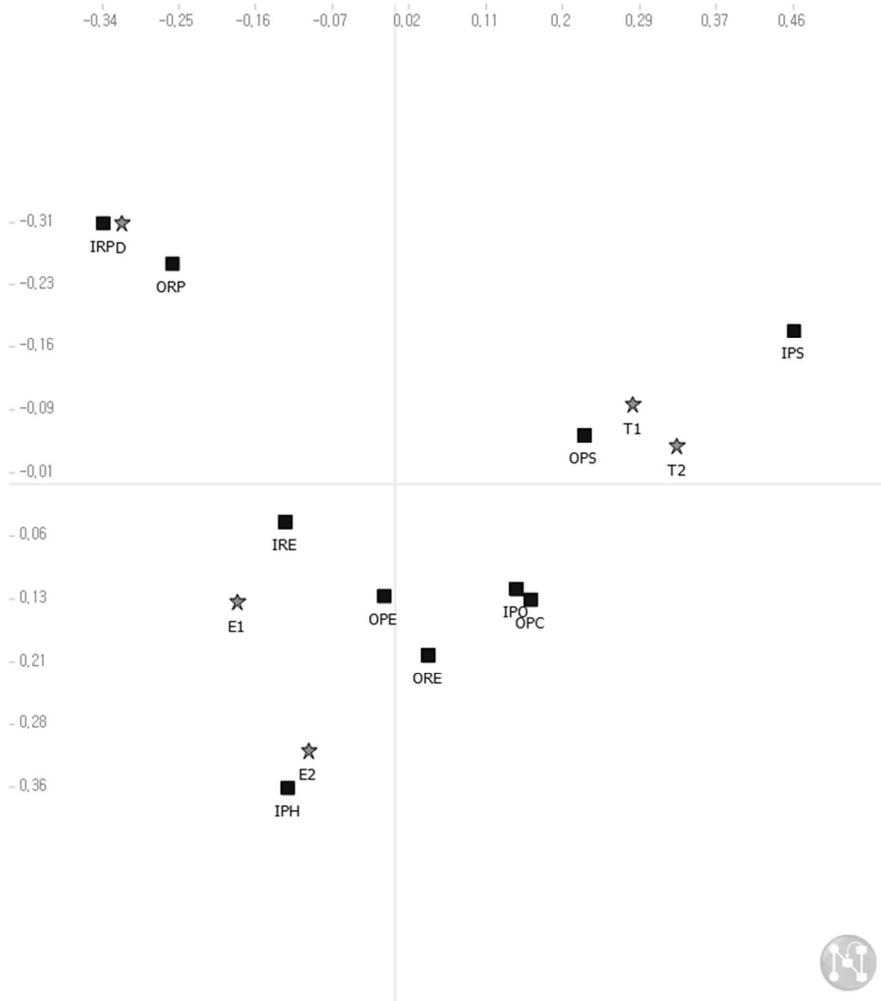


Figure 5-4 Knowledge acquisition route for each rank

Table 5-2 shows corrected residuals for each route and rank. When we set corrected residual as  $d_{ij}$ ,  $d_{ij}$  shows normal distribution which the average

equals 0 and the standard deviation equals 1. Thus, if  $d_{ij}$  is bigger than 1.96 or smaller than -1.96, we could say big or small according to the level of significance 0.05. And we have the cell which the absolute value is bigger than 1.96 shaded.

Table 5-2 Corrected residuals for each knowledge acquisition route(rank)

Knowledge acquisition route	T1	T2	D	E1	E2
IRE	-1.4	-0.7	0.7	0.6	0.7
IRP	-0.9	-1.7	3.9	-0.1	-1.2
IPS	3.2	2.9	-1.6	-2.2	-2.3
IPO	0	0.9	-1.4	0.5	0
IPH	-0.6	-1.6	-1.5	1.2	2.5
ORE	-0.3	0.2	-1.3	0.6	0.8
ORP	-0.4	-0.9	1.8	0.7	-1.3
OPS	0.5	0.8	-0.3	-0.9	-0.1
OPC	-0.1	0.6	-0.5	-0.6	0.7
OPE	-0.1	-0.1	-0.2	-0.1	0.7

The study found some facts that are related to the difference in knowledge acquisition routes according to the rank from the corrected residuals above. Staff and assistant manager mainly acquire knowledge from the employees who work in the same construction site and the employees of subcontractors.

