METHODOLOGY FOR ESTABLISHING A SCHEDULE SIMULATION SYSTEM FOR RAILWAY INFRASTRUCTURE PROJECT USING THE CONCEPT OF STANDARD 4D FRAMEWORK

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Abstract- Recently, various studies about BIM and its application cases have been reported, however, most of them are based on 3D modeling technology for design stage and some application of 4D CAD systems consists merely of passive BIM functions which provide simple visual information. This study proposes essential functions to develop a 4D CAD system specialized in project management for construction stage of railway infrastructure. For this purpose, this study also proposes a methodology for establishing a location-based simulation system which is adequate for linear facilities.

Index Terms- Building information modeling, Railway Infrastructure, Schedule simulation system, Standard framework

I. INTRODUCTION

In the existing schedule management process of railway construction project, 2D drawings and Primavera or MS-Project, which are dedicated schedule management systems, have been used. However, such 2D-based schedule management system is likely to be accompanied by low level of understanding of participants so that the system is often irrelevant to the field work and unclear cost and schedule control can occur. For this reason, the utilization of BIM technique, which can visualize a percentage of completion by integrating 3D object model and schedule/cost/site management, is more and more necessary. The schedule management in the area of building project is used for vertical and repetitive process in a limited space, while railway facilities need horizontal and non-repetitive process configuration including the large volume of earth work and wide spatial composition1).

Consequently, the current 4D simulation functions for building project are not applicable to railway facilities and specialized BIM functions for such facilities are to be configured. The purpose of this study is to propose a methodology for studying and developing a schedule simulation system which can be applied to schedule and cost management of railway infrastructure facility constructed linearly in a wide range of construction sites where an activity is configured in a complex way to include earthwork, electric, signal and mechanical processes.

II. RECENT TREND OF BIM APPLICATION FOR RAILWAY INFRASTRUCTURE

As Hong Kong MTR (Mass Transit Railway) project is a complex project having many participants and multi touch point, a risk factor in a process needs to be removed. For this reason, BIM technology is applied to this project not only for collaboration or mediation but also for examination of simulation and constructability. The East Japan Railway project is a project with investment of 112 billion dollars for earthquake recovery. In order to support 3D design, the '3D model design support system' has been developed, and civil 3D and Revit structure are also utilized for design process.

BIM model was developed to be used for reducing construction period, estimating amount and planning earthquake recovery in the restoration process of the existing tracks. The railway model originated from Civil 3D and other similar commercial systems allows design modification and rule examination through a separate system to be designed conforming to Japanese standards. The Crossrail Project is another UK project to construct 118KM railway which is to be completed by 2017. By applying BIM for this project, design and construction could be visualized and error rate was decreased by detailed examination and improved constructability. It is reported that the working time has been reduced by applying adequately collaboration solution and complying with the British BIM standard.

III. NECESSITY OF SPECIALIZED 4D CAD FUNCTIONS FOR RAILWAY INFRASTRUCTURE PROJECT

There are various development cases of 4D CAD system and also many commercial systems in a market. The commercial 4D CAD SWs presented in Table 1 like Navisworks and Navigator have a high level of applicability for architecture and plant projects which can be characterized by vertical work and repetitive objects.

However, they may have difficulties in using for railway infrastructure which consists of horizontal linear working areas in a large construction site. Consequently, it is necessary to develop a specialized 4D CAD functions for simulating schedule and cost for railway infrastructure project.

