PRELIMINARY STUDY REGARDING A DB CONSTRUCTION PLAN TO SUPPORT PERFORMANCE TECHNICAL A REMODELING ELEMENT TO BIM

Yong-Hyun Lee[1], Jong-soon Park[2], Jong-Sik Lee[3], Jae-Sauk Lee[4] and Jae-Youl Chun[5]

[1] Master's course, Department of Architectural Engineering, Dankook University, Yongin, South Korea
[2] Ph.D Candidate, Department of Architectural Engineering, Dankook University, Yongin, South Korea
[3] Ph.D Candidate, Department of Architectural Engineering, Dankook University, Yongin, South Korea
[4] Research Professor, Department of Architectural Engineering, Dankook University, Yongin, South Korea
[5] Professor, Department of Architectural Engineering, Dankook University, Yongin, South Korea
Correspond to zodiaccan@nate.com

ABSTRACT: If a brief direction and plan for a remodeling project are decided, it may moves to a concrete design step of which to select the most suitable alternative out of applicable compounding devices to reveal dynamic drifting performance. However, the volume of knowledge baseed utility which can refer to systematic evaluation regarding remodeling element technology and the accumulation of realistic cases are not only sufficient, but also short including its system for expression and consistency. Therefore, it may necessary to deliver the main frame which make enables the Owner, designer and builder to get performance technology for applying advanced remodeling element and knowledge based utility. There is a necessity to provide an information with latest made by virtue of modeling in the 3D/4D based on construction-based knowledge etc. which we can use for life cycle of a project, as a prominent way of knowledge based utility. Then, it is sure that remodeling can become more activative by sharing of knowledge based utility formed in electronic 3D/4D which is a systematic and expressed consistently to a performance and applicability in preservation of savings. It is expected for modeling of the 3D/4D in knowledge based utility enables to verify the practicability of each technology on effective application, and the use of technology might be spread widely due its obvious and oriented expressions. Further, this knowledge based utility formed in electronic 3D/4D may applicable for VE process in addition to remodeling design fields.

Keywords: BIM, Remodeling; Performance; Applicability;

1. INTRODUCTION

1.1 Research background and objective

They have high interest in remodeling of an apartment complex in both standpoints of a user and a supplier of construction service. The reason in the standpoint of the supplier is because the diffusion rate of housing is exceeding 100% in the nation(the past criterion) and remodeling can be an evasion method of sale risk due to real estate recession. And the reason in the standpoint of the user is though to be due to quality security of residence as well as current investment gains under the circumstances that re-construction is not easy.

However, it is also true that remodeling of an apartment house is not progressing like forecast or expectations. It can be thought that the external reason is because remodeling is inferior to re-construction in view of improvement of residence environment and development gains, and the internal reason can name that related laws or a system such as decision-making of residents or finance, etc. is insufficient.

Especially, clarity and objectivity of decision-making of a drive process are very important. That is, many important decision-makings such as performance understanding of existing builds, policy decision, direction setting of design, etc. should be performed in the initial stage such as remodeling planning/design, etc. By the way, it is the reality that a theoretical basis and systematic support backing up decision-making about main technology influencing a practical direction of remodeling are insufficient.

If the problem is substituted in a spiral process of knowledge creation of Nonaka Ikuziro, it is as follows.

That is, in two types of knowledge flow like tacit knowledge and explicit knowledge, the basis of the model is that new knowledge is created or existing knowledge is improved through 4 kinds of conversion processes(SECI) such as socialization which is a process that tacit knowledge is changed to another tacit knowledge, externalization converting tacit knowledge to explicit knowledge, combination which is a process that explicit knowledge is changed to another explicit knowledge and internalization which is a process that explicit knowledge is changed to tacit knowledge.

If we think on the basis of the model, there are the following problems in our society. First, the work

externalizing the remodeling element technology existing tacitly or disorderly is connected.

Second, although there is the remodeling element technology formalized according to each enterprise or institute, a tool connecting a detailed project or supporting it is not existent explicitly.

As socialization or internalization is an internal process that each individual or organization constitutes or improves technology of knowledge, the present research considering decision-making of a project level or its support system excludes it from a view range. That is, the purpose of the present research is, first, to externalize performance information of the element technology with theoretical systematicness and consistency, namely, to make it a knowledge basis, so that the related subject such as owners or designers can always refer it comprehensively in policy decision of remodeling and decision-making at the time of planning and design.

