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COMPARATIVE ANALYSIS OF BIM ADOPTION IN KOREAN CONSTRUCTION INDUSTRY AND OTHER COUNTRIES

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ABSTRACT: Construction companies in Korea have shown interest in BIM (Building Information Modeling) even if late, adopted it, and applied it to several projects. But, it is hard to figure out the status of BIM implementation. Thus, this study is to figure out the status of BIM implementation in Korea by surveying major construction companies in Korea and comparing with similar surveys abroad. The survey result shows that only 11 companies in Korean construction industry adopted BIM. The clash check (73%) was mostly used among various BIM functions and other functions were used less than 30%. As of 2008, only 8 construction companies have used BIM in 27 projects and thus, Korean companies are in the BIM introduction period. Therefore, successful introduction of BIM is required by benchmarking the BIM introduction process of overseas construction industries

Keywords: BIM (Building Information Modeling), Survey, KSFs (Key Success factors)

1. INTRODUCTION

Construction market in Korea has been very active with the market size of 124.7 billion dollars in 2007, ranked as 9th in the world. But, the adoption of BIM (Building Information Modeling) was several years later than other advanced countries. Especially, construction companies started to adopt it a couple of years later than architectural firms. Despite the late adoption, there have been a number of projects adopting BIM, such as the Central Library of Sungkyunkwan University, Training Center Complex for National Sports Teams, etc [5].

To show the development path in the future, this study was to reckon the BIM technology level in the construction industry of Korea and analyze and compare it to overseas cases. For this purpose, surveys were conducted against top 30 construction companies and others which showed interest in the adoption of BIM. Meaningful survey questionnaires were deduced through the previous study review and two pilot surveys. Aforementioned construction companies were surveyed with these questionnaires. The survey result was analyzed and some questionnaires were compared to other BIM-related survey results for the analysis and comparison of Korea with other countries in the adoption of BIM.

2. QUESTIONS IN PREVIOUS SURVEYS ON BIM

Due to recently growing interest in BIM, surveys have

been conducted following growing number of researches and reports. Gilligan and Kunz (2007) [4] and Young Jr., et al. (2008) [8] Han Yan and Peter Damian (2008) [7] are such survey results, commonly asking the benefits and barriers of BIM and effects of adopting BIM. Table 24 shows survey questionnaires gathered for survey questionnaires deduction.

Table 24 Questions in previous surveys on BIM

Author (year)	Questions
Gilligan and Kunz (2007) [4]	· Number of BIM projects (current and future) · Attention, modeling and significant progress of adopting BIM in what project phases place. · Perceived value to four parties from different points of view · Total value of new projects where VDC gave a competitive advantage · Factors impeding value derived from BIM · Effects of adopting BIM (e.g. unintended consequences, change order, risk management, design errors and cost & duration conformance) · Business purpose for adopting BIM · Established VDC users are expanding their focus
Young Jr. et al.	· Growth in BIM uses · BIM training (e.g. methods, level and

(2008) [8]	・ needs) ・ BIM use in green projects ・ Challenged to BIM adoption ・ Primary drivers of BIM user on projects ・ Owner willingness to pay extra for BIM ・ Modeling detail (e.g. function, outsourcing, modeling elements) ・ Effects of adopting BIM (e.g. ROI, impact by experience level) ・ Awareness of BIM software
Han Yan and Peter Damian (2008) [7]	・ Benefits of BIM ・ Barriers to implement BIM ・ Know about BIM in UK and US ・ Future of BIM

3. KEY SUCCESS FACTORS ON BIM ADOPTION

This study tried to use core factors for the successful adoption of BIM in the survey questionnaires to make such survey as to figure out the current status of those factors which may have effect on the BIM introduction path in the future. But, there was no such study on the core success factors for BIM introduction. Thus, they were deduced by expert survey in this study.

