A Plan for Constructing an Information Service System for Construction Project Management using GIS Information

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Abstract: Construction Management System provides assistance in the online exchange and sharing of various documents related to projects, contracts, and processes between government agencies and construction companies that perform national road and river construction projects. The system is being used for the road and river construction projects at approximately 500 locations. The recent development of various information technologies, including big data, GIS(Geographic Information System), and cloud, has enabled construction workers to utilize information devices for their work. A plan for improving Construction Management System was suggested in this study by applying spatial information so that various map-based information services could be provided to construction workers. The suggested plan is expected to provide workers with the visual construction status, including the cost, by integrating construction information and spatial information, and to reduce the onsite work hours and efforts by providing customized functions for each user.

1 INTRODUCTION

Construction industry is a national key industry, and thus, it is being provided with consistent investments for employment creation, economic growth, and the improvement of the people's living conditions. Construction projects are generally on the rise these days. While construction technologies are the basic key elements that can enhance the competitiveness of construction companies, the recent convergence of construction and information technologies, such as Internet of Things(IoT), big data, drones, cloud, and spatial information, is transforming the construction industry from the past labor-intensive industry to a convergence cutting-edge-technology industry(MSIP, 2013). Especially, the convergence of construction and Information Technology(IT) is actively taking place in the areas of low cost and high efficiency, energy saving, design/construction/maintenance automation, and intelligence. The market size of these areas was KRW3.4 trillion in 2010 and increased to approximately KRW6 trillion in 2015(KAIA, 2014, Hwangoo Jeon, 2008).

Construction Management System provides assistance in the online exchange and sharing of various documents related to projects, contracts, and processes between construction companies and government agencies for the smooth management of national road and river construction projects, and is being used in approximately 500 road and river construction projects. Since its establishment in 2005, the system has managed approximately 300,000 documents and 200,000 reports each year (JinUk Kim, 2013).

The system, however, is used only for administrative work, and is not ready to cope with the growing demand of the users for providing various information services. Therefore, a plan for improving the system was suggested in this study to provide visual construction management services by utilizing the map-based spatial information among the recent information technologies. The suggested plan is expected to shift the system operation paradigm from information-collection-oriented system operation to diversified-information-service-oriented system operation.

2 CONSTRUCTION MANAGEMENT SYSTEM STATUS

The government has been separately operating the electronic government network being used by the

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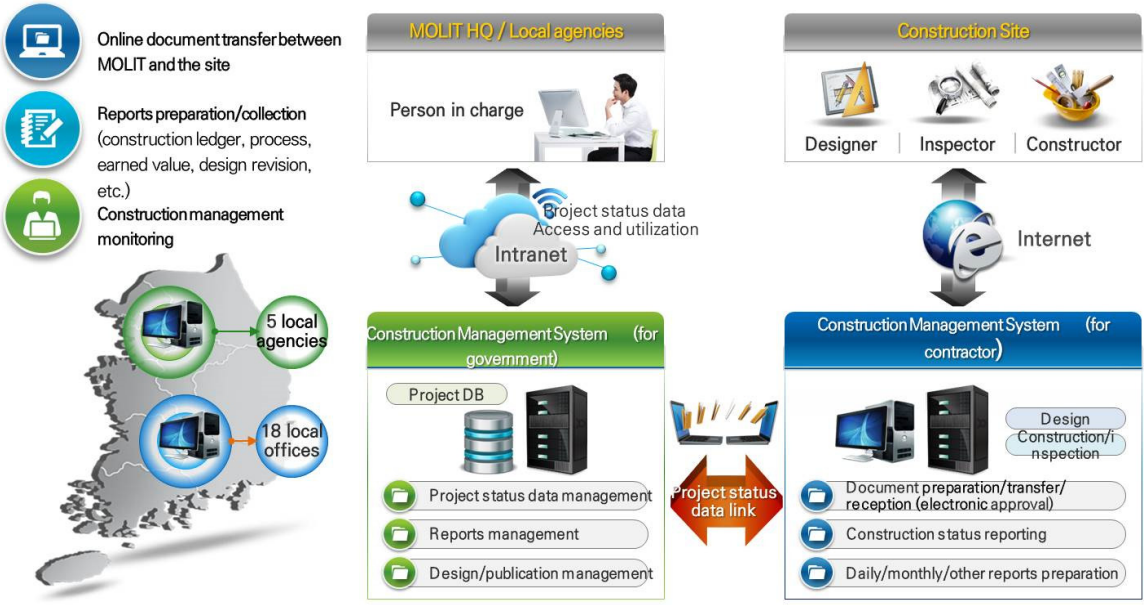

Figure 1: Concept of Construction Management System (KICT, 2015).

government and the Internet being used by the general public since 2000 to strengthen the information security of the public sector by separating the public and private information. Hence, most of the users in the Ministry of Land, Infrastructure, and Transport(MOLIT) are using two PCs, one for the electronic government network and the other for the Internet(MOLIT, 2012).

