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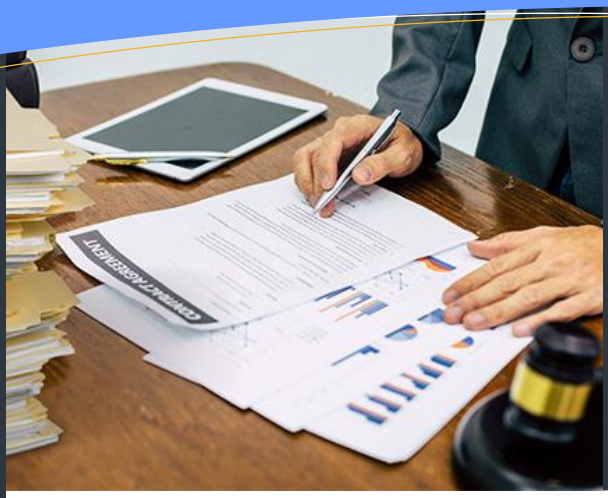
# "Proof and Analysis of Delays in Construction Projects with the Critical Path"



## this issue



## What is Critical Path?

Critical Path is the longest sequence of tasks in a construction project that must be performed consecutively to ensure successful completion of the project. A well-planned construction project will identify the Critical Path, which is determined through calculations in project planning software such as Primavera Planning Program or MS Project.

If any activities or tasks on the Critical Path are postponed, it would result in an overall increase or decrease in the project completion time.

In a project plan that displays the Critical Path, there is the "Total Float" which represents how many days for each activity or task can be delayed without impacting the overall project completion. Activities on the Critical Path which have zero Total Float are considered Critical Activities.

On the other hand, activities with a Total Float greater than zero are considered Non-Critical Activities and can be delayed by the amount of Total Float without affecting the overall project timeline. However, if these activities are delayed beyond their Total Float, they may become Critical Activities. Monthly planning is a process performed each month to monitor the progress of various activities and adjust plans to accommodate changing circumstances. A monthly plan is like a guiding indicator that helps determine whether the project is on the right track. If progress does not align with the plan, team members must take an action to adjust the work plan and control measures to bring the project back on track

## Importance of Critical Path

Construction projects involve complex processes, diverse management and multiple stakeholders, along with various components that require coordination to ensure the project's completion as per plan schedule.

Examples of components in construction projects include contractors who are responsible for foundation work, structural work, architectural work, electrical systems, plumbing, HVAC systems, communication systems, building facades (glass and windows), interior finishing, roofing, project management consultants, and designers in each branch.

Furthermore, each type of work typically involves several stages that require approval before moving on to the next phase. These stages include preparing and submitting detailed shop drawings, addressing requests for information (RFIs), submitting material approval documents, sending method statements, responding to or approving submitted documents, requesting access to sites, delivering sites and requesting inspections.

In large construction projects, numerous individuals are involved, ranging from hundreds to thousands, and there are multiple waiting approval stages within constrained time frames and spaces. Numerous activities occur simultaneously. Therefore, determining which tasks are the most time-critical (Critical Activities), which tasks need to be performed first, and which tasks can afford some delays (Non-Critical Activities) can be challenging.

The Critical Path is a crucial tool that helps each team understand and plan their work appropriately. Tasks on the Critical Path are significant and should not be delayed. If delays occur, it becomes necessary to expedite the task or rearrange the sequence of remaining tasks to mitigate or avoid overall construction project delays.

## Changes to the Critical Path During Project Execution

The Baseline Schedule initially shows the Critical Path planned from the start of construction work. As time goes by, activities that were not initially on the Critical Path in the first month may become Critical Activities or part of the Critical