

A Study on the Development of Standardization for Building Process based on BIM

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Abstract

Recently as construction environments in speedy way, BIM technologies are used as a powerful tool in construction project for construction management and operation. The technologies are based on integrated management system of the whole construction process with using 3D simulation, 4D (work management), 5D (cost management) and 7D (environment and energy). Model based on BIM 3D, 4D (work management) and 5D (cost management) and 7D (environment and energy) are established during phases (pre-design, concept design, design development, construction documents and construction) aiming at building. A BIM process standardization of construction phase is suggested to review constructability (interference check using BIM modeling of construction phase etc.) and efficiency.

Keywords: Building Process, Building Information Modeling (BIM), Construction Sites.

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INTRODUCTION

Recently, construction projects have become larger, more complex, and more amorphous, and the introduction and application of Building Information Modeling (BIM) technology are rapidly spreading. In addition, as the number of organizations participating in the project increases, the smooth exchange of information between each participating entity is emerging as an important factor in determining the success or failure of the project. In order to respond to such changes, BIM-based processes and standardization development are needed to quickly utilize information flows for 4D (process management), 5D (estimate management), and 7D (environment and energy) of the design stage through BIM.

In Europe and the United States, manuals for various processes have been developed and consistently provided to apply and utilize 3D information from construction planning to design, construction, and maintenance through the introduction of BIM. In particular, by standardizing these standards and applying them to various project models, the efficiency of construction management is maximized.

However, in Korea, BIM information cannot be shared and integrated between construction participants, and it is limitedly operated for mutually limited data. By applying only a part of advanced BIM system tools, technical performance effects such as design and construction efficiency analysis and cost reduction are limited.

Therefore, this study aims to present a BIM-based architectural integrated management model that processes and standardizes the process for project participants to efficiently operate BIM 3D, 4D, 5D and 7D utilization technologies.

A REVIEW OF EXISTING RESEARCH

Establishment of BIM Business Processes at Home and Abroad

There is no clear definition of the practical BIM process for domestic and foreign design and construction stages. The currently reported processes (Table 1) are mostly published by public institutions or research institutes, and manuals such as the management tasks and requirements of the orderer regarding BIM are mainly presented. Various standards of order guidelines can be reviewed through the BIM guidelines presented by domestic and foreign public institutions, but there is a limit to BIM practical guidelines applied to the field of design and construction sites.

Table 1: BIM domestic and foreign process manual

Organ		Guide name	Year
South Korea	Hanyang university graduate school of engineering	A study on a collaboration model for the integrated bim process implementation on structure	2017
	KIBIM	Schedule(4d) and cost(5d) implementation using bim integrated data	2017
	KIBIM	Construction Safety Management using 4D BIM Tool	2017
	KJCEM	Smart City Development Using BIM Information Model Based on Artificial Intelligence	2019
	Yeungnam university graduate school	The construction project ev tracking process based on the 3d point cloud and 4d bim	2021
	Seoul national university of science and technology	A study on the efficiency of 4d schedule management of mechanical facilities according to the 4d bim-based schedule management Process	2021
	Korean institute of BIM	A collaborative process between employers and practitioners for utilization of bim and 3d scanning	2022
	Korea institute of building construction	Integration of 3d laser scanner and bim process for visualization of building defective condition	2022
	United States of America	Sciencedirect journal	Bim-based 4d mobile crane simulation and onsite operation management
United kingdom	IOP publishing	Research on fine management of expressway construction schedule, quality and safety based on mobile terminal	2021
China	Zibo vocational Institute	Bim-based strategies for construction quality control in building engineering	2022
	Cornell university	Semantic localization in Bim using a 3d LiDAR sensor	2022

Domestic BIM business process examples=>International and international BIM business process examples

S University's Academic Information Center is an amorphous building and is a representative example of BIM application in Korea that reviewed construction feasibility using 3D BIM, created shop drawing using 4D BIM, and calculated quantity through 5D BIM. (Figure 1) At the time of the project, there were a shortage of BIM experts, a problem of settling the BIM process, and technical limitations of BIM tools, but some meaningful results were derived in the field of interference check, coordinate value derivation, and engineer understanding.