Manager mostly acquires knowledge from the record which published in and outside firms. Lastly, deputy general manager and general manager mainly get knowledge from head office and electronic information of inside firm.

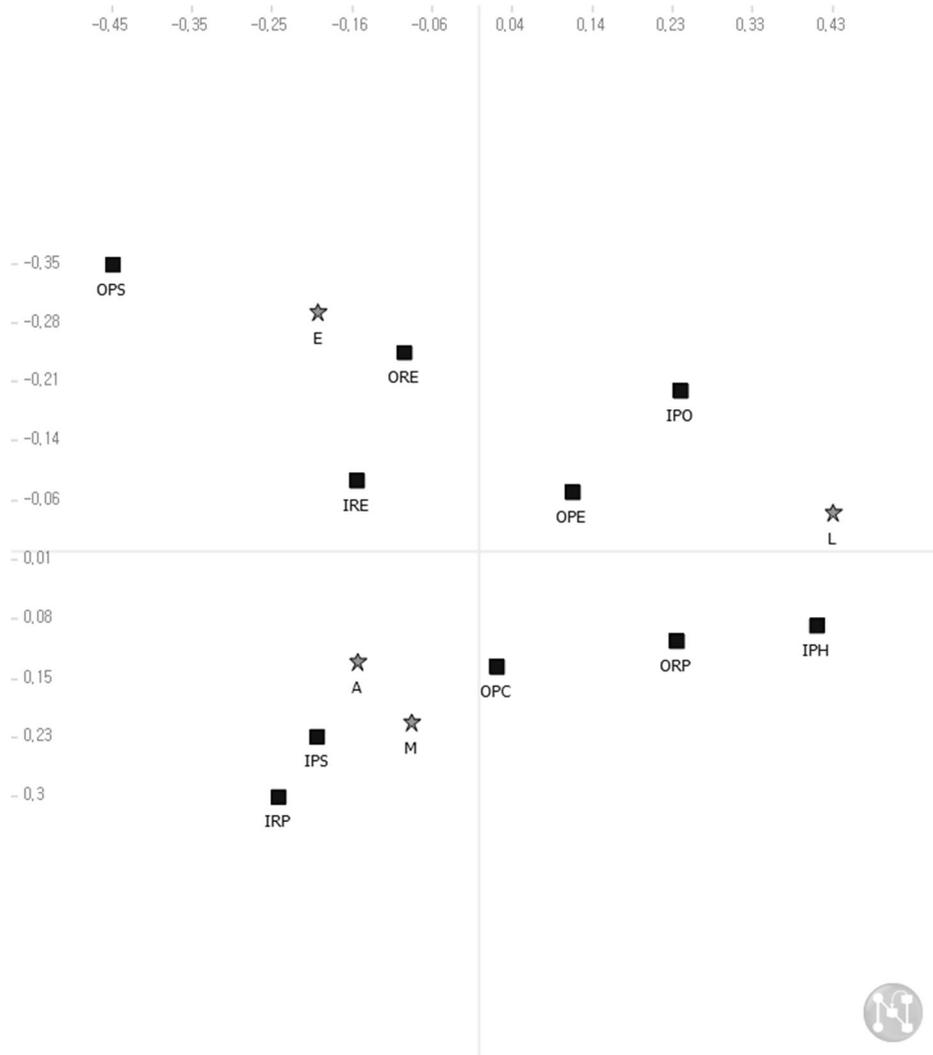


Figure 5-5 Knowledge acquisition route for each occupational type

Figure 5-5 and Table 5-3 show the result of analysis according to occupational type of engineers; architectural (A), electronic (E), mechanical (M), landscape (L). To verify the correlation between the two categories, we conducted chi-square test and the result shows that p equals 0.184 at level 1, 0.021 at level 2 respectively. It means that the result of CA is valid at level 2 according to the level of significance 0.05.

As Figure 5-5 shows, architectural and mechanical engineers are located in the third quadrant, electronic and landscape engineers are located in the second and first quadrant, respectively.

