Research on the Application of GIS-based Measures in the Advancement of the CPMS

Hyun Ok, Seong-Jin Kim, Jin-Uk Kim, Young-Jin Kim

ICT Convergence and Integration Research

Korea Institute of Civil Engineering and Building Technology, KICT

Goyang-si, Gyeonggi-do, Korea

{okhyun, sjkim72, jukim, yjkim73}@kict.re.kr

Abstract—**The Construction Project Information System (CPIS) is an information system constructed as part of the Construction Continuous Acquisition & Life-cycle Support (CALS) of the Ministry of Land, Infrastructure, and Transport (MOLIT). As such, CPIS aims to digitize construction projects across all stages, improve the construction project implementation procedures, and enable sharing and exchange of information so as to enhance the productivity and efficiency of construction projects and secure their transparent administration. CPIS consists of five information systems-- construction project management, facility maintenance, construction approval, land compensation, and construction project information portal systems. Of these, the Construction Project Management System (CPMS), one of MOLIT's internal work systems, is designed to enable ordering agencies and constructors(designers, builders, and supervisors) to share documents, drawings, and other various information created across the entire process of road and river construction projects, and to process works online. CPMS, now over 10 years old after its construction, focuses on work processing functions and data management. Thus, CPMS's construction project information consists chiefly of text and documents, and makes it impossible to link with visualization-based Geographic Information System (GIS), thereby limiting its sharing and dissemination and the determination of the overall construction project situations. This paper examines domestic and overseas GIS technology trends and relevant information systems, analyzes the CPMS status and problems, and presents GIS application measures to advance CPMS. Thus, this study seeks to link text-information-based and documents-based construction projects information with GIS to assist in determining the total situation information and in decision-making, and to provide diverse statistics and analyzed information.**

Keywords-CALS; CPIS; CPMS; GIS; MOLIT

INTRODUCTION

The Construction Project Information System (CPIS) is an information system constructed as part of the Construction Continuous Acquisition & Life-cycle Support (CALS) of the Ministry of Land, Infrastructure, and Transport (MOLIT). CALS is a total information system designed to enable ordering agencies, relevant companies, etc. to exchange and share the information created across the entire process of construction project planning, design, execution, and maintenance through computer networks. Thus, CALS aims to digitize all construction project stages, improve the construction project implementation procedures, and enable sharing and exchange of information, so as to enhance the productivity and efficiency of construction projects and secure their transparent administration. CPIS consists of five information systems--construction project management, facility maintenance, construction approval, land compensation, and construction project information portal systems.

Of these, the Construction Project Management System (CPMS), one of MOLIT's internal work systems, is designed to help ordering agencies and constructors (designers, builders, and supervisors) share documents, drawings, and other various information created across the entire process of road and river construction projects and to process works online.

CPMS, now over 10 years old after its construction, focuses on work processing functions and data management. Thus, its construction project information consists chiefly of text and documents, which makes it impossible to link with visualization-based Geographic Information Systems (GIS), thereby limiting its sharing and dissemination and the determination of the overall construction project situations.

This paper examines domestic and overseas GIS technology trends and relevant information systems, analyzes the CPMS status and problems, and presents GIS application measures to advance CPMS. Thus, this study seeks to link the text-information-based and documents-based construction projects information with GIS to assist in determining the total situation information and in decision-making, and to provide diverse statistics and analyzed information.

PRELIMINARIES

A. Analysis of Domestic and Overseas GIS Technology Trends

For the domestic GIS technology trends, in accordance with the 1995 First Master Plan for the Construction of a National Geographic Information System (NGIS), the NGIS project was pursued. Currently, in accordance with the Fifth National GIS Policy, seven major strategies and 27 detailed tasks were announced and are now being implemented. Domestically, the government and public agencies positively

use GIS to formulate various policies and make decisions. They use information on industrial parks, land use, environment management, etc. to formulate future-oriented national geographic plans, and are constructing and managing the databases needed for relevant works. Notably, recently, with the development of information technology, GIS technology development speeds are increasing, and convergence technologies involving cloud, augmented reality, big data, and other technologies are arresting attention.

Abroad, governments provide open-type standards, open GIS to the private sector, and transfer GIS to the private sector, thereby ensuring the efficiency and reliability of GIS construction. In the USA, at the state level, the Federal Geographic Data Committee (FGDC) undertakes the construction of GIS infrastructure, with the participation of 19 public agencies, including the Defense Department and other government departments, and agencies under their control. To facilitate the dissemination of the constructed GIS, FGDC operates a one-stop service site and is currently disseminating 130,000 types of GIS data. The U.K., led by the public agency Ordnance Survey, produces and disseminates road network maps, topographic maps, and tourist maps covering nationwide areas, and conducts relevant studies.

In recent years, open-source GIS solutions are being used, which significantly furthers the development of GIS construction technology. Globally, some 300 open-source GIS solutions have been disclosed, and some solutions have been developed to a level equivalent to that of commercial GIS software. Domestically, there is still a lack of awareness of open-source GIS software, but MOLIT leads the way in the development and spread of open-source GIS solutions, and local governments are increasingly adopting open-source GIS solutions in some of their projects.