Figure 1: BIM domestic and foreign process manual

K University's dormitory is an example of BIM modeling-based construction and CM management that manages the attribute information value and work set of BIM models to calculate supplies and solves the problem of missing quantity in the existing 2D drawings. [6] It is a project that documents the information in modeling and actively utilizes BIM modeling from design to construction stage. Before entering the construction stage using BIM, the digitized modeling was reviewed to minimize redesign and re-construction in the design process, and the Digital Tool Programming was

connected to the construction rather than simply design and presentation elements. (Figure 2)

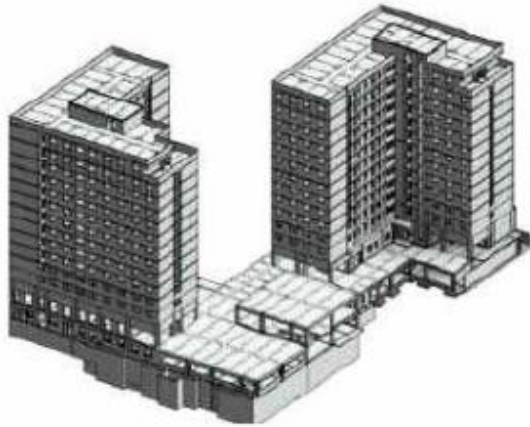


Figure 2: Overview of the Rental-type Private Capital Project at K University

The Korea Air Museum is an example of a project that selected and arranged cranes through a load review using BIM at a time when a review for ordering materials before construction is required. [6] For the design changes that occur during construction, the adequacy of the design was reviewed using BIM and reflected in SHOP-DWG to ensure accurate and safe construction.

From design modeling to design error, interference review, quantity calculation, visualization data production and process simulation, COST savings have been achieved with

BIM. Effective BIM use is a project that can be seen to be associated with air reduction and cost reduction. (Figure 3).



Figure 3: A bird's-eye view of the Korea Air Museum

The Ministry of Land, Infrastructure and Transport's basic guidelines for BIM application to establish BIM process systems as a key means of integrating and communicating information exchanged and transmitted throughout construction, such as planning, design, procurement, construction, and maintenance. [7] In 2021, a BIM roadmap for the construction industry was also announced that includes BIM development strategies and implementation plans, such as mandatory application of BIM in the public construction industry. In the construction industry, BIM design obligation and building BIM for turnkey and public road projects are being activated, and research is being conducted to establish strategies for implementing BIM processes in the overall construction sector. (Figure 4).

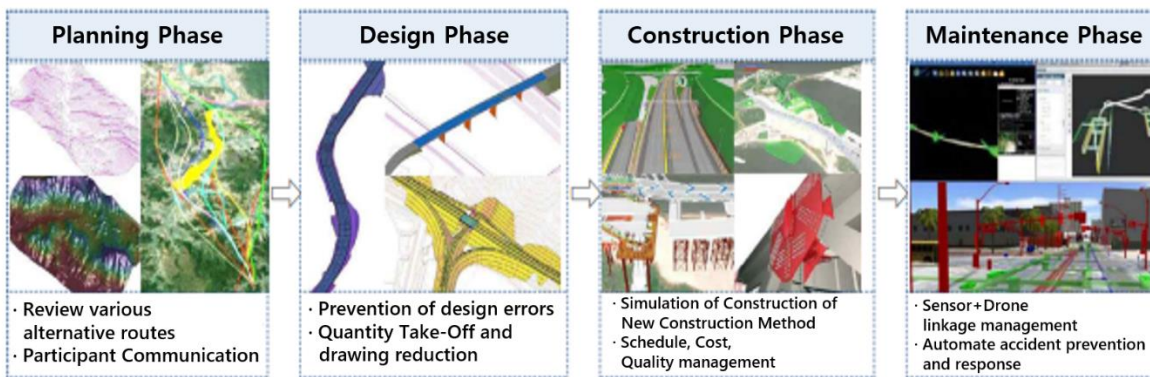


Figure 4: Carry out BIM process throughout construction

Pennsylvania State University in the United States developed the 'BIM Project Execution Planning Guide' to develop BIM execution plans optimized for the specific purpose and characteristics of construction projects. [8] This guideline defines BIM Goal & Users and includes design of BIM project execution process, type of project-related information, LOD, responsible location, and definition of the infrastructure required to carry out the project.

It can be used to identify the characteristics of the project and set the correct direction for establishing BIM strategies for construction companies, and the U.S. Army Corps of Engineers uses this guide as a basic work framework according to the organization's BIM introduction purpose, and define BIM application technologies according to the characteristics of the project. (Figure 5).