Table 5-3 Corrected residuals for each knowledge acquisition route(occupational type)

Knowledge acquisition route	A	E	M	L
IRE	0.9	1.3	-0.9	-1.3
IRP	0.6	-0.9	2.2	-2.0
IPS	2.0	-1.0	0.7	-1.7
IPO	-1.2	0.5	-1.2	2.0
IPH	0.7	-2.2	-0.4	3.3
ORE	-1.0	1.9	-0.5	-0.4
ORP	-0.9	-1.0	0.7	1.2
OPS	-0.3	2.3	-0.3	-1.7
OPC	-0.3	-0.4	0.7	0
OPE	-0.3	-0.1	-0.7	0.5

Table 5-3 shows the corrected residuals for each knowledge acquisition route according to occupational type of engineers. Knowledge acquisition patterns are different for each occupational type of engineers. Architectural engineers relatively often acquire knowledge from the people who work with in the same construction site compared to the other occupational type. Electronic engineers relatively often get knowledge from the employees of subcontractor compared to the other occupational type. Mechanical engineers and landscape engineers relatively often acquire knowledge from the records which was published in the firm and the people who are not in the same construction site but in the same firm, respectively compared to the other occupational type. Meanwhile, in case of electronic engineers and landscape engineers, they relatively rarely acquire knowledge from the people who work in the head office and the record which was published in the firm, respectively compared to the other occupational type.

The study investigated the difference of knowledge acquisition routes between general building project and apartment project. In this case, it is hard to judge the correlation between the two project types on account of insufficient number of comparable target. So, the study would show just general outline with the bar chart.

During the survey, we interviewed construction site managers. Most construction site managers said that they have less opportunity to decide what materials and methods of construction to apply in apartment project. Thus, they expected that the result would be different according to the project type.

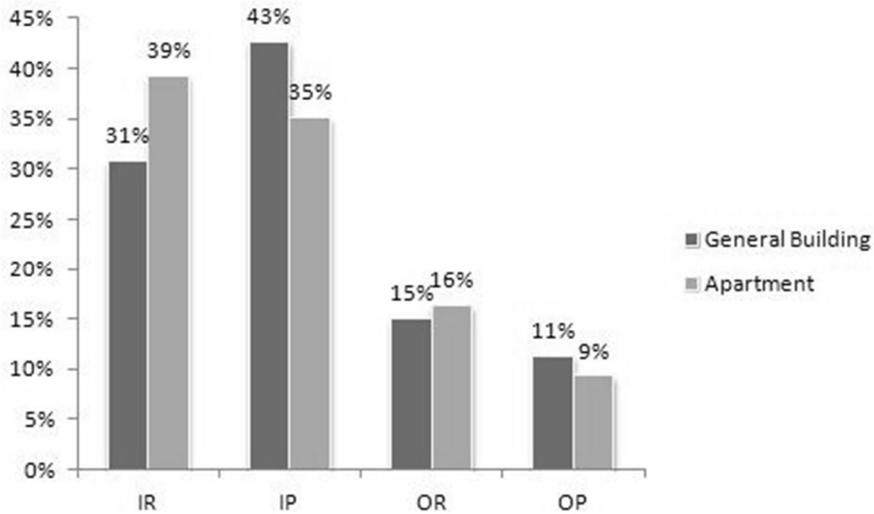


Figure 5-6 Knowledge acquisition route for each project type(Level 1)

Figure 5-6 shows the result of analysis according to the project type in level 1 with the bar chart. When categorizing knowledge acquisition routes in level 1, the distinct difference between the two project types is the acquisition ratio from record and people inside firm. In case of apartment project, there are lots of records and experienced employees, so the ratio of acquisition from records inside firm relatively high compared to general building project.