Table 25. Key success factor

No.	Key Success Factors
1	Organizational structure to support BIM
2	Number of subcontractors/partners who have experienced BIM projects
3	Continuous investment on BIM
4	BIM training programs
5	Number of BIM software experts in a company
6	Master BIM model team/manager
7	Effective collaboration between project participants
8	Leadership of senior management
9	Clients' interest/request for BIM
10	Clients' satisfaction level on BIM projects
11	Incentive programs for using BIM
12	Standardized work procedures for BIM
13	Metrics for quantitative evaluation of the effectiveness of BIM projects
14	Technical supports for interoperability issues
15	Abundant BIM content Libraries
16	Collaboration (project) management tools
17	Shared liability between project participants
18	Information sharing protocals
19	Clients' interest/request on BIM

First, to make the basic list of core success factors,

Inho Kim [1] and Seokmook Lee's [3] research on the limitations in the BIM adoption and consideration factors for the adoption of a new technology was referred [4,6-8]. Based on this, pilot survey was conducted on 6 BIM experts in Korea. The result shows satisfactory internal consistency level with 0.761 of Cronbach's coefficient alpha value (number of items: 23). 19 KSFs were made by excising cumulative contents and based on BIM experts' opinion, and then, surveys were distributed to 206 internationally renowned BIM experts and 61 replied. Cronbach's coefficient alpha value of the main questionnaire was satisfactory as 0.922 (number of items: 19) and the following 19 KSFs were deduced by the survey. Based on this, the main survey was made to evaluate the level of BIM introduction in Korean construction companies.

The main survey consists of four evaluation factors: BIM-related structure, BIM organization, Investment in BIM, and BIM-applied projects (Table 26).

Table 26. The Contents of the Survey

Category	Evaluation Factor	Sub-Category of Evaluation Factor
Overall Application of BIM	BIM Structure	・ Senior manager's interest in BIM adoption ・ Incentive for active use of BIM ・ Management of return on investment ・ BIM project management system ・ Procedure for BIM project performance ・ Securing BIM libraries ・ Status of BIM sub-contractors
	BIM Organization	・ Status of BIM organization ・ Number of staff for BIM
	Investment in BIM	・ Training time for BIM related education ・ Amount of investment for BIM adoption in 2007, 2008 and 2009
Degree of BIM Use	BIM Projects	・ Scope of BIM application in projects ・ Introduction function by BIM-applied projects ・ Number of projects where BIM was requested by owner ・ Data interoperability in BIM application

4. SURVEY RESULTS

The main survey was conducted for two months from October to November, 2008, on top 30 construction companies and others which had strong will to adopt BIM. The result of survey is as follows.

4.1 Ration of Companies Which Adopted BIM

The survey target was BIM staff at construction companies in Korea, and 11 out of 29 companies which responded to the survey answered they have introduced BIM, which means 38% of the whole respondents have introduced BIM. But, another survey conducted at the same time showed that 81% (35 firms) of Korean architectural firms responded to have adopted BIM.

On the other hand, according to the survey conducted by CIFE of Stanford University through web survey and interviews in 2007, more than 50% builders among respondents turned out to have already introduced BIM [4].

4.2 Support and Work Procedure for BIM

Expected interest of superior decision-makers was asked and replied on a 5-point scale in 2007, 2008 and 2009 (1 point: insignificant, 7 point: very critical). The gross average of 11 companies were 2.1 in 2007, 3.2 in 2008, and 3.5 in 2009, showing the interest of the chief decision-making group on BIM have been statistically increasing each year (p-value <.05).

Among all the companies which replied the survey, no company has company-level incentive program about employees' interest and use of BIM, and return on investment evaluation model.

Only one company has the BIM project management system, and has evaluated the usability by applying to the actual BIM project. BIM of six other companies turned out not in the level of application to actual projects.

9 out of 11 respondent companies didn't have the standard and procedure for BIM project performance processes and only two did.

Among the respondent companies, only one which introduced BIM relatively early due to its active performance in plant related projects replied that it secured about 80% of BIM model libraries needed, and the rest secured only about 0~10% of needed libraries.