B. Analysis of the GIS Status

Domestic GIS-applied information systems are being actively used in a wide range of industries, including in the national land and transport, environment, forestry, marine affairs, agriculture, safety administration, and commerce industries. Twenty-six types of information systems have been constructed and are being used. In the national land and transport field, diverse information systems, including the Korea Land Information System (KLIS), Urban Planning Information System (UPIS), realty administration integrated information system, cadastral resurvey administration system, and LURIS, have been constructed and are being used. Of these, KLIS inquires and searches GIS data on the Web to improve work efficiency and reduce administrative errors. Also, local governments have constructed and are using UPIS to implement an array of administrative policies for managing roads, parks, and other urban facilities, and are approving the development and selecting the locations thereof.

C. Analysis of the CPMS Status

CPIS is designed to support all work stages of construction projects, and. CPMS is designed to process MOLIT-ordered road and river construction projects in their planning, design, and execution stages.

CPMS consists of the system for agencies and the system for contracts. The CPMS for agencies is designed to systematically support the availability of construction work information, including the construction work status and contracts, to identify work reports and statistical data in real time so as to support efficient project management and decision-making by ordering agencies. The system for contracts is designed to distribute online various official letters and design documents between construction sites (builders, supervisors, and designers) and ordering agencies in all construction stages, from the commencement to the completion of the construction, and to formulate various reports online, thereby shortening the work handling time and efficiently managing construction works.

Figure 1. Configuration diagram of CPMS
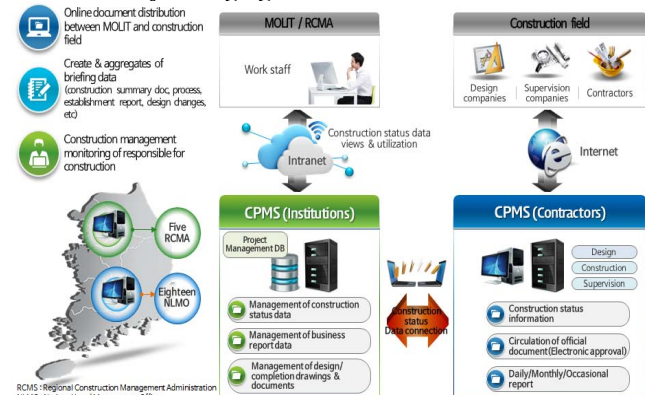
CPMS, which has been constructed and operated with focus on MOLIT's works, has boosted work efficiency, but it should be advanced by adopting GIS, Building Information Modeling (BIM), and the convergence and combination of mobile and big data as well as other state-of-the-art information technologies. Towards that end, this study provides the total status of construction project information and the diverse statistics and analyzed data, and objectively analyzes these information to support decision-making.

The existing CPMS has been operated to express construction work site location information on MOLIT-crafted national road map images for the management thereof. To apply GIS to CPMS, the application should be expanded from only the construction work site location information to also the information on the process management, design changes, construction execution management, etc. Towards that end, drawings (BIM) information, work breakdown structure (WBS) information, and location information should be combined on the GIS map to visualize the total project management information.

D. GIS Application Measures in CPMS

This study applies GIS to CPMS in two stages. In Stage 1, the GIS operation environment is constructed, and the construction work and facility status is inquired on the GIS map. Then the GIS location map is constructed by construction site, and the construction work status and process information, drawings information, and major pending agenda information are provided.

In Stage 2, WBS and BIM are applied to CPMS to automatically link the system with design drawings, etc. so as to visualize the information. Furthermore, WBS is linked to express the facility and earth work progress rate status in charts, and to express the progress rates and execution rates by work type, segment, and facility on the GIS map in graphics.

First, GIS is to be applied to the initial CPMS screen to check various statistical information on construction work sites and approval rates, and to acquire detailed information on construction works by selecting map information.

Figure 2.   Initial CPMS screen

Next, the total screen for national roads divides the entire nation into five regions and is designed to inquire on the total process rate, construction cost spending rate, and total project status. Also, all construction work site locations are put together on the GIS-based map to inquire on the construction work status according to the routes of national roads so as to express the details of the construction work status and its characteristics by route.
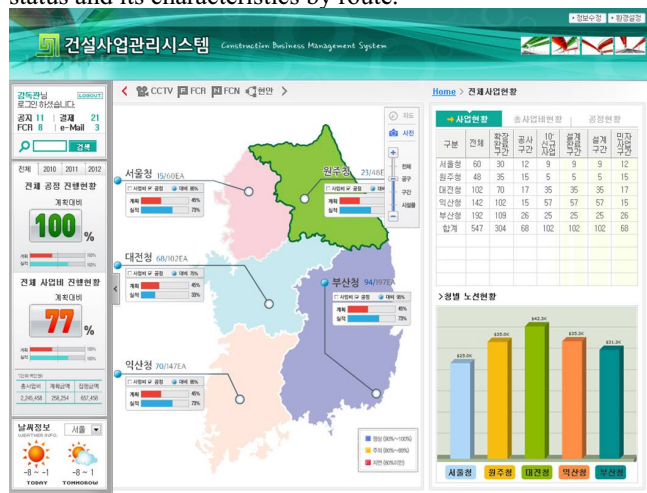
Figure 3.   Overall national roads screen
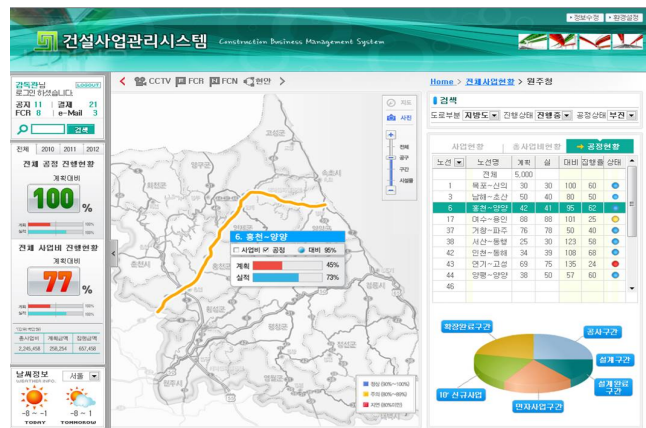
Figure 4.   National road status screen by route