Table 1. Main functions of 4D and 5D CAD SWs

Software	Main Functions
VICO Office[2)]	▪ Compatible with data of Revit, Tekla and ArchiCAD ▪ Examination of interference, arrangement of member, quantity take-off ▪ 4D/5D BIM: schedule simulation, budget visualization
Navis works[3)]	▪ 3D model review ▪ Examination and management of interference and collision ▪ 4D/5D BIM: schedule simulation, budget visualization
Synchro[4)]	▪ Application of automated matching rule for schedule-3D model ▪ IFC and many file format support ▪ 4D/5D BIM: schedule simulation, budget visualization
Navigator[5)]	▪ Examination and modification of 3D models ▪ Interference check up and 4D/5D simulations ▪ Management of relevant models in connection with Projectwise

Most of the existing 4D CAD systems tend to focus on simple simulation of schedule situation compared with the planned schedule, thereby having a low level of applicability as instrument of construction management. In other words, not only simple simulation function but also active BIM functions are required to improve the applicability for construction field. Such active BIM functions will have a decision-making support function which analyzes schedule interference and simulates a schedule with least interference. Railway construction project possesses over 10,000 drawings for 2D design and each department also maintains drawings of earthwork, structures and tracks, thereby lacking interfaced-based management system. This situation often results in modification of railway alignment because of some problem at a final stage of construction, which again incurs overestimation of necessary amount of materials at an early stage. This is the main cause of increases in the construction costs and period.

IV. CONCEPT OF 4D CAD SYSTEM FOR RAILWAY INFRASTRUCTURE BASED ON STANDARD FRAMEWORK

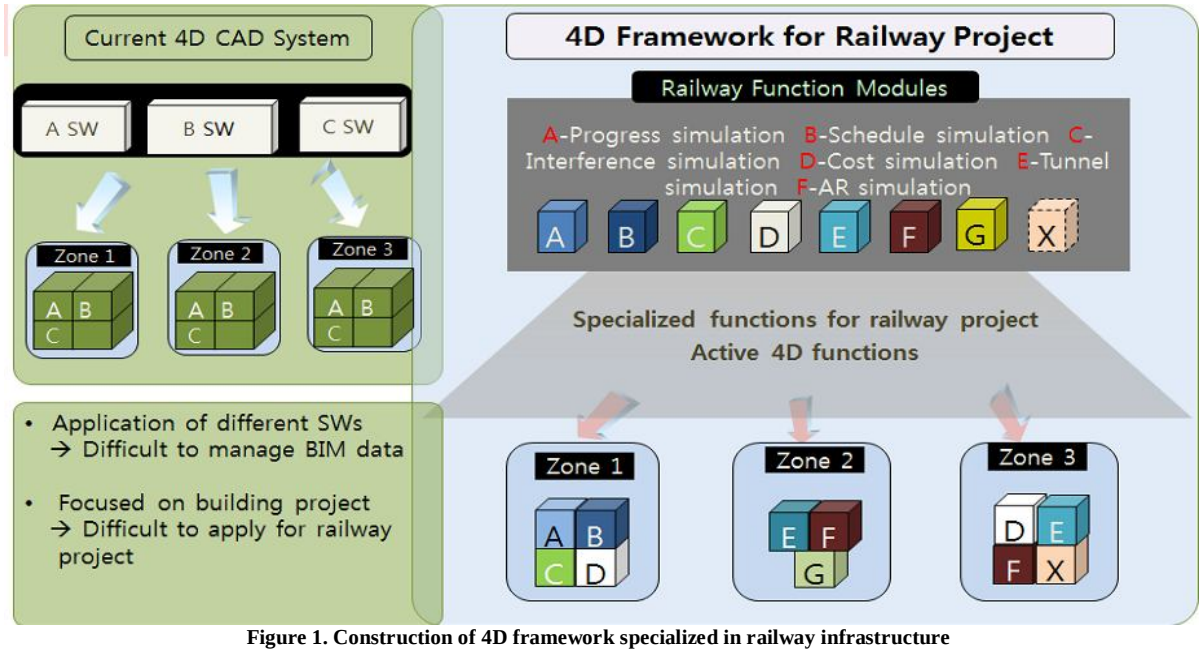


Figure 1. Construction of 4D framework specialized in railway infrastructure

As shown in the figure 1, various simulation functions are configured as modules within the BIM framework for railway project. Each contractor can select a simulation module necessary for its construction zone to complete a necessary BIM system for railway construction. The detailed

functions of BIM are divided into functions of design stage and those of construction stage. These can correspond to establishment of library including IFC standard necessary for design stage on the right side of the figure 2 and various simulation functions required for construction stage on the left side of the same figure, respectively. Such BIM functions for design and construction stages can be implemented in the product life-cycle management (PLM) system to be utilized during the life cycle of railway infrastructure project, thereby securing reusability of BIM data during the life cycle