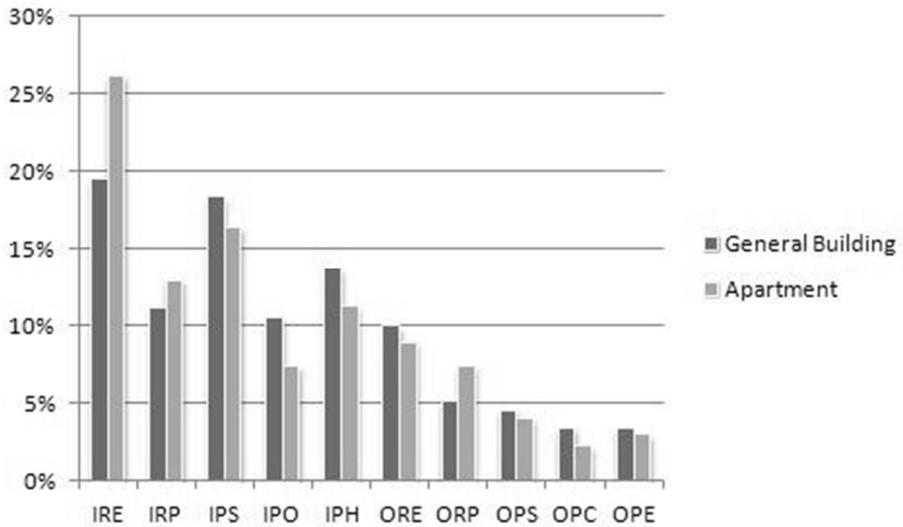


Figure 5-7 Knowledge acquisition route for each project type(Level 2)

Figure 5-7 shows the result of analysis according to the project type in level 2 with the bar chart. Level 2 classification makes it easier to understand the difference. As shown in Figure 5-7, in case of apartment project, engineers relatively often acquire from the electronic record which was stored in the firm's intranet server and the record which published outside firm compared to general building project. It means that there is lots of record which has codified and opened to the public in case of the apartment project. But in the general building project, the acquisition ratio from the employees who work the other projects is distinctive.

## 5.3 Application

The study has showed that the pattern of knowledge acquisition is different according to the rank and occupational type of engineers in the second paragraph. In this paragraph, we would like to consider how to apply these differences to set a KM strategy.

Basically, the main objective of KM is knowledge sharing between employees who are distant from each other in time and space. So, it is worth considering whether employees are together or away in time and space when analyzing for knowledge acquisition route. When it comes to knowledge sharing, the constraint of time could be overcome by codified information. And the space constraint could be overcome by codified information and communication between employees who are away spatially. In the above case, as shown in Figure 5-2, the knowledge acquisition ratio from codified record is 49.5%, people who work in the same project site 18%, and people work in the other space 34%. In case of the employees who work in the same construction site, they are together in time and space. So, it's not under consideration for KM. If we compare the ratio between the same project and the others or codified record and people, we could get some useful information to set the KM strategy in the future.

The second consideration for setting KM strategy is velocity of internalization. As mentioned chapter 3, codification strategy which focuses on codified information in sharing knowledge has a disadvantage that the velocity of internalization is slower than personalization in spite of advantages;

high speed of proliferation, overcoming time constraint and so on. Figure 5-4 shows that staff and assistant manager relatively often acquire knowledge from people compared to the other rank of employees. The rank of staff and assistant manager generally do not have time on their side in construction site. For that reason, we suppose that they get more knowledge from people than codified record. As shown in the second paragraph, if we consider the differences of knowledge acquisition pattern according to rank and occupational type of employees, we could set the KM strategy more efficiently.

The third consideration for setting KM strategy is about determining of strategy. A problem comes up, after analyzing the current status of KM in the firm. The problem is which route we should support for efficient KM. Metaphorically speaking, it correspond with the problem of road whether the company widens the road which many people pass through or the road which the company wants employees to pass through. We need to consider this problem focusing on the characteristic of each knowledge acquisition route. Table 6 shows the characteristics of knowledge acquisition routes in respect of social capital, human capital, costs and so on.

In case of record which codified in the firm, it requires much time and effort to codify and to internalize information. When it comes to people in the firm, people could be categorized into the same project, the other project, and head office/laboratory. Knowledge sharing between employees in the same project is not under consideration. And it is possible to define knowledge

sharing with other project and head office as distributed KM and Centralized KM, respectively.

Table 5-4 Characteristics of each route

Level 1		Level 2	Characteristics
Inside	IR	IRE	- Codification Cost(time, efforts, system construction etc.)
		IRP	- Internalization Cost(time, efforts)
	IP	IPS	- No barrier of time and space
		IPO	- Distributed KM
		IPH	- Centralized KM
Outside	OR	ORE	- Low Codification Cost
		ORP	- Low Competitiveness in knowledge
	OP	OPS	- Accumulation of social capital : Outside
		OPC	- Low grade of human capital - High possibility of confliction for benefit
		OPE	- Academic knowledge

We need to consider codified record and people from outside firm separately. First, codified record such as internet website or publications which was not written in the firm does not require employees to codify. So, preventing employees from reproducing information by using information which was opened to public is one way that could cut the opportunity cost of employees which is incurred when they codify information. And if employees have no difficulty in carrying out the project only with the information which

is located outside firm, the company should focus on the other competitiveness such as business management capability, system competitiveness and price competitiveness. Second, when it comes to knowledge acquisition from the people who are not belongs to the firm, relation of gain and loss is important. Because, when companies have conflicting interests, it is obvious to make a loss without knowledge competitiveness over the other firm.