The system is to be designed to inquire on the construction work information and facility information by construction segment in each construction site on the GIS electronic map, and to express the plan versus the result progress ratio, progress by construction segment, photos, etc. Also, the system is to be designed to link WBS with the GIS electronic map based on the builder's 3D design drawing files to illustrate and visualize the facility construction progress for the review of the overall progress by work type and process.

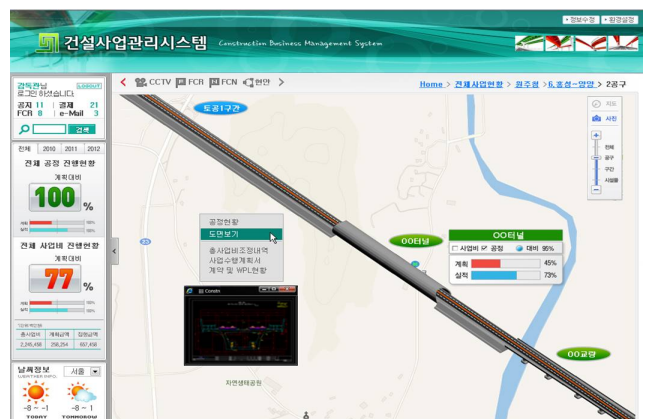Figure 5.   Status screen by construction site

Figure 6.   WBS and GIS applied detailed screen

The planned CPMS architecture consists of six layers--the interface layer, application layer, data layer, management layer, interface layer, and infrastructure layer.
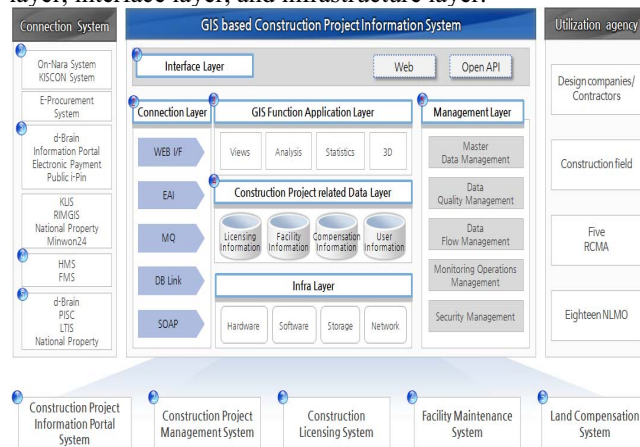

Figure 7.   CPIS architecture

The six layers consist of the interface layer designed for interfacing with the linkage systems, the application layer designed for performing the GIS function, the data layer designed for storing data on the construction work database, the management layer designed for managing the data, and the physical infrastructure layer designed for communicating with users of the agencies.

CONCLUSION

As one of MOLIT's work systems, CPIS has long been operated, but needs to adopt GIS to be aligned with the government's GIS policy or to synergize with other fields. This requirement is imperative to upgrade the functions and future information value of the system.

This study examined domestic and overseas GIS technology trends and relevant information systems, analyzed the major status and problems of CPMS, and proposed GIS application measures for upgrading CPMS.

These efforts are expected to transform the system from a monotonous user interface to a user-friendly GIS function interface so as to boost user convenience and shorten the work-handling time, and thereby expand the work efficiency

REFERENCES

[1] MOLIT, 13 Construction CALS System Operation and Function Improvement (I) and (II) Final Report, KICT, 2014.

[2] MOLIT, 14 CPIS Operation and Function Improvement (I) and (II) Final Report, KICT, 2014.

[3] MOLIT, Fifth Master Plan for National GIS Policy, MOLIT, 2013.

[4] CPIPS(Construction Project Information Portal System), http://www.calspia.go.kr

[5] MOLIT, http://www.molit.go.kr

[6] US FGDC, http://www.fgdc.gov

[7] US federal government data total storage location, http://www.data.gov

[8] The UK Ordnance Survey, http://www.ordnancesurvey.co.uk