

# A CONSTRUCTION DELAY ANALYSIS APPROACH BASED ON LEAN PRINCIPLES

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## 1 INTRODUCTION

Delay is one of the most typical consequences of performance problems in the construction industry. Existing construction management practices are often oriented towards how delays can be calculated more precisely. Although these practices have different approaches for estimation of delays and assessment of liabilities, they lack of a systematic mechanism and protective approach that shields projects from further delays while analyzing the existing ones.

Authors of this paper believe that a delay analysis approach based on the Last Planner System (LPS) principles can make a significant contribution to overcoming delay problems. However, there is not a formal delay analysis procedure in lean construction since lean philosophy does not advocate the utilization of Critical Path Method (CPM).

This paper proposes a methodology based on integrating CPM with LPS and lean principles. When lean principles are applied appropriately, the proposed methodology is expected to help construction practitioners by;

- Preventing delays,
- Enhancing schedule accuracy,
- Improving communication between the stakeholders.

## 2 PROPOSED METHODOLOGY

The proposed methodology is composed of four steps as summarized below:

- First step is preparation of a level 0 milestone schedule. It should be prepared based on contractual documents and requirements of the Owner by participation of all related parties. From the perspective of lean construction, the approach of consensus based milestone scheduling will help to establish better communication between the contract parties at the very early stage of the project.
- Second step is preparation of a detailed schedule for the following milestone period. This steps includes procedures of lookahead planning in LPS. Before preparing the schedule, a constraint analysis should be carried out by the project team and alternative plans should be developed for the expected problems. The pull based scheduling approach will support lean construction principles by constituting a continuous work flow. The schedule will be the basis for delay analysis throughout the period.
- Third step has two main processes: periodical analysis of delays and meetings for preventive actions. A window based delay analysis approach should be utilized to estimate delays throughout the regular update intervals. Following the quantification of delays at

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each window, delay meetings should be organized between the project team and the Owner representatives. Delay meetings correspond to the learning phase of LPS and a delay register should be the output. Main contribution of the delay meetings to lean principles is improved communication between the contract parties throughout the project. In addition, lessons learned from the current delays will be transferred to following period while preparing its schedule.

- Last step of the proposed methodology is transfer of delays. Inexcusable delays, excusable-compensable delays, and excusable-non compensable delays estimated at the end of third step are transmitted to the following period. This operation is repeated for each period until the end of project. Figure 1 illustrates the overview of the proposed delay analysis methodology.

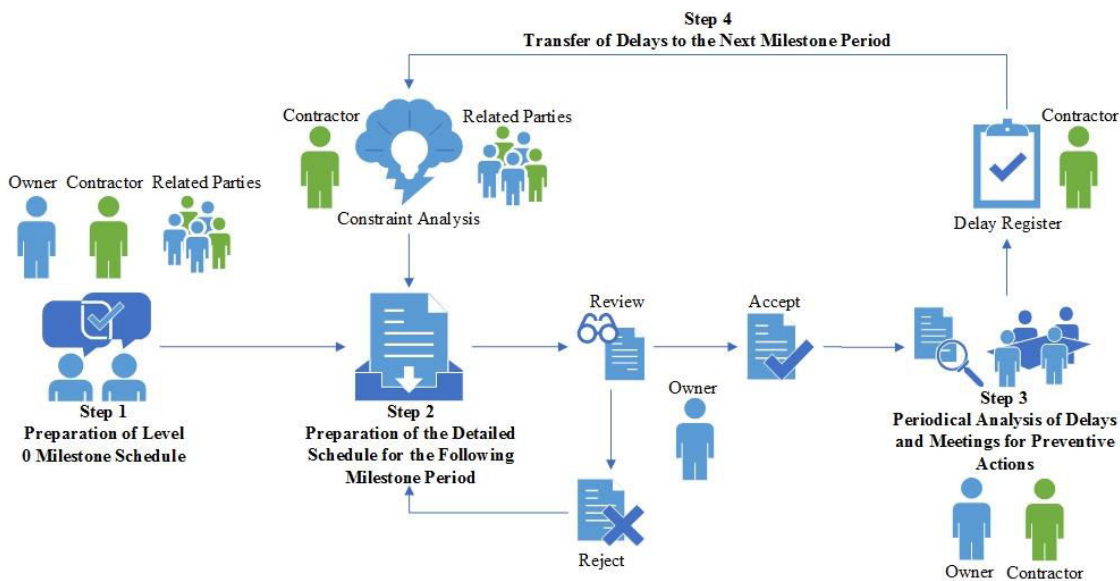


Figure 1: Implementation Steps of the Delay Analysis Methodology

### 3 IMPLEMENTATION PROCEDURE

Implementation procedure of the proposed methodology is exemplified using a real project data and actual delays in the project, though it has not been directly implemented. The example project involves the construction of 34 towers for an energy transmission line.

All steps of the methodology is represented over this project to demonstrate how it can be implemented under real project conditions. Steps regarding the preparation of the milestone schedule and detailed schedules, periodical delay analyses, delay register examples, and transfer of delays are explained in detail within the article. Although how the project parties can communicate could not be demonstrated in the example, proposed methodology is believed to advocate a consensus-based decision making at each step of delay analysis.

### 4 CONCLUSIONS

This article recommends an integrated methodology for delay analysis based on lean construction principles. It has a potential to improve the performance of construction projects by providing a delay-preventive mechanism, accurate and contemporaneous schedule information, and improved communication.

The applicability this methodology is planned to be tested on real cases by using action research methodology and its advantages/disadvantages will be tried to be evaluated by



conducting interviews with construction professionals. It is also believed that development of a tool that facilitates the implementation of the methodology can increase its applicability.