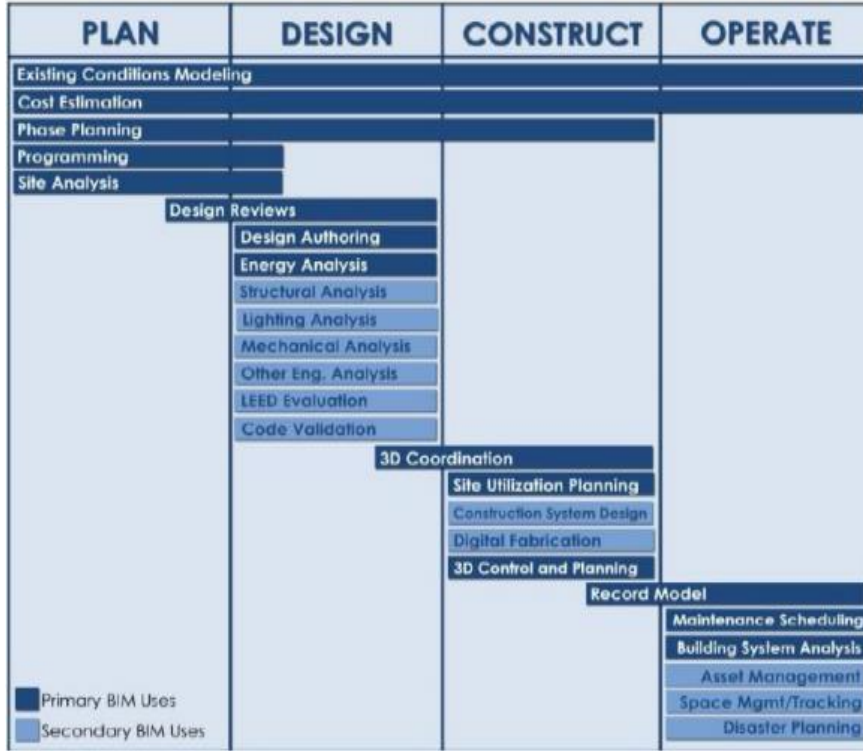


Figure 5: BIM Uses throughout a Building Lifecycle (Messner, 2009)

Comprehensive analysis of BIM applications in korea and abroad

BIM, which was examined through domestic and foreign case studies, has been performing pre-design errors and spatio-interference checks based on 3D drawings. In particular, overseas cases of BIM 4D and 5D types of practical application and development have been actively conducted compared to Korea, and BIM 7D, a preliminary simulation analysis stage for the environment such as BIM-based structural analysis, sunlight, and view, is applied to project practice. In addition, processes of planning and design stages and construction stages are established to perform various tasks in advance through the BIM integrated operation organization (Table 2).

Table 2: BIM applicable analysis of domestic and international construction

Domestic	Foreign
3D Simulation ⇒ Three-dimensional visual effects (understanding) and review	Same as left
2D Drawing error checking ⇒ Repeat flaw the verification	Same as left
3D Interference check process ⇒ Time savings, Cost savings	Same as left
BIM 4D(work management) and 5D(cost management) ⇒ Try part	Europe (active) North America (try parts)
BIM 7D Comprehensive Environmental Analysis (sunshine, incense) ⇒ Try part	Applicable to the project actively

**ARCHITECTURAL BIM PROCESS PROCEDURE
BIM Integrated Management Organization Operations**

BIM managers in each sector are needed to coordinate collaboration between designers and construction companies in BIM practice, which can lead to overall work coordination. Vertical operation, which is an existing construction organization, creates an unreasonable structure in the relationship between A and B, which hinders collaboration and information exchange.(Figure 6) Therefore, it is possible to derive efficiency and standardization of BIM process work in construction work through a horizontal management organization that can be integrated between BIM participants.(Figure 7)