Construction Management System is being used by both MOLIT users and private construction companies, thus having two systems, one for the government and the other for contractors. Construction Management System for the government provides assistance in the online sharing of various kinds of information, including the documents and drawings generated from the entire process of road and river construction projects between the ordering agencies and construction companies (design/construction/inspection). The system provides assistance in the efficient project management and decision-making of the ordering agencies by systematically managing the construction information, such as the onsite construction status and contract information, and by monitoring work reports and statistical data in real time. Construction Management System for contractors, on the other hand, reduces the work hours and efficiently assists in the construction management by enabling the online sharing of various documents (official documents, design drawings, etc.) and various work reports between the construction sites (construction company, inspector, and design company) and ordering agencies from the start to the end of a construction project(SeongJin Kim et al, 2016).

Fig. 1 shows the concept of Construction Management System. As the two construction management systems (the one for the government and the other for construction corporation contractors) are separated from each other, real-time data transfer between the construction sites and MOLIT is required for sharing information.

Fig. 2 is a screenshot of the information service of Construction Management System. Based on the nationwide map imaging, the information and status of approximately 500 construction projects by agency and by project progress can be accessed.

Construction Management System, however, is facing an increasing demand for improvement due to its text-based information service. The functions of Construction Management System that require improvement are as follows. First, most of the construction project data consist of text- or document-based construction status and statistical data, thereby lacking visualized spatial information and thus making it difficult to share information and to understand the overall status of the project. Second, the existing system is focused on administrative work and data management. Efficient data sharing and transfer as well as comprehensive status monitoring are required through the integration of the future construction project information and visualized spatial information.

Table 1: Status of Construction Information Systems.

System	Operation	Characteristics
Highway Management System (HMS)	Manages road-related infor-mation in connection with Vworld, and runs an integra-ted database for the organic sharing of information	· (Integration) One system performs the integrated management of various data from a road-related computing system (road ledger, pavement, bridge, traffic, road slope). · (Remark) Data construction and access are separated.
Facility Management System (FMS)	Inputs and manages facility information according to the Seoul City special law	· (Management) Manages facility data, performance certificates, safety diagnosis, precision inspection results, design drawings, and various reports (inspection and overall safety review reports) · (Remark) Administrative-work-oriented information system for type 1 and 2 facilities
Road Signal System	Offers GIS-based road signal information services	· (Overview) Comprehensively manages road signs for their connectivity, consistency, visibility, readability, and locations · (Remark) Offers user-intuitive convenient functions by managing road sign information on a GIS electronic map
Geotechnical Information Portal System (GeoInfo)	Offers GIS-based geotechnical information services	· (Overview) Systematically manages the geotechnical information of all lands, and collects, manages, and utili-zes the geotechnical information from construction sites · (Remark) Consistently investigates the unconstructed geotechnical information of the public and private sectors, collects data and constructs a database (DB), improves the reliability of geotechnical information, and creates business models for the private sector

Third, comprehensive status information linking the construction project information and the spatial information, decision-making assistance, and various statistical and analysis data need to be provided.

Fourth, although the system spurred progress in terms of work efficiency as the internal work system of MOLIT, the introduction and application of GIS is urgently required to convert the system into a qualitative-use-oriented one, to improve its functions and information values, and to obtain synergy with the spatial information policy of the government and other areas.

The status and research direction of the domestic spatial information introduction were investigated in this study to expand the information service through the introduction of spatial information.

3 STATUS OF GIS INFORMATION INTRODUCTION

While the maps before the development of computers could contain only information on simple terrains and features, the recent electronic maps can record attribute information that represents the natural, social, and economic characteristics as well as figure data, including terrains and features.

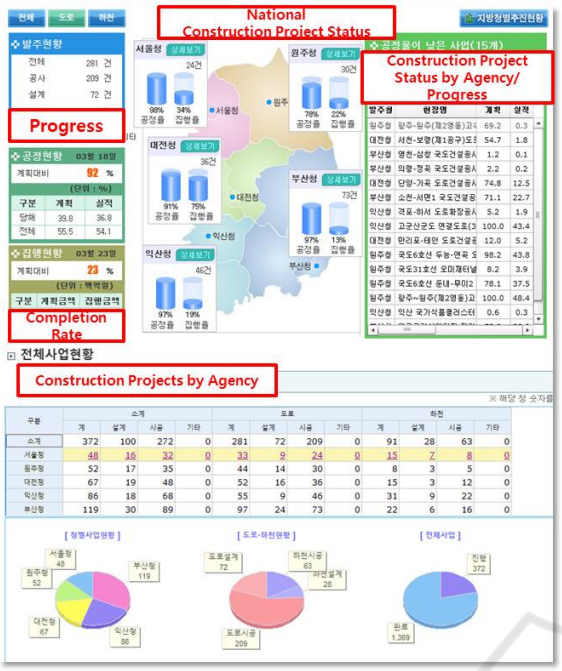

Figure 2: Screenshot of Construction Management System(Hyun Ok, 2015).

