A STUDY ON ALGORITHM OF PROGRESS MANAGEMENT PROTOTYPING IN STEEL CONSTRUCTION

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ABSTRACT: Current construction project planning tends to be made based on a planner's experience, opinion, or equipment supplier's technical support. Furthermore, there is inefficiency and error occurring due to lack of materials for project planning, easy-to-use guidelines or tools.

Construction planning needs to accommodate predicted scheduling and be regularly modified to economically meet the schedule having remaining work. The system provides construction managers with construction progress information for more effective construction management.

This study examines internal and external cases and theories with the purpose of suggesting a real-time progress management protocol algorithm for steel frame work.

Keywords: *Progress Management, Algorithm, Prototyping*

1. INTRODUCTION

1.1 Background and Goals of the Research

For successful project delivery, a reliable monitoring and control system is essential. Actual data is collected to measure the actual values of a project`s basic variables, such as the percent complete, the quality of work, and cost. Comparing this data with planned values indicates if the project is meeting the targets of the work plan. The necessary adjustments then can be made to meet the project objectives [1].

In construction, while the average duration of activities typically falls within a range of days, the usual frequency of reporting is weekly or monthly. Therefore, in the case of deviations, traditional project control systems used in the construction industry may yield corrective actions too late. This can result in cost and schedule over-runs. As well, the longer it takes to recognize deviations, the greater the potential damage [2].

Current construction project planning tends to be made based on a planner's experience, opinion, or equipment supplier's technical support. Furthermore, there is inefficiency and error occurring due to lack of materials for project planning, easy-to-use guidelines or tools [3].

Accordingly, this study is to analyze actual project planning on construction site and to suggest an algorithm of progress management prototyping by automatically creating work processes as a systematic basis framework for a project planning and managing them real-time.

1.2 Scope and Contents of the Study

The scope of this study was limited to automated steel frame work for a high-rise building, and to development of work information automatic creation module, real-time progress management and analysis of assembling steel frame. To resolve these limitations, artificial intelligence began to be applied to project planning in construction projects.

The objective of this study is to suggest a real-time progress management protocol algorithm for steel frame work. First, planning, composition, and process for progress management prototyping algorithm were suggested by reviewing domestic and overseas cases and theories on progress management.

2. Literature Review

2.1 System Application Cases of Construction

PERT and CPM, which are mathematical methods developed in 1950s, are representative project management methods. However, Raymond noted the limitations of those mathematical methods in 1990 in that characteristics within each application are hard to be reflected; uncertainties are hard to be considered; new planning is hard; and there are not many cases that they are applied to complicated situation.

To resolve these limitations, artificial intelligence began to be applied to project planning. Tables 1 and 2 show major expert systems developed for planning stage, design stage and construction stage of construction project management in the US [4].

Table. 1 Systems for planning stage and design stage

Funtion	Expert System
Selection of contract clauses favoring a project owner	PROPICK(Selection of a Contract Type)
Analysis of construction site and environment	DSCAS(Differing Site Conditions Analysis System)
Feasibility analysis of the construction	Platform-3
Construction cost prediction for the initial design	HI-COST ; Cost Estimating from Preliminary Design
Owner's budget planning and investment analysis	ELSIE ; Expert System for Strategic Planning of Construction Projects
Design analysis system	Expert System for Construction and Resolution of Multicriteria

In terms of integrated control systems, most of the developed systems focus on data models that integrate cost with schedule data [5–15]. However, current systems are plagued by one or more of the following shortfalls [2]:

- Manual data collection/entry.
- The lack of some of the important functions of an integrated project control system, such as forecasting performance, analyzing variances, and recommending corrective actions.
- System inflexibility and interoperability issues.
- Difficulties regarding data sharing.

Table. 2 Systems for construction stage

Funtion	Expert System
Claim handling system	CGS-DSC ; A Claims Guidance System Differing Site Condition Claims
Project planning and progress analysis	CALLISTO ; An Intelligent Project Management System(for large projects)
Resource management for a large construction site	Interpreting Collective Agreements in the Building Industry
Diagnosis of design and construction decision making	FDES ; Failure Diagnosis Expert System(Construction Error)
Safety analysis system	HOWSAFE ; Safety Analysis System

Therefore, there is a growing necessity for the development of a progress management system, to which a state-of-the-art IT technology is applied, for systematic and efficient cooperation system for a construction project.