Second, it is to develop connection tools that can help the persons related with the remodeling execute decision-making of the facing project by using or referring the knowledge basis of externalized element technology. That is, it is to be effectively utilized in the design & construction stage as well as the maintenance stage by being linked to the BIM tool which is a connection tool. However, the first purpose mentioned above needs social consensus as only a device of an individual researcher is not enough, and the second purpose properly shows function only when it is linked with a CAD system, etc., being used in case of architectural planning or design and maintenance. However, as the system is also developing, the present research focuses on preparing the basis as a preliminary research.

1.2 Research method

The research deals with introduction of remodeling element technology, analysis of characteristic performance and application performance, efficient management of BIM database in the following manner in order to support decision-making of project participants and to enable efficient management of remodeling technology.

First, the preliminary research introduces remodeling element technology and shows necessity of characteristic performance and application performance, categorizing them by items.

Second, BIM is defined and current state of BIM tool is analyzed based on actual construction projects, both at home and abroad.

Third, the research examines problems in cases of applying BIM tool in domestic projects, and explains a need to apply element technology through BIM in a remodeling project.

Fourth, the research suggests how to establish database on element technology of a remodeling project using BIM, and provides a future research direction

2. ITEM DISTRIBUTION OF PERFORMANCE AND APPLICABILITY OF REMODELING ELEMENT TECHNOLOGY

The most prominent difference between new construction and remodeling is the existence of an owner(user) and structure. Performance of a remodeled building depends on remaining part of the previous structure and newly added structure. Since many residents become an owner of the project, their decision and demand determine whether the project will be implemented regardless of whether a legal requirement (building needs to be over 15 years old) is fulfilled. Multitudinous needs make it difficult to fulfill all demands. From standpoint of the residents, it is critical to identify a remodeling technology that has excellent performance and highly suitable for the existing structure in terms of cost and construction period in order to improve living environment of the deteriorated housing.

(1) Introduction of performance improvement technology

Technology is briefly reviewed in order to understand existing remodeling element technology centered on objective of technology, field of application, implementation method and main benefits with reference to Building Structure Remodeling Technology (2004, Korean Intellectual Property Office).

Table 1. Brief of Performance Improvement Technology

Item					Index
Technology					
Developer					
Development fiscal year					
Patent registration number					
Actual object or Example of application (picture or Plan)					
1. Technical field & application part					
Architect-ure	Structure (Support)	Entire of building or Insert material having entered to a lot of wealth			
		Wall construction-Wall			
		Column of Column-Beam contruction			
		Beam & Wall of Column-Beam contruction			
		Roof, Roor Slab, Terrace			
		Foundation			
		Stair			
		Additional structure sieve increase having made for the purpose of purity structure to existing structure external circular notch.			
	In-fill	Cladding	External wall	Wall, parapet	
				Window	
				Balcony (railing)	
				blind, Canopy	
			Partition	Wall	
				Door	
		Finish	Slab		
			Wall		
			ceiling		
			External wall,		

			Balcony
			Roof, Rooftop, terrace
			Others finish
		Facility	Elevator
			Ventilation & breathing facility
			Air conditioning facility & Plumbing
			Electric facility & wiring
			Communication facility / wiring
			Gas facility & Plumbing
			Water supply facility & Plumbing
			Rain-water, pumping out facility & Plumbing
			sanitation
			security (lightning, fire-protection) crime prevention
	Space extension	front and rear extension	
		Right and left extension	
		Rooftop extension	
		Underground extension	
	Dismant-ling & Deduction	Deduction	
		Dismantling	
Parking Area	Inside	machine	
		independence	
	outside	ground (machine / independence)	
		index	
		underground (machine / independence)	
landscape	Outside ground		
	Rooptop		
	External wall		
	Etc.		
Engineering works	roadway, pavement		
	a water-purifier tank, water supply of outside sewage & rain-water, Sanitary sewage treatment tank. etc. laying equipment		
4. Characteristics and main benefit (Critical problem of existing housing or merit solved through this technology)			
5. Data source			

(2) Characteristic performance of performance improvement technology

Characteristic performance included quantitative elements such as energy-saving, environment-friendliness, non-toxicity for a human body and qualitative elements such as safety and aesthetical value. The following classifies characteristic performance of performance improvement technology in reference to a research on performance criteria of housing complex by items (1988, Housing Research Institute of Korea National Housing Corporation).