As mentioned above, since there are considerable pros and cons for each route, the person in charge of setting KM strategy in the firm should check and decide something prior to setting the KM strategy. As Figure 5-8 shows, this study proposes a strategic approach for setting KM strategy.

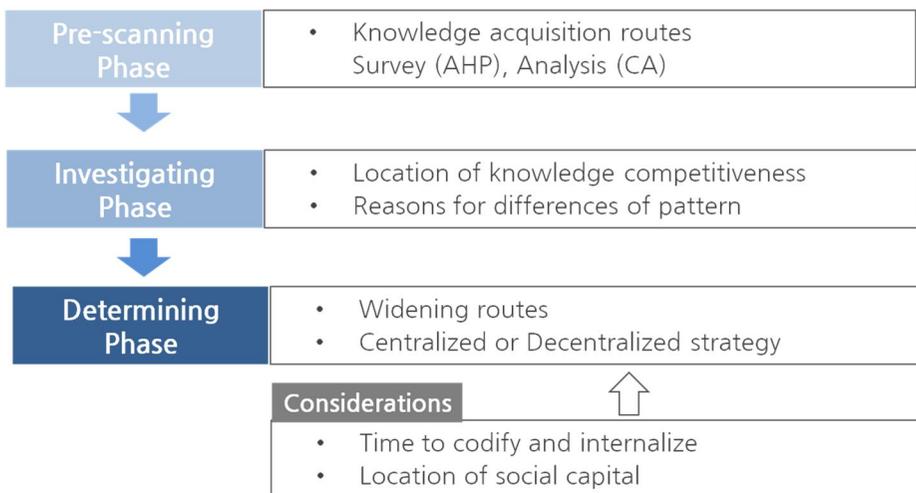


Figure 5-8 Strategic approach procedure for setting KM strategy

The first step is pre-scanning phase. At this phase, KM strategist who in charge of setting KM strategy in contracting firm gets data related to knowledge acquisition route of engineers in construction sites by conducting a

survey which is applied AHP methodology and analyzes pattern of engineers' knowledge acquisition route through CA methodology. By checking the result of CA, the KM strategist gets something to investigate.

At investigating phase, the KM strategist has to check whether knowledge competitiveness exists in or outside firm. And if the result of analysis for knowledge acquisition routes according to the rank and occupational type is different, he should find the reason why the difference occurs.

The last phase is determining phase. At this phase, decision making is required. The matter is whether company invests to the route which many employees exploit or the route which company wants their employees to exploit. And which strategy to decide between distributed and centralized one is another problem. To determine these problems, the KM strategist should consider perceived cost for codifying and internalizing knowledge and the location of social capital which is aggregated.

By following the procedure above prior to set the KM strategy, the KM strategist could set more effective KM strategy.

## **Chapter6. Conclusion**

KM is essential part to sustain relative competitiveness for contracting firms. But Contracting firms have reduced investment on KM because of recently construction business recession. Thus this study proposed a strategic approach which could help the KM strategist in contracting firm to set KM strategy more effectively in restricted investment on KM.

### **6.1 Summary**

Over the past 10years, the domestic contracting firms have pushed KM to accumulate company knowledge and take advantage of it effectively in a variety of ways, such as developing KMS, operating learning organizations and so on. They carried forward KM initiatives actively, focused on developing system having support of executives at the beginning. Although KM is still substantial, the initiatives are implemented on a reduced scale recently on account of construction business recession and difficulties in evaluating the effectiveness of KM.

This research is aimed to help the contracting firms set the KM strategy more efficiently. To achieve this, the study proposed a method that was applied classification of KM strategy which had been selected through investigating KM strategy and knowledge transfer process in line with the KM strategy. The survey with AHP methodology allowed us to get more reliable responses and the analysis with CA facilitated the understanding by outputting the results visually.

And also the case study was performed. The results of case study showed some interesting results and helped us establish procedure prior to set KM strategy. The results of analysis could be useful basic information, and proposed approach could be helpful to set KM strategy in contracting firms.