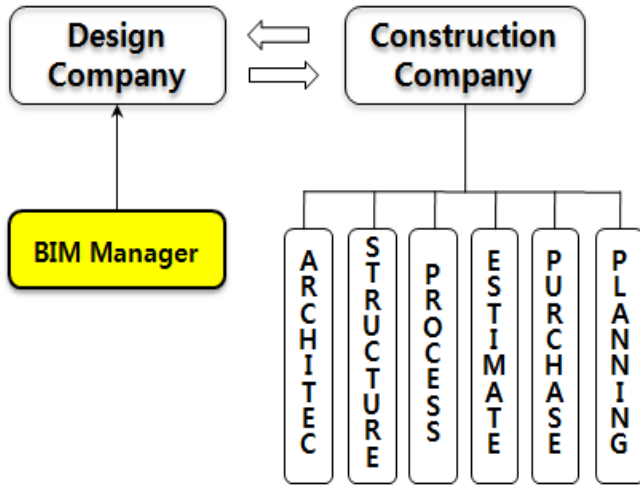


Figure 6: General construction of vertical organization operating

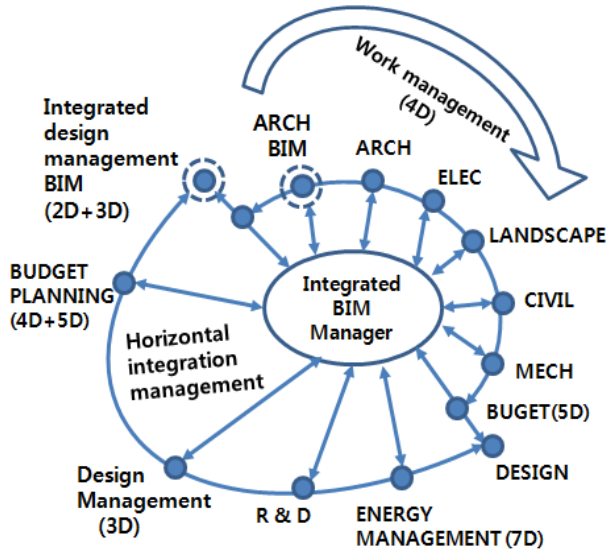


Figure 7: Horizontal integration construction organizations operating

Detailed Management Work by Sector

Detailed management details for each sector participating in the project are as follows. First, the construction site agent must integrate and manage BIM data in the design and construction stages. Second, the construction team actively uses BIM-based 3D modeling and drawings for each construction type as a means of communication during process meetings or business collaborations with other construction types. Third, the BIM team leader of the designer shares the process simulation (4D) and quantity calculation (5D) BIM data with the relevant collaborative agencies and performs the integrated work through unified code.

Through this, site changes that occur until completion can be accurately reflected in BIM data and used for future maintenance through integrated management consistent with

the site. Fourth, construction contractors apply BIM files, checklists, BIM-based Shop Drawing, and VR File creation through BIM software-related training at the same time as the contract is signed.

BIM Writing Principles for Process Standardization

It is necessary to standardize process procedures for BIM integrated management organizations. This integrated 3D, 4D, and 5D BIM processes from the initial design department stage to site construction and maintenance can be operated to provide the foundation for BIM process standardization with an integrated database through the review of construction cost and construction schedule.

Design and Construction BIM Business Process

BIM models in the design stage are promoted in consideration of modeling criteria that can utilize BIM data in the construction stage, and standards such as code systems such as WBS, CBS, and OBS for linkage with BIM models, and object location information such as LOD, floor, and site.

The business processes that conduct BIM are standardized by considering the implementation cases of design BIM, estimate BIM, and process BIM together with the existing business processes. In addition, the implementation order is carried out by organizing the existing design, estimate, and process work processes, and establishing a system such as BIM software and hardware, considering the modeling method, design, estimate, and connection of process BIM.

Standardization of business processes for BIM application should be a complete schematic of the entire process from design to structure, estimate, and construction to organize business processes, and improve completeness through continuous revision as projects are carried out. In particular, BIM-based design work requires construction companies to participate from the initial stage to smoothly utilize the design BIM model during the construction stage. (Figure 7).