Table 2. Evaluation Criteria for Characteristic Performance of Performance Improvement Technology

Group	Category	Item
Durability/ safety	Durability of Structural Material	Repair/maintenance of initial performance
		Structural life extension
	Structural Design & Structural Safety - ISO 15928-1:2003)	Improvement of Earthquake resistant performance
		Improvement of seismic-response controlled performance
		Improvement of base isolation performance
	Fire Safety	Improvement of Fire detection/alarm
		Improvement of Smoke extraction / evacuation
		Improvement of Fire-resistant, flame-resistant
	Natural Catastrop-hes	Improvement of Safety against natural disaster(typhoon, thunder, heavy rain)
	Life safety	Prevention Of Slip, Overturning & Fall . etc.
Amenity, Health, Illness and Injury Protection	Functiona-lity of Space	Area expansion
		Insurance of ceiling height
	Walking sensation	Shock absorption, Insurance of Noise
	Visual environm-ent	Fine view
		Natural lighting
		improvement of Artificial illumination
		visual fatigue prevent & visibility ensure
	Audio environm-ent	Improvement of Sound absorption
		Improvement of Noise isolation
		Reduction of itself Noise occurrence
	Climatic Loading	Insulation, thermal storage, thermal generation, anti-dew condensation
	Air environm-ent	Decrease work period pollutant release in the hall which is harmful to a human body.
		Improvement of ventilation performance
Consid-eration for the elderly	Comport	People with impaired vision
		People with impaired hearing
		Disabled, Consideration for children, senior, aged
Maintainability	Easy maintena-nce and change	strengthening of Anti-contamination
		Spatial flexibility
		facility flexibility
		Easy maintenance/repair (Interoperability of components)
		Easy maintenance/repair (Compatibility of components)
Security	Security in Use	Intrusion Protection performance
		Enhancement functional a watch
Environment – friendly-	Embodied Environ-mental	If make dismantling, Classified waste collection, recycling
		Prevention of air pollution from

ness	Loads, Energy and raw Material Content, Emissions, Recycling	waste disposal
		Prevention of soil pollution from waste disposal
		Prevention of water pollution from waste disposal
Energy-saving	Architect-ure Ener-gy-saving performan ce	Natural energy utilization
		Improvement of Insulation performance
		Improvement of confidentiality performance
	Facility performa-nce	Performance of Facility & Improvement of Function
		Efficiency improvement of facility (operational energy & water consumption reduction)
		Life extension of facility
Aesthet-ical value	Aesthetic-al perfor-mance	Improvement of Aesthetical performance of indoor common part
		Improvement of Aesthetical performance of indoor private part
		Improvement of Aesthetical performance of External wall
		Improvement of Aesthetical performance of Rooftop
		Improvement of Aesthetical performance of outdoors

(3) Applicability performance of performance improvement technology

Applicable performance includes quantitative elements such as cost (economic feasibility) and qualitative elements such as easiness to combine with other technology.

Table 3. Evaluation Criteria of Applicability of Performance improvement Technology

application performance department	Category / Item
Application method	Re-construction after removal
	Additional mounting
	Replacement
	Add on the existing member
	Arrangement change in a building
	Change of building's form & scale
	Change of arrangement of Each hall & House
Cost	Cost throughout economic life
	Initial cost (Construction cost = Estimate basis application)
	Annual average maintenance cost
	Cost of Removal & abrogation
	Recycling Profit
	Life cycle cost
Applicabil-ity	Periods on construction (or Model type of 1 Dong)
	Engineer being required for a construction (or Model type of 1 Dong)
	Temporary structure being required for a construction (or Model type of 1 Dong)
	Quality stability
	Connectivity of existing parts whit surrounding part / easy attach - take off (Joint technology)
	Dgree of difficulty of curing
	Workability
	Compatibility
Work safety	Construction of work safety
	maintenance of work safety
Energy-saving Performance	Energy consumption in production stage
	water consumption in production stage
Environm-ent - friendliness	Discharge of toxic, volatile substance
	Dust in production stage
	noise in production stage
Others	easy of dicision making(resident agreement) Influence of elevation, building coverage, floor space index

After deciding on general direction and option of remodeling, the process moves on to a design stage to combine most suitable alternatives among specific technology candidates with similar performance capacity. However, in reality, systematic evaluation of remodeling element technology and database for reference are insufficient, and also lack structure and consistency. Thus, with like table 1, 2, 3, it is important to establish database on performance and applicability of remodeling element technology for a project owner, designer and builders to utilize widely, which supports decision-making in schematic plan phase of a remodeling project.

3. DEFINITION OF BIM AND CURRENT STATE OF RELATED TOOLS

3.1 Definition of BIM

BIM stands for Building Information Modeling, and indicates a technology to produce and manage information in a 3D system that is applied to entire lifecycle of a project from schematic plan to maintenance.