2.2 Progress Management

Progress management is to review current work progress and adjust remaining work to keep work schedule updated. In other words, in consideration of performance and other conditions, planning is modified by logic modification, parallel work, and construction period adjustment.

2.3 Construction Automation in High-rise Building

Construction automation for a high-rise building includes robot technologies and construction technique for high-rise steel frame building using robot and IT technologies.

Construction automation drew attention because it can achieve a pleasant site environment and an image of a construction industry as a state-of-the-art technology industry, resolve the problem of lack of skilled workers, improve productivity and building quality, and prevent accidents (Hyunseong Jang, et al., 2003).

2.4 Prototyping Method

Prototyping means the initial model to progressively improve its functions where a simple system model is first made to be presented to users and then, the users add, modify or delete functions while using it

3. Development Planning of Progress Management System

3.1 Development Planning

Construction planning takes a lot of time even to a planner having a lot of knowledge and experience and thus, using a body of knowledge from past cases can enable fast and reliable construction planning.

Accordingly, the system of this study is to obtain an optimal construction planning in the initial stage and implementation stage of construction by automatic creation of work processes, modification and adjustment, and productivity analysis and solutions for construction delay.

Construction planning needs to accommodate predicted scheduling and be regularly modified to economically meet the schedule having remaining work.

Besides, to achieve the goals of management planning, work processes must be precisely described in the planning stage and selected construction plan needs to be performed in accordance with construction specification.

Progress management system is to repeatedly mange what is occurring in the construction, where the construction progress is, how to achieve goals, and future predictions. The system provides construction managers with construction progress information for more effective construction management.

3.2 Steel Frame Work Planning

For steel frame work planning, work zones, floor work relation and work crew flow were investigated. There are four types of task dependency; FS (Finish-to-Start), SS (Start-to-Start), FF (Finish-to-Finish), and SF (Start-to-Finish).

Hard logic means the relation of two tasks where their order cannot be changed. In construction, it means the order of two tasks cannot be changed, for example, finishing work can be done only if frame work is completed, or upper floor steel work can be done only if lower floor steel work is completed [3].

Table. 3 System Development Process

Category		Remarks
Planning stage	Preliminary needs analysis	Current technologies Requirement analysis Development environment analysis
	Implementation planning	System development planning Development method selection System effectiveness analysis Feasibility study Development planning
	System planning	Defining automation demand Classification of detailed tasks Defining objects Defining input and output
Development stage	Design and coding	Establishment of knowledge base Software design Hardware design Interface design
	Testing	Knowledge base test Precision test Suitability test Reliability test

Soft logic frequently occurs in finishing work where the order of two tasks can be changed. Generally, after completing lower floor finishing work, upper floor finishing work begins, but at times, upper floor finishing work begins first.

3.3 Development Process of Progress Management System

System development consists of planning stage and development stage and their contents are as in the following table. However, the scope of this study is limited to planning stage. Table 3 shows System development consists of feasibility study stage, development environment establishment stage, prototype development stage and maintenance stage.

4. System Composition of Progress Management System

4.1 Major Process for Progress Management

Major process of project planning is in the order of defining element tasks, order of element tasks, prediction of time for each element task, deduction of scheduling, management of scheduling.

4.2 System Development Planning

Progress system was constructed to enable faster and more reliable initial construction planning and expert construction management by non-experts using a computer through automatic reflection in a new project of case based database which was established based on exemplary actual schedule or project planning.

4.3 Composition Planning for Time Management

Tasks and their order for the whole construction work are verified and denoted in the progress management protocol, and construction progress status is always updated. Importance of each task and major tasks for monitoring are verified and solutions for project delays are analyzed.

- Project planning for the whole construction work
- Project plan update through real-time progress management
- Major tasks for monitoring
- Solutions for project delays

4.4 Composition Planning for Project Management

Earned value is automatically calculated by updating schedule because construction progress status can be verified by only updating schedule.

- Progress analysis based on revenue
- Progress analysis based on real-time progress management
- Accumulation of construction data by reporting standard progress analysis

4.5 Composition Planning for Expected Project Process

If a project manager inputs information on construction status and site conditions, the progress management system saves construction overview information. For retrieval of material list, object information (location and material) for a steel member can be obtained by retrieving 3D-CAD information.