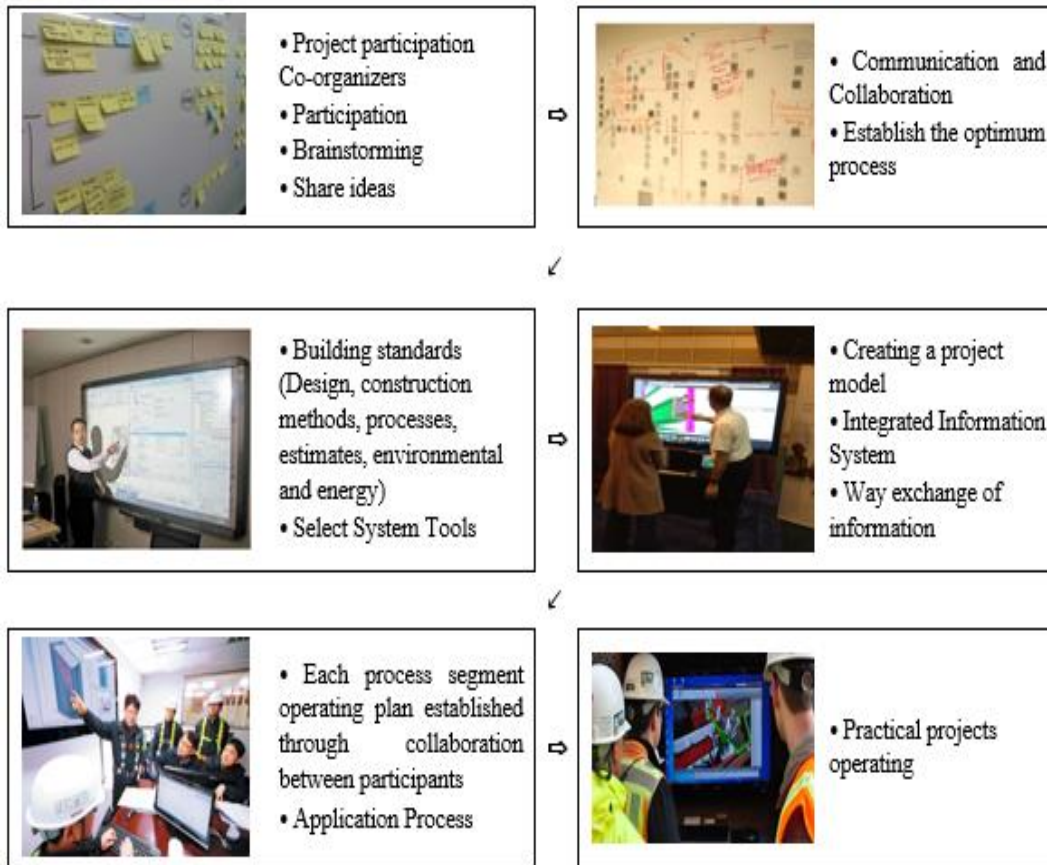


Figure 8: Design work process of BIM

Setting drawing ranges

In extracting drawings from the design BIM model, it is divided into parts that extract data from BIM and create drawings using existing 2D CAD. Rather than extracting all elements of drawings with BIM based on efficiency, it is more efficient to use the existing 2D CAD software simultaneously if the existing method (2D) is more productive such as the period of drawings and the underground detailed structure.

analyzed through simulation on the impact of buildings on the environment and energy aspects using a 3D model. In addition, various information can be transmitted using 3D data, and the energy performance of buildings can be analyzed through this information. These analysis results are reflected in the architectural design stage and reconstructed into efficient buildings.

Development of Building BIM Process Standardization

In order to organize BIM process procedures and standardize them, operational processes from design planning to construction should be integrated. In addition, standardization development can play a role as a major decision-making tool for construction participants by reviewing three-dimensional pre-information exchange, efficiency of budget work, and construction plan (process).

The BIM-based process model for the management efficiency of the construction system visualizes 2D drawings based on the 3D model of the building, thereby minimizing time and economic loss by pre-extracting errors and interference in the drawings. (Figure 8) BIM 7D can be