Table 4. Concept of BIM [3)]

Building	Lifecycle of a building (design, construction, operation, management)
Information	Entire set of information in regard to lifecycle of a building
Modeling	Integrated tool and platform to produce, manage, publish all information in regard to lifecycle of a building

NIBS (National Institute of Building Sciences) of the U.S defined BIM as a digital presentation of physical and functional characteristics of a facility. At first, the concept focused on information exchange and provision among softwares centered on IFC (Industry Foundation Classes) of IAI (International Alliance for Interoperability), but its scope expanded to a concept that integrates information, process and interoperability related to an entire lifecycle of a construction project from planning to maintenance.

3) Kim, Eonyoung, " Digital Architecture Tools and BIM Paradigm", Special Issue, 2005

3.2 Application example of BIM tool and its analysis

Two main merits of BIM are strong graphic tools and provision of information management environment. BIM combines design elements of 3D with their attributes. Overall 3D modeling is realized by combining design elements of door, wall, curtain wall, floor, beam and column, which includes architectural elements of measurement, material, texture, and which includes managemental elements of unit cost, work process and specifications.

BIM management environment should enable efficient delivery of all information throughout a lifecycle of a project. It helps project participants to reuse or refer to information and make a new decision through information management by addressing on problems such as loss, re-input and redundancy of planning data in collecting, processing and DB performance information of technology.

The following surveys and analyzes widely used BIM tools in Korea.

1) A company

This BIM tool brought about substantial cost-saving by avoiding design errors of 2D drawings, for projects including Freedom Tower that is being erected at former World Trade Center site that became a ruin with 9.11 terrorist attack in 2001.

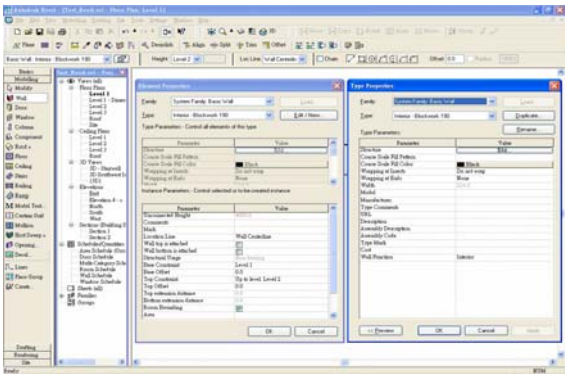

Fig 1. Interface of A company

2) G company

This BIM tool is charged of entire design of Eureka Tower project in Southgate area of Melbourne, Australia and has a market share over 70% in the global market.

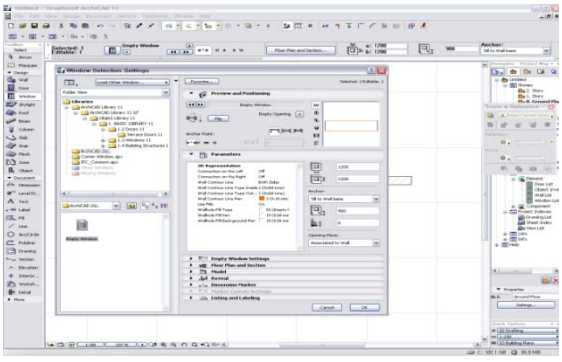

Fig 2. Interface of G Company

The tool examines workability of housing-commercial complex and office facilities built by large construction companies in Korea. It minimizes interference among different materials to save cost and reduce construction period.

3) Analysis result

Most commonly used BIM tools in Korea were firstly used for newly built structures; secondly, in terms of information input by elements, they consisted of only numeral data such as size, quantity and amount like in 2D drawings with like table 6.

Table 5. Utilization scope of BIM Tool

	Utilization scope
1	3D Design
2	Detailed estimates, approximate estimates
3	Cross check (Frame, Architecture, Finish, Machine, Facility)
4	Progress Simulation
5	Progress , prime cost management
6	Output of amount of material
7	Communication, Cooperation
8	Plan management (Save, Application)

Information input items for BIM objects are as follows.

Table 6. Drawing Items of BIM Object (example of window)

Item	Elements of BIM object (ex.window)
Plan	Interior materials hatch (steel, wood, glass, etc.), finish line, pen type, opening direction, background line, inner/outer line, no. of frames, depth, hinged, anchor point, inside measure, etc.
Elevation	Exterior materials hatch (steel, wood, glass, etc.), finish line, pen type, background color, grille, background pen type, no. of frames, etc.
Section	Section line, section pen type, hatch line, hatch color, finish line, inner/outer line, background color, background pen type
Dimensions	Center line, inside measure, thickness measure, wall center measure, height measure, floor height measure, etc.
ID	Architectural symbol (window symbol), ID
Mark	Letters, diagram, line
Item	Elements of BIM object (window)