## 6.2 Contribution

Knowledge Management is still substantial for gaining competitive advantage in today's fast-paced business environment. But the difficulties in evaluating the effectiveness of KM and construction business recession has been reduced the investment psychology of the contracting firms. Thus, the study attempted more strategic approach for KM.

Contributions of the proposed method in this research are as follows.

(1) Company could realize the location of knowledge competitiveness. It provides opportunity for company to consider what competitiveness is their competitive edge. For example, if the knowledge competitiveness is located outside firm, the competitive edge of the firm could be system competitiveness or price competitiveness, and so on.

(2) The method shows the differences of pattern when employees acquire knowledge according to the rank and the occupational type of the engineers. According to the result, company should check the reason and could set more efficient KM strategy that reflected the result.

(3) The study informed things to check and consider prior to set the KM strategy.

(4) The method could be an alternative for evaluating the effectiveness of KM, if the survey of knowledge acquisition routes is conducted periodically.

### **6.3 Further Study**

As a result of this research, the limitations and areas for future have been identified. They include the following.

(1) The study was limited in terms of quantity that the employees get from each route. It means that the study could not give information about the amount of knowledge in the firm. So, In case of comparative analysis of knowledge competitiveness between the contracting firms, it is hard to know the disparities in knowledge competitiveness.

(2) It is uncertain whether the assumption which was applied in chapter 4 to interpret meanings of the result is valid or not in construction industry.

(3) Further study is needed to know the pattern of knowledge acquisition through people according to the rank and the occupational type in detail.

(4) If we conduct more surveys for the other contracting firms and carry out a comparative analysis, we could get some implications according to their KM strategies.

## **Appendices**

**Appendix A : Questionnaire**

**Appendix B : Participants Attributes**

**Appendix C : Survey Data**

# Appendix A : Questionnaire

## 1. 일반사항

성 명	
현 장	주택사업현장, 일반건축사업현장
직 위	사원, 대리, 과장, 차장, 부장
직 종	건축, 설비, 전기, 토목, 조경
실무경력(현재 근무 중인 회사)	년
실무경력(Total)	년

※ 현장, 직위, 직종은 해당항목에 “O”표로 표시

## 2. 용어 설명 및 방법

### (1) 용어설명

본 설문지에서 정의하는 지식은 “건설현장에서 공사 진행을 위해 불가피한 의사결정에 직접적으로 도움을 주는 정보”를 뜻합니다. 현장의 공사진행과 무관하게 개인적인 학습(eg. 자격증 취득)을 위한 정보의 획득은 제외합니다.

### (2) 설문방법

각각의 지식획득경로가 자신의 현장업무수행에 있어 얼마나 더 중요하다고 생각하시는지 ① 우선순위를 선정하고, ② 2개 경로씩 쌍대 비교하는 방식입니다.

## 3. 설문 문항

(1) 우선순위 선정 : 아래 표는 레벨에 따른 설문의 전체적인 구성입니다. Level 1 항목 간의 우선순위와 Level 2 항목간의 우선순위를 표시해 주십시오.