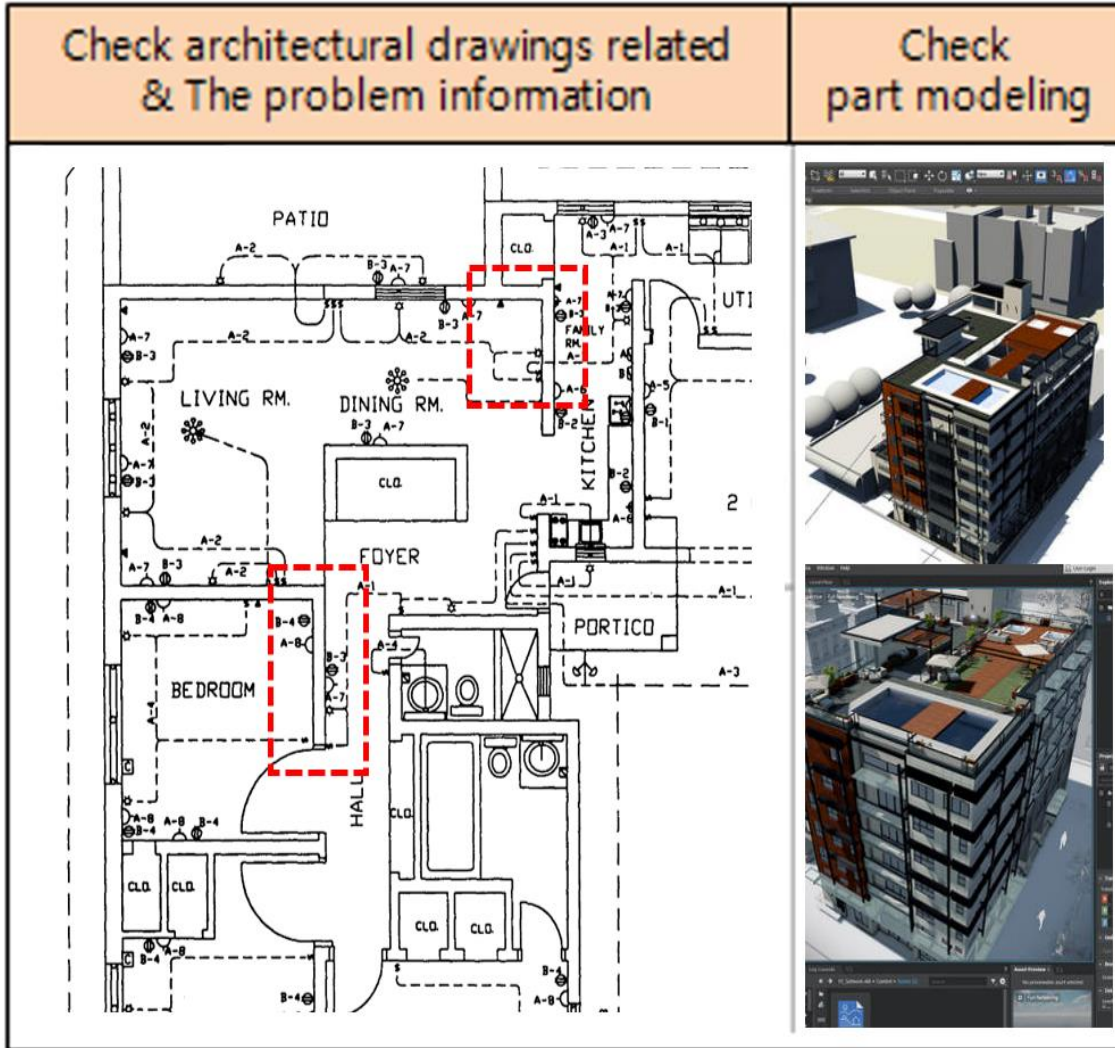


Figure 9: BIM construction interference checks

The BIM 5D system, which can improve the accuracy of budgeting based on the quantity information and architectural information of the 3D model, can be estimated and cost-managed. At the same time, in the construction plan establishment step, certainty can be given to setting the direction of construction progress with the building information and volume information of the accurate drawing. It can be seen that in order to minimize re-construction, process management is performed based on BIM-based construction information including object information for each part, and quality management is possible.

The use of BIM process management (4D) technology is promoted with the aim of overcoming the limitations of 4D use in the existing practice and developing a plan for use in process planning, simulation, and progress management in the actual field. The existing 4D technology establishes a

process plan using the process management software, Ms Project, Primavera, etc., and visualizes the work order by linking the object of the 3D model and the activity established in the process plan. The process BIM (4D) work process is standardized in the order of Activity generation(CBS consideration based on details) ⇒ Zoning (application of task classification system) ⇒ Schedule Modification (Activity interference check and manpower input readjustment) ⇒ Schedule calculation (LOB, Gant, Network Schedule) ⇒ 4D simulation (Progress Management). (Figure 9).

