A Conceptual Framework for Scheduling Constraint Management

Introduction

Every construction project is unique and has its own operating environment and sets of technical requirements. As a result, the execution of a construction project is subject to numerous constraints that limit the commencement or progression of field operations, which invariably have significant negative impact on overall project performance. By definition, constraints refer to any condition, such as temporal/spatial limitations and safety/quality concerns, which may prevent a project to achieve its goals. Successful execution and control of a construction project relies on effective identification and management of constraints through master planning and short-term look-ahead scheduling. While the master schedule provides a global view of a project and the overall execution strategy, a look-ahead schedule offers a detail account of operational constraints and a detailed plan showing work to be done within a relatively short time window. Ideally, these detailed schedules should reflect actual field conditions and provide field personnel with operation instructions free of constraints and conflicts (Hinze 2008). This look-ahead scheduling and constraint analysis procedure is also a critical component of the last-planner methodology proposed by Ballard (2000). This research project will provide an overview of state-of-art schedule constraint analysis practice during look-ahead scheduling. In addition, it will propose a conceptual framework for managing constraints.

Brief Literature Review

A preliminary literature review shows that past studies are primarily focused on understanding and modeling a particular type of constraint, such as technological, contractual, resource, spatial, and information constraints. Limited progress has been made on classifying various constraints according to their characteristics in a comprehensive manner. In terms of modeling and resolving constraints, various approaches have been recommended. For example, many CPM-based methods are applied to deal with time-related constraints; knowledge-based systems were used to automate work plan generation; network-based optimization algorithms were developed to resolve constraints; and databases and visualization techniques, such as 3D, 4D, and Virtual Reality (VR), are used to communicate and visualize constraints. What is missing from the past studies is a comprehensive and structured approach in managing constraints

Research problem (explain the particular topic which you wish to study)

The importance of developing a constraint-free and reliable work plan has long been recognized by the industry. However, numerous construction projects are still plagued by delays and cost overruns, which can frequently be traced to ineffective identification and treatment of constraints. First, when a constraint is not properly identified during scheduling, subsequent conflicts in the field are inevitable. Today's projects are becoming more and more technically complex and logistically challenging, which exposes construction operations to even more complex constraints. Second, the traditional scheduling methods, bar charts and Critical Path Method (CPM) which are widely used as a basis for constraint analysis, greatly limit our capability in modeling and resolving constraints during look-ahead scheduling. These methods have long been blamed for their limitations in modeling and communicating constraints, including inability to cope with non-time-related precedence constraints and difficulty to evaluate and communicate inter-dependencies at the field operation level (e.g. Sriprasert and Dawood 2002; Chua and Shen 2001). In summary, there is a need for a better understanding of constraints in construction and a structured approach in identifying and modeling constraints to ensure a constraint-free work plan

Research Objectives

The long term goal of the research is to develop a formalized constraint management system. Constraint management is defined herein as the process of identifying, classifying, modeling, and resolving constraints. The objective of the current study is to provide a comprehensive review of literatures and industry practices in relation to constraint analysis and outline a conceptual framework for constraint management. Particularly, the study has the following sub-objectives:

1. To provide a comprehensive review of sources and characteristics of constraints typically found in construction projects;
2. To develop a constraint classification method for easier constraint identification and modeling;
3. To review current industry practices and researches in regards to constraint modeling;
4. To outline a conceptual framework for total constraint management. The result of this study will be valuable to the industry practitioners as well as related software providers in developing better practice and tools for constraint management and look-ahead scheduling.

Research Questions

The following research questions need to be addressed:

1. What are the typical constraints found in various construction projects?

2. How to classify these constrains for easier identification and modeling?
3. What are the current industry practice as well as research advancements in modeling and resolving constraints?

Significance of Research

1. To provide a comprehensive review of sources and characteristics of constraints typically found in construction projects;
2. To develop a constraint classification method for easier constraint identification and modeling;
3. To review current industry practices and researches in regards to constraint modeling;
4. To outline a conceptual framework for total constraint management. The result of this study will be valuable to the industry practitioners as well as related software providers in developing better practice and tools for constraint management and look-ahead scheduling.

Research Methodology

The primary research method for this study is literature review and conceptual modeling. Constraint identification and classification through a structured approach is the very first step toward a "zero-constraint" environment. This study will first review various types of constraints in construction and their characteristics. Based on this understanding, a classification method will be developed to categorize constraint factors for the purpose of constraint identification and modeling. In the second stage of this study, existing constraint modeling methods will be identified based on a comprehensive review of current industry practices and academic researches. Finally, once the constraint classification and modeling techniques are identified, a conceptual framework for total constraint management will be outlined. This study will be conducted between September 2010 and May 2011