Beginning location to assemble steel is set by creating the order of processes and tower crane moving time is brought from vertical zone input. Overall construction progress is monitored by reviewing construction beginning date and weather information and by obtaining expected construction processes before beginning construction.

4.6 Composition Planning for Progress Management

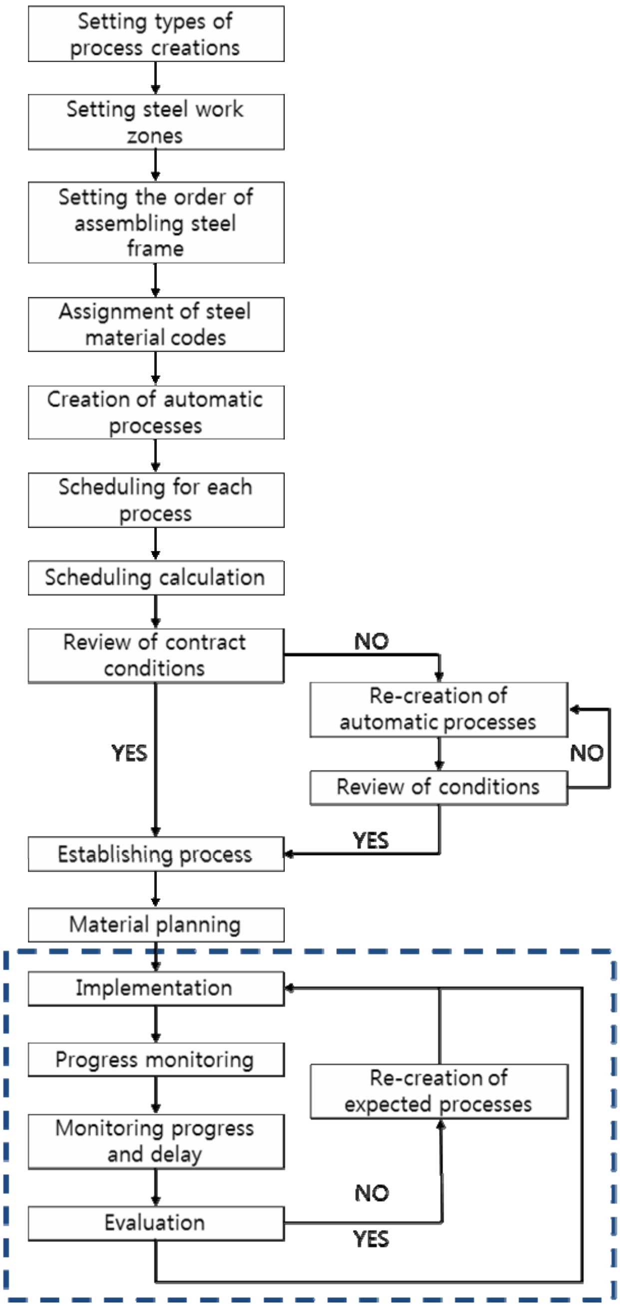
Progress management protocol obtains actual process information by inputting actual work time on site.

Real-time progress management system to find optimal work process shows process delay and process information based on process information accumulated from project implementation and creates optimal process information by comparing process information to the initial expected process information.

4.7 Composition Planning for System Mutual Information Exchange

Real-time material information service transfers material information real-time to the internal database of the progress management system and shows the status of materials (not arrived, arrived, beginning of assembly, and completion of assembly).

Fig. 1 Progress Management System Process



Besides, the real-time simulation service provides a process manager with real-time progress status using a real-time monitoring system.

5. Progress Management System Process

Process management process consists of construction planning, schedule planning, work progress monitoring, and control and adjustment. Time schedule is made in the schedule planning; the work progress monitoring compares performance to plan; and control and adjustment establish solutions to delay and their implementation (Fig. 1).

6. Conclusions

Advanced IT technologies of Korea, a powerful country in IT, and construction automation are expected to lead the changes in the construction industry. Especially, adoption of IT, advancement in construction material and construction techniques, and competitive edge will stimulate the construction industry.

This study reviewed domestic and overseas cases and theories and suggested planning, composition and process of a real-time progress management system for the system's implementation in the actual site.

This study suggested a real-time progress management protocol algorithm for a high-rise building steel work using IT technology where project management is planned and performed based on a planner's experience or opinion, or equipment supplier's technical support.

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