In addition, the electronic maps can be copied and distributed more easily through the Internet or various storage media compared to the paper maps, and their storage is easier as they are in a file format and are not vulnerable to elongation, distortion, and deformation(Min-soo Kim, 2010).

Also, overlay analysis using various thematic maps can provide the data required for decision-making. Spatial information refers to all the discernible data on a map, including locations and distribution. It is classified into figure data and attribute data according to the data type. Also, it can be classified into national spatial data or city spatial data according to the point of view. When spatial data are seen from the national point of view, they become national spatial data, which include the terrain, geographical features, land use, natural environment, and statistical data. The city spatial data are spatial data considered in city scales and include roads, land, houses, water and sewage, gas, and electricity supply facilities. The industries that produce, manage, process, distribute, and utilize these spatial data or integrate them with other information technologies to build systems and to provide related services are collectively called “spatial information industry”(Yong-joon Lee, 2015).

Table 1 shows the status, operation, and characteristics of the systems using the recent spatial information.

This study aimed to improve the performance of Construction Management System based on Vworld, a spatial-information open platform, to apply spatial information to the system. Vworld is a high-quality 3D-based open platform that provides various spatial

Table 2: GIS utilization plan by function.

Function	Function description	Remark
Construction status data	Provides real-time construction data and status onsite	Provides data on the location, ordering agency, construction company, inspector, construction period, manager, contract amount, and progress
Technology data	Provides the work know-how and quality/safety data of the site	New-technology data, including cost-saving data
Process data	Provides progress data by space and section in connection with WBS	
Drawing	Confirms the drawings and design history data of the site	2D drawing data of the site
Current issue	Reports the issues, delays, and solutions of the site	Construction issue data
Construction log	Construction log data of the site	
Meeting contents	Provides the major meeting data of the site	Meeting contents

Figure 3: Service screen of construction management using GIS information(SeongJin Kim et al, 2016).

and administrative data possessed by the public agencies, including the government and local governments, through the Web. It provides basic spatial information, including 3D information, aerial photographs, and cadastral maps; eight thematic maps, including land use zones, ground coverage, and ecological zones; and three types of administrative data, including building information and officially announced values. The performance of Construction Management System was sought to be improved based on these spatial information services.

4 A PLAN FOR IMPROVING THE PERFORMANCE OF THE SPATIAL-INFORMATION-BASED CONSTRUCTION MANAGEMENT SYSTEM

The architecture configuration of Construction Management System is as follows. First, the system architecture consists of six layers: the linkage layer connecting to the linked system, the application layer performing the GIS function, the data layer storing a construction project DB, the management layer managing the data, the interface layer communicating with the system users, and the infra layer. Second, the introduction of two GIS servers to Construction Management System according to the network separation needs to be considered based on the existing system that uses the cloud system. The existing construction management DB was utilized, and a GIS server that specializes in the functions of the GIS DB server for the government and that for contractors was considered for the new server. Table 2 shows the spatial information utilization plan by system function based on this system architecture.

Table 3 shows a construction management improvement plan using GIS and convergence technologies, and Fig. 3 shows the service screen (plan) of Construction Management System using spatial information according to the aforementioned utilization and improvement plans.

5 CONCLUSIONS

As an information system that supports the construction project management of the public sector, Construction Management System has provided text-based information services for the past

Table 3: Plan using GIS and convergence technologies.

Function	Function description	Remark
Design history management (GIS+BIM)	The model history management of the site enables BIM data modification, history management, and instantaneous checking of the revisions.	
Performance review	Verification of the BIM supply system of the site	BIM supply verification
Performance evaluation	Case analysis and verification of the performance evaluation using the supplied data	Provides excellent performance evaluation cases
Process management using WBS	Checks the 3D progress (AR and VR) and the delayed process of the site according to the time series	Real-time and virtual simulator
Earned-value management	Provides earned-value information according to the construction progress	Earned-value information
Ordering assistance	BIM ordering assistance information for the same or a similar site	

10 years and has had increased user complaints regarding its fragmentary information services and utilization. To address such problems, a plan for improving the system by introducing spatial information was suggested in this study to provide visual information services.

The status of the existing construction management system and of other information systems that use spatial information was investigated and analyzed. The considerations for the future architecture construction of Construction Management System was suggested, along with GIS utilization and system improvement plans.

The integration of spatial information into Construction Management System, as suggested in this study, is expected to provide the users with the visual construction status, including the cost, by integrating the construction information and the spatial information, to facilitate information search and to facilitate decision-making through the analysis of complicated and objective information. It may also provide various information services using spatial big data based on the accumulated spatial information.

Later, when the functions of Construction Management System will have been improved based on spatial information, studies on the utilization of the spatial information based on the big data of the construction project information will be required.

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