The survey result on sub-contractors which have the ability of BIM performance in each field and thus can perform the project together shows that there were many such sub-contractors only in design field as 82%. The rest of the fields, such as schedule management, structure and facilities, however, have less than 27% of sub-contractors which can perform BIM projects.
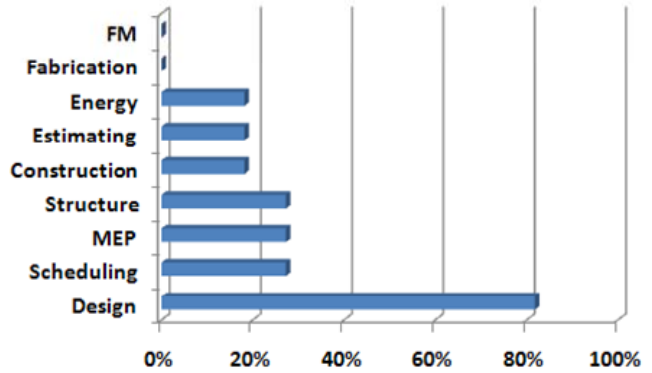

Figure 11. Status of subcontractors

5.2 BIM-Related Organization

BIM organization is one of the key success factors in BIM introduction, and understanding the current status is important. In Korea, only 2 companies have inside BIM organization with clear job description for the roles of its staff. Five construction companies had computer related organization in charge of BIM related tasks. Regarding this, the interview with BIM staffs of two construction companies in the US shows that they have organizations only for BIM which perform BIM modeling, analysis-related work and supporting effective adoption of BIM to construction sites. Table 27 shows the comparison between BIM staffs and the total number of employees in two construction companies in the US. The number of employees per a BIM staff was around 180.

Table 27. Comparison to BIM specialist

Company	Employees	BIM Specialist	Ratio (Employee/BIM)
A	539	3	180
B	706	4	177

5.3 BIM-Related Investment

Figure 11 shows the average training time of each company for five detailed items of training. Training time means the total time for one person to get related-education.
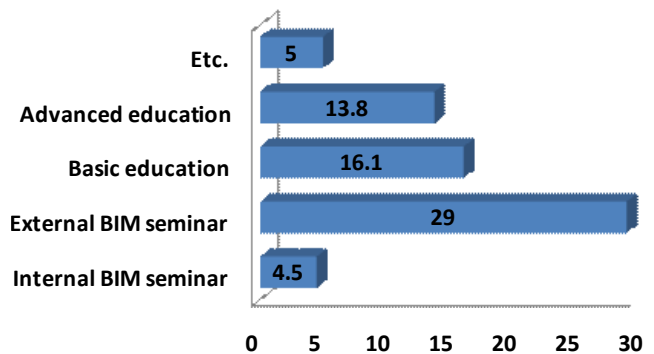

Figure 12. Education period for BIM

As shown in Figure 13, the average investment in BIM introduction in 2007 was $28,106 (3.8M KRW), and the expected investment in 2008 and 2009 are respectively $163,550 (221.11M KRW) and $217,781 (294.44M KRW), showing over 30% of annual increase rate.

Figure 13. Investment cost for BIM adoption ($)

5.4 BIM-Applied Projects

The scope of BIM application in projects was investigated from the four different perspectives such as project size and number of conducted projects, based on stage of application on the horizontal axis, and application method on the vertical axis. According to the phase of application, it is mainly applied to schematic design, detailed design and construction stages.
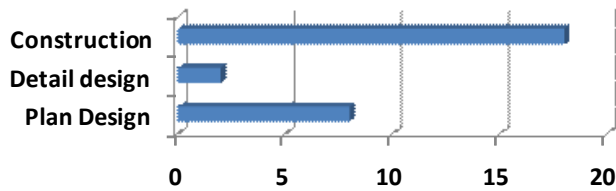

Figure 14. Number of BIM-Applied Projects

Only eight companies introduced BIM to projects as of 2008 in Korea, and the number of projects was merely 27. The BIM survey of CIFE in 2007 shows that 88 of respondent companies didn't perform BIM project as of 2007, but about 70 companies conducted at least one BIM project. Comparing the two surveys, even though this survey was conducted one year later than that of CIFE, it can be concluded that overseas BIM introduction level is higher than that in Korea.