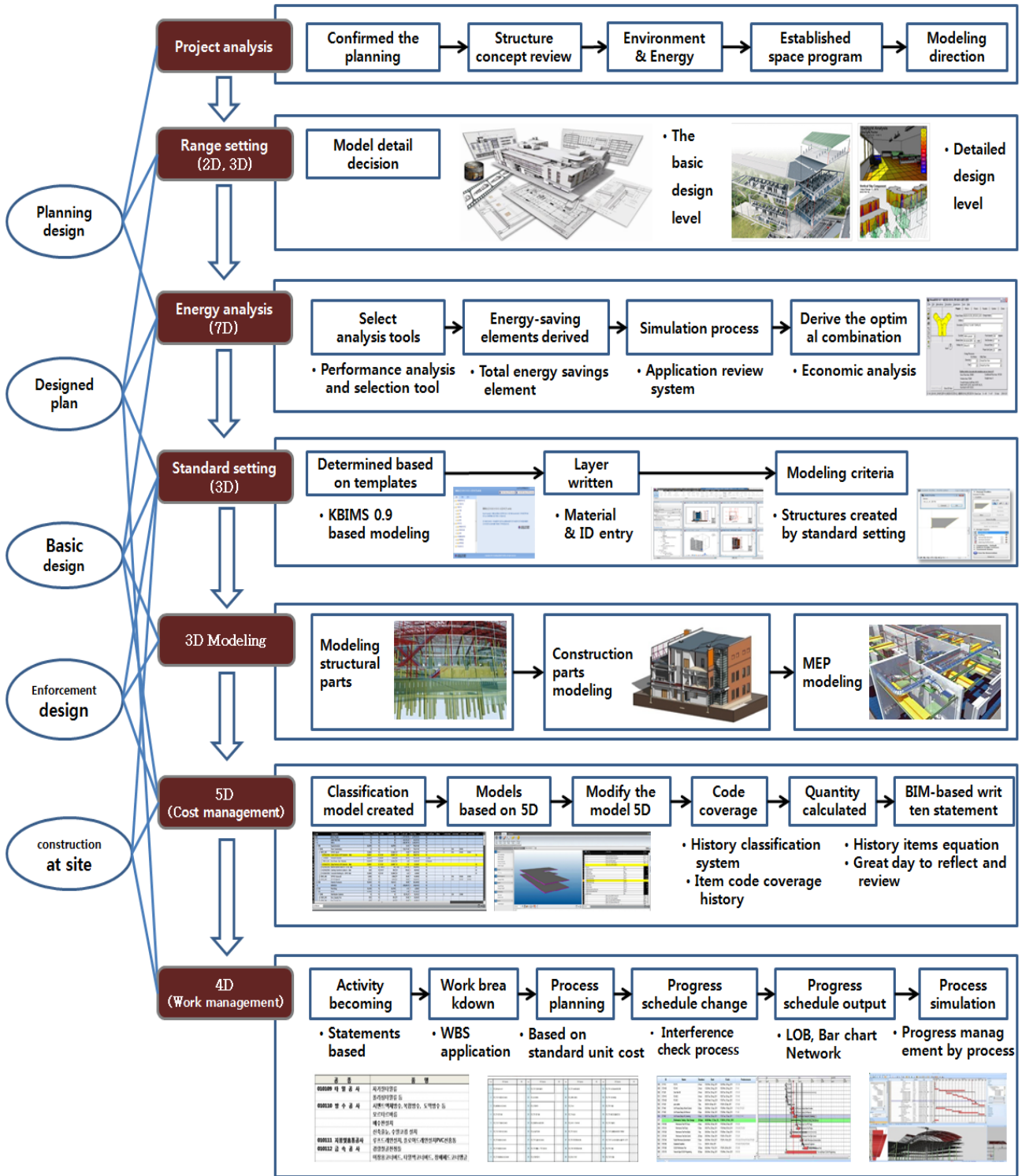


Figure 10: BIM Standardization for Constructor Process Based on BIM 3D, 4D, 5D, 7D

CONCLUSIONS

In this paper, the standardization of BIM-based construction process from the design stage to the construction stage was reviewed, and an efficient construction system plan was proposed through this. In addition, the status and possibility of BIM application were identified through theoretical consideration of BIM and domestic and foreign case studies. BIM's various tools, 3D, 4D, 5D, and 7D, were reviewed for efficient process development through the overall flow of the project and the role of participants, and work procedures were presented to standardize them.

The BIM-based architectural process and the process of standardizing it have limitations in spreading it throughout the architecture through the pilot application or research stage of some projects. Through BIM-based 3D, 4D, 5D, and 7D accumulation of integrated system cases, quantitative and qualitative analysis of process efficiency, it is believed that a sustainable market will be formed in the long run if various expert groups, including countries, project participants, and field practitioners and academia, recognize the need.

In addition, if the BIM standardization process solves various problems such as productivity improvement, error reduction, and eco-friendly low-energy direction construction, and actively introduces them in large-scale projects such as complex and amorphous buildings, it is expected to contribute to the construction industry.

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