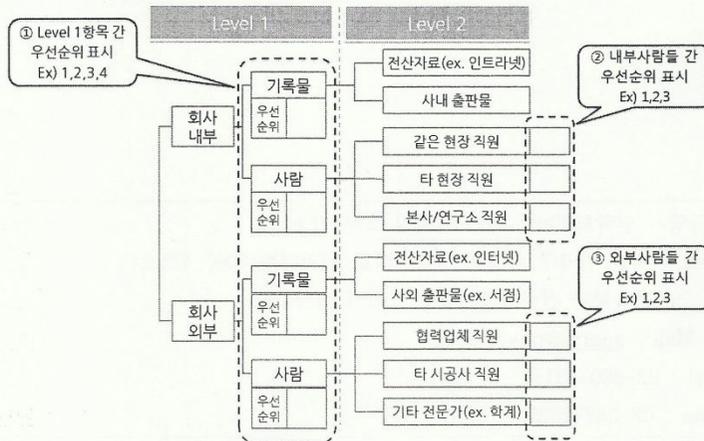


Figure A-1. Questionnaire page 1

(2) 쌍대비교에 의한 설문 : 1~14까지의 문항에 대해 중요도( ~ 배 중요) 'V' 표시

① Level 1

· 지식획득경로에 있어 기록물과 사람(회사 내/외 구분) 간의 중요성 비교

No	비교 아이TEM	매우중요 ←				동 등	→ 매우중요				비교 아이TEM
1	회사내부 기록물	⑤	④	③	②	①	②	③	④	⑤	회사내부 사람
2	회사내부 기록물	⑤	④	③	②	①	②	③	④	⑤	회사외부 기록물
3	회사내부 기록물	⑤	④	③	②	①	②	③	④	⑤	회사외부 사람
4	회사내부 사람	⑤	④	③	②	①	②	③	④	⑤	회사외부 기록물
5	회사내부 사람	⑤	④	③	②	①	②	③	④	⑤	회사외부 사람
6	회사외부 기록물	⑤	④	③	②	①	②	③	④	⑤	회사외부 사람

② Level 2

· 지식획득경로에 있어 회사 내부 기록물 간의 중요성 비교

No	비교 아이TEM	매우중요 ←				동 등	→ 매우중요				비교 아이TEM
7	회사내부 전산자료	⑤	④	③	②	①	②	③	④	⑤	회사내부 출판물

· 지식획득경로에 있어 회사 내부 사람들 간의 중요성 비교

No	비교 아이TEM	매우중요 ←				동 등	→ 매우중요				비교 아이TEM
8	같은 현장 직원	⑤	④	③	②	①	②	③	④	⑤	타 현장 직원
9	같은 현장 직원	⑤	④	③	②	①	②	③	④	⑤	본사/연구소 직원
10	타 현장 직원	⑤	④	③	②	①	②	③	④	⑤	본사/연구소 직원

· 지식획득경로에 있어 회사 외부 기록물 간의 중요성 비교

No	비교 아이TEM	매우중요 ←				동 등	→ 매우중요				비교 아이TEM
11	회사외부 전산자료	⑤	④	③	②	①	②	③	④	⑤	회사외부 출판물

· 지식획득경로에 있어 회사 외부 사람들 간의 중요성 비교

No	비교 아이TEM	매우중요 ←				동 등	→ 매우중요				비교 아이TEM
12	협력업체 직원	⑤	④	③	②	①	②	③	④	⑤	타 시공사 직원
13	협력업체 직원	⑤	④	③	②	①	②	③	④	⑤	기타 전문가
14	타 시공사 직원	⑤	④	③	②	①	②	③	④	⑤	기타 전문가

Figure A-2. Questionnaire page 2

## Appendix B : Participants attributes

ID	Site	Site type	Rank	Occupational type	Career(yr)
ENG19	A1	A	D	A	12
ENG20	A1	A	E2	E	27
ENG21	A1	A	E1	A	17
ENG22	A2	A	E2	A	22
ENG23	A2	A	E1	A	20
ENG24	A2	A	T1	A	1
ENG25	A2	A	D	A	15
ENG26	A3	A	T2	A	9
ENG27	A3	A	T2	A	8
ENG28	A3	A	E1	L	13
ENG29	A3	A	D	M	13
ENG1	G1	G	E2	A	22
ENG2	G1	G	T1	A	2
ENG3	G1	G	T1	A	1
ENG5	G1	G	T1	A	2
ENG4	G2	G	T1	A	2
ENG6	G2	G	E2	A	22
ENG7	G2	G	T1	A	1
ENG8	G2	G	T1	E	1
ENG9	G2	G	T1	M	4
ENG10	G2	G	E1	A	15
ENG11	G2	G	E2	M	27
ENG12	G2	G	E2	A	22
ENG13	G2	G	T1	A	4
ENG14	G2	G	E1	E	17
ENG15	G3	G	T2	A	10
ENG16	G3	G	T2	A	6
ENG17	G3	G	E2	A	15
ENG18	G3	G	E1	A	22
ENG30	G3	G	T2	A	5