4. APPLICATION OF REMODELING ELEMNT TECHNOLOGY USING BIM

The basis of remodeling is an old building; it has limitations such as expanding and integrating plan due to

existing structures. Therefore, unlike technology applied to a new project, remodeling element technology needs to consider characteristic performances and applicability more carefully. Thus, the purpose can be manifolds in adopting BIM in a remodeling project, but mainly, they are for design decision-making, elimination of risk factors with prior check on workability, securing accurate and timely drawings, cross check, and budget establishment using data on quantity and estimated figures. Merely adopting BIM does not guarantee best result; database needs to be established to effectively utilize BIM in remodeling.[4)]

As we generally removed all things except structure, it selected other technology which can compare in BIM tool, for example, Performance items regarding the existing remodelling earthquake resisting performance elevation technology. This numeric information and similar technical performance for the equal purpose make comparison possible among BIM working environment.

Table 7. BIM Item of application possibility (example of Constucture Tecnique)

Technology		A	B	C
Technique Area		Rahmen	Rahmen	Rahmen
Type of complex for application		Higher	Middle	Middle
Area of application		Common	Common	Private
Application purpose	Spatial function	Top	Middle	top
	Environment-friendliness	Top	Top	Middle
	Energy-saving	Middle	Top	Top
	Structural performance	Top	Top	Top
Application method		Replacement	Supplement	Replacement
Durability		Top	Top	Top
Structural safety		Top	Middle	Low
Maintainability		Middle	Middle	Low
Aesthetical value		Low	Middle	Middle
Initial cost	Material costs	$4,040	$2,336	$3,055
	Labour costs	$3,853	$1,545	$4,716
	Temporary costs	$877	$1,107	$754
	Etc	$265	$352	$179
Quality stability		Top	Top	Middle
Workability		Middle	Middle	Middle
Work safety		Top	Middle	Low
Noise		20db	30db	10db

5. CONCLUSION

Project process and result whose resident collecting decides requirements make or break in the plural habitants and each of the various requirements at remodeling.

In the study, Owner and designer could refer to make a decision which the element technical remodeling establish complex knowledge basement at remodeling plan and design phase.

First of all, Contents of preferential complex knowledge basement arranged to summary, nature performance, application

Recently interest in remodeling is rising in terms of government policies as well as individuals. Success in initial stage of remodeling depends on whether it can effectively accommodate the residents' needs. This research classified items in regard to element technology, characteristic performance and applicability of remodeling technology in order to establish knowledge database that enables systematic evaluation and reference to the result. In addition, the research analyzed component elements virtues and faults in remodeling objects through comparison of the above BIM Tool, suggesting establishment of performance information of remodeling technology applicable knowledge base BIM tool.

It is important that we identify conditions that can support BIM for deteriorated apartment, excluding newly built housing, limiting a scope of applying element technology. To do so, BIM is able to present performance items that are particular to remodeling project, instead of merely listing figure data found in 2D drawings.

Technology can be more actively used as BIM inspects its usefulness (practicability) in a visual and comprehendsive manner, presenting them systematically. As, in the initial stage of a project, BIM can be used for remodeling design that satisfies demands of a majority of the residents, as well as for VE process. Further research is expected to develop supportable interface, as a way to store and utiize the knowledge database of performance information of the technology.

6. ACKNOWLEDGEMENT

he present study was supported Ministry of Land, Transportation Affairs(MLTM) through High-Development Program(HUDP) of the of Construction & Transportation Evaluation and Planning(KICTEP).

REFERENCES

[1] 1 persons except for Kwon, O-Cheol, "*A Study on the Improvement of 2D Digital Drawing Standards Considering the Paradigm Shift to BIM*", Journal of the Architectural Institute of Korea, 2008

[2] Seo, Hyeong-wook, "*A Study on the Performance Evaluation System for Remodeling Apartments House*", Dankook University Master of Arts

[3] Jang, Se-Jun, "*Study on Substitution Effect caused by Application of BIM Simulation System to Mock-up Site"*, Journal of the Architectural Institute of Korea, 2008

4) 1 persons except for Kwon, O-Cheol, A Study on the Improvement of 2D Digital Drawing Standards Considering the Paradigm Shift to BIM, Journal of the Architectural Institute of Korea, 2008

[4] Kim, Eonyoung, " *Digital Architecture Tools and BIM Paradigm*", Special Issue, 2005

[5] Timo, Hartman, *"Areas of Application for 3D and 4D Models on Construction Projects."*, Journal of Construction Engineering and Management, 2008. 10