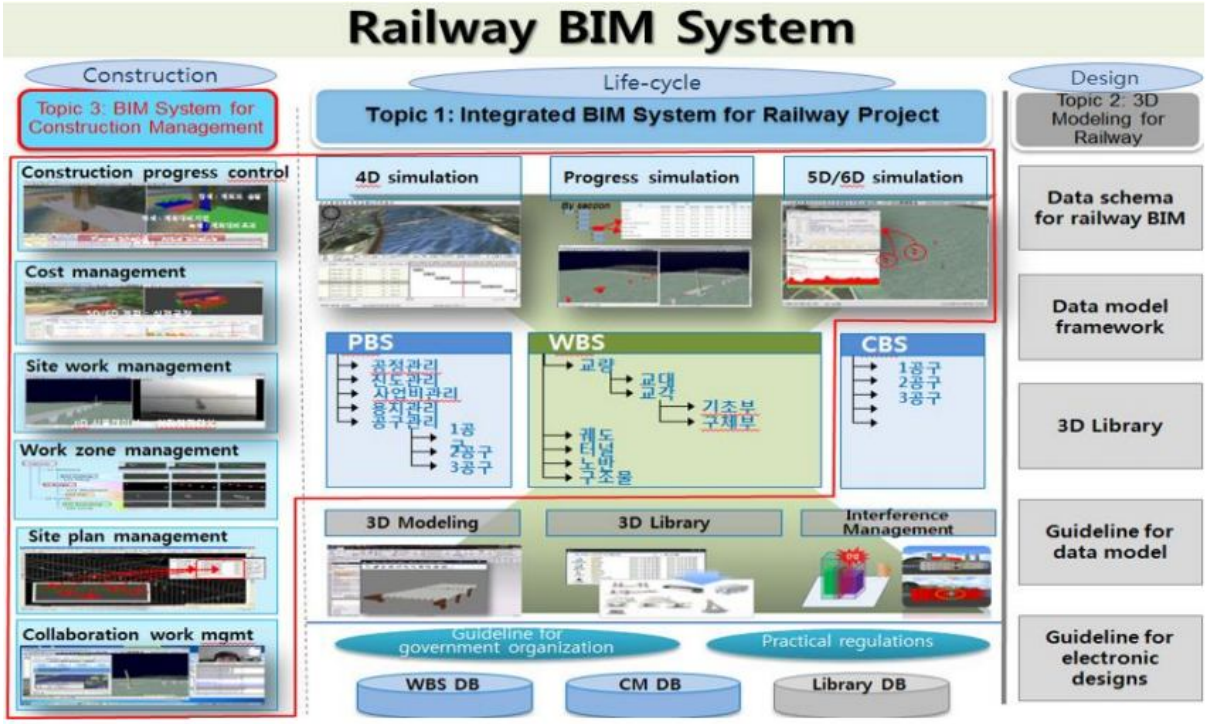


Figure 2. BIM operating system during life cycle of railway infrastructure

CONCLUSION

This study has proposed specialized BIM-based functional constituents including 4D CAD function for railway facility in order to apply BIM functions, which are currently used mainly for building project, to railway project. In building project, since the activity processes are conducted repeatedly in a limited space, schedule simulation is relatively easy and the application of BIM functions is mostly concentrated on design interference management. However, the processes of railway construction are conducted non-repeatedly in a horizontal work site including a large volume of earthwork, thereby making simulation difficult. In this respect, such functions as earthwork simulation and location-based simulation for processes which are conducted linearly need to be developed.

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