Table A-1. Participants Attributes

## Appendix C : Survey Data

ID	IRE	IRP	IPS	IPO	IPH	ORE	ORP	OPS	OPC	OPE
ENG1	0.23	0.06	0.08	0.08	0.30	0.11	0.03	0.06	0.02	0.05
ENG2	0.25	0.05	0.38	0.05	0.11	0.05	0.02	0.06	0.02	0.02
ENG3	0.24	0.24	0.17	0.08	0.04	0.07	0.07	0.06	0.03	0.01
ENG4	0.16	0.08	0.36	0.13	0.06	0.07	0.07	0.04	0.02	0.02
ENG5	0.23	0.23	0.12	0.04	0.12	0.10	0.10	0.02	0.01	0.05
ENG6	0.39	0.13	0.06	0.02	0.09	0.10	0.03	0.07	0.04	0.05
ENG7	0.16	0.05	0.26	0.10	0.16	0.16	0.05	0.03	0.01	0.03
ENG8	0.10	0.03	0.18	0.18	0.09	0.08	0.04	0.17	0.06	0.06
ENG9	0.19	0.10	0.28	0.13	0.09	0.05	0.02	0.04	0.08	0.02
ENG10	0.13	0.40	0.08	0.03	0.17	0.07	0.07	0.01	0.01	0.04
ENG11	0.09	0.18	0.11	0.05	0.24	0.16	0.05	0.06	0.04	0.01
ENG12	0.20	0.05	0.05	0.11	0.41	0.07	0.02	0.01	0.02	0.05
ENG13	0.13	0.13	0.38	0.07	0.12	0.03	0.07	0.04	0.02	0.01
ENG14	0.23	0.08	0.10	0.21	0.07	0.21	0.04	0.05	0.01	0.01
ENG15	0.30	0.08	0.16	0.08	0.11	0.12	0.06	0.01	0.02	0.05
ENG16	0.27	0.09	0.12	0.07	0.05	0.21	0.07	0.03	0.06	0.03
ENG17	0.09	0.05	0.21	0.13	0.17	0.12	0.12	0.05	0.02	0.02
ENG18	0.13	0.04	0.06	0.31	0.13	0.05	0.02	0.04	0.15	0.07
ENG19	0.31	0.31	0.06	0.06	0.06	0.05	0.05	0.06	0.03	0.04
ENG20	0.39	0.13	0.04	0.01	0.08	0.21	0.07	0.04	0.01	0.02
ENG21	0.44	0.09	0.05	0.05	0.18	0.07	0.07	0.01	0.02	0.04
ENG22	0.35	0.09	0.24	0.04	0.10	0.10	0.02	0.03	0.01	0.03
ENG23	0.45	0.11	0.04	0.04	0.11	0.09	0.09	0.03	0.02	0.03
ENG24	0.11	0.04	0.34	0.05	0.16	0.15	0.08	0.02	0.01	0.04
ENG25	0.24	0.24	0.21	0.03	0.10	0.04	0.08	0.04	0.02	0.03
ENG26	0.10	0.03	0.31	0.14	0.07	0.06	0.02	0.16	0.07	0.03
ENG27	0.13	0.13	0.38	0.13	0.06	0.03	0.05	0.04	0.02	0.02
ENG28	0.15	0.05	0.08	0.18	0.25	0.10	0.10	0.01	0.03	0.04
ENG29	0.21	0.21	0.08	0.08	0.08	0.10	0.19	0.02	0.02	0.02
ENG30	0.19	0.06	0.34	0.14	0.09	0.07	0.02	0.04	0.02	0.01

Table A-2. Survey Data

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## 국 문 초 록

2000 년을 전후로 하여 국내 건설사들 사이에서 지식관리 (Knowledge Management)가 화두로 떠올랐다. 국내 건설사들은 급변하는 시장 환경 속에서 경쟁기업에 대해 상대적인 경쟁력을 확보하고 이를 유지하기 위해 명시적인 지식관리가 필요함을 인식하고, 사내 지식관리시스템(Knowledge Management System)을 구축하거나, 학습조직, 멘토링 제도 등의 운영을 통해 다양한 방법으로 지식관리를 추진해 왔다.

지식관리는 여전히 중요하지만, 최근 건설경기의 둔화와 지식관리 실효성 측정의 어려움은 기업의 지식관리에 대한 투자에 걸림돌이 되고 있다.

따라서 본 연구는 건설현장 시공기술자들의 지식획득경로에 대한 분석을 통하여, 효율적인 지식관리전략의 수립을 위한 전략적 접근 방법을 제안하다. 연구의 결과는 국내 건설사들이 추후 지식관리전략을 수립할 때, 지식관리를 보다 체계적이고, 전략적인 시각으로 접근하는 데 도움이 될 것으로 기대한다.

**주요어:** 건설지식관리, 지식관리전략, 지식전달과정, 지식획득경로

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