Functions that respondent companies adopted in the BIM projects and that they intended to introduce in the future were examined.
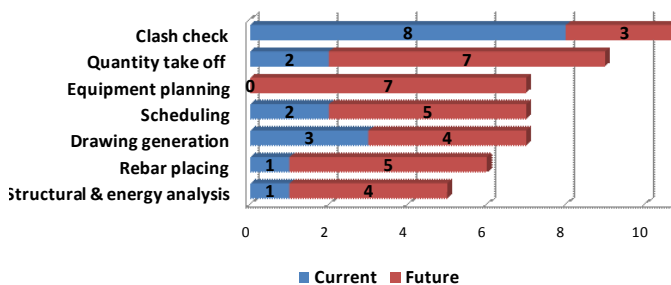

Figure 15. Adopted BIM function in Korea (current and future)

Figure 17 below shows survey result of adopted BIM function of McGraw-Hill construction report (2008), and Figure 18 shows survey result of adopted BIM function of CIFE's survey of BIM use in 2007. The function of clash check using BIM model is being used basically in both overseas and Korean construction industries. Besides, Figure 15 shows functions such as quantity estimation and schedule management are in need in the future. It is because BIM applications used and functions supported by BIM software are the same despite the cultural and technical differences between Korean and overseas construction industries.

Diverse functions are used such as quantity estimation, schedule management, energy analysis, submittal, and fabrication process by using BIM model abroad. However, the functions for temporary material planning or machine planning are still in low level in advanced countries of BIM. Many functions such as drawing production, estimation, temporary construction, and machine planning as well as clash check are expected to be introduced to domestic Korean construction companies soon.
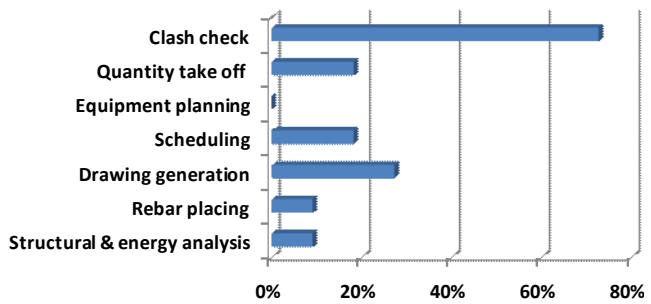

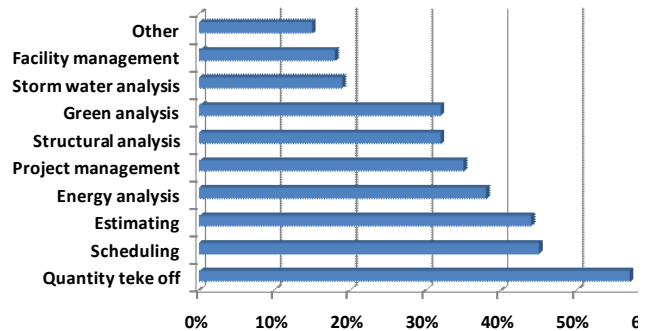**Figure 16.** Adopted BIM function in Korea (current, 2008)

Figure 17. Adopted BIM fucntion (McGraw-Hill construction)
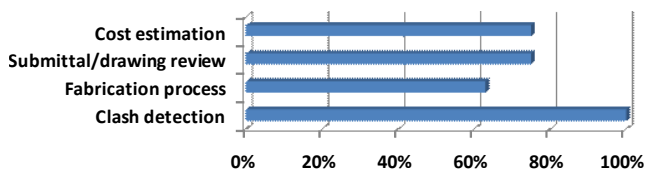

Figure 18. Adopted BIM functions (CIFE)

Among the expected projects of the respondent

companies, the number of projects where the owner wanted the application of BIM was surveyed as expected number for 2008 and 2009. 3 out of 7 respondent companies answered they have no such project for which the owner requested the application of BIM. The expected number of total BIM projects of the rest 4 companies in 2009 proved to be 11. According to the survey result of CIFE (2007), on the other hand, the companies which replied that the number of expected BIM-applied projects in 2008 would be more than 9 were over 45%, and 95% of 171 respondent companies expected at least one BIM-applied project [4]. Given this trend, BIM-applied projects in Korea are expected to increase in geometric proportion.

The experience of using more than two software programs during the BIM project was surveyed. 3 out of 9 respondent companies answered they used more than two different software programs during their BIM project performance. One of them answered it was difficult to conduct smooth construction work due to poor data interoperation, and they requested technical support from software supplier to solve the problem but couldn't get solution. Another company answered they managed to perform the tasks despite some problems in data interoperation, and they searched for solutions by themselves or used the software within certain limitations through technological research. Another company responded that even if there was data interoperation problem, it didn't directly bother the performance.

Interoperability is a cost issue abroad. It is reported that interoperability problem incurs around 3% of overall project cost. And, 58% of BIM users considered interoperability as a crucial factor in choosing BIM software [8].

5. CONCLUSION

After the introduction of BIM to AEC industry in Korea, the introduction spread quickly and enabled successful BIM-applied projects. But, the general introduction in Korean construction industry was difficult because most introductions involve limited aspects of BIM. Thus, this study is to figure out the BIM introduction status in Korea by surveying major construction companies in Korea and comparing with similar surveys abroad. The survey for the status of BIM introduction in Korea was composed based on the core success factors for BIM introduction deduced by the survey on two BIM specialists.

The status of BIM introduction of Korean construction companies was examined by overall application of BIM and degree of BIM use in 11 respondent construction companies. Among these, the following shows the part where comparison to overseas construction companies was possible.

BIM was introduced by only 11 out of 30 leading construction companies in Korea (2008). However, more than 50% of overseas construction companies have adopted BIM (2007).

Regarding BIM organization, one of the key success factors for the adoption of BIM, only two Korean construction companies clearly established their role. In abroad, many companies have already established exclusive organizations, and the number of employees per a BIM specialist was about 180.

Comparing the BIM project experience, 8 Korean companies conducted only 27 projects while more than 70 overseas construction companies have experienced at least one BIM project.

The frequently used BIM function in both Korean and overseas companies was clash check function. In Korea, however, it was not usual to adopt the other functions except clash check. The expected BIM introduction functions in Korea were not so different from those in abroad because the same BIM application is used around the world.

BIM in Korean construction industry is still in its introduction stage, and its adoption is becoming active. The survey suggested that the BIM related experiences and experts are still in short. Consequently, construction companies need constant efforts to expand the scope of application of BIM projects or applied functions within the limitation of current technology level based on the effort to raise BIM related specialists and establish the overall structure to successfully introduce BIM to Korean construction practice.

In Korea, around 4,500 construction companies are registered [2]. Even though the survey was not conducted against the all construction industry in Korea, this survey is meaningful in understanding the overall status of BIM introduction of Korean construction industry because the 30 leading companies are taking almost half of the whole construction business revenue. The survey may have errors due to the respondents' subjective replies because it was designed to require one BIM related staff of each company to answer the questionnaires, and may have statistical deviation caused by the fact that the number of the companies in survey was only 11.

For Korean construction companies, quick spread of BIM introduction is expected due to the application experience of CIC (computer-integrated construction) and established infrastructure. But, in Korea, there is no quantitatively evaluated case after the adoption of BIM yet. Thus, the survey on the adoption effect could not be conducted. In the future, it is expected that the increase in BIM adopted projects in Korea enables the comparison with the projects of existing method. The future study will cover the deduction of consideration factors for construction stakeholders like owners, contractors, and managers to successfully introduce BIM, and, based on this, a model that evaluates the degree of BIM introduction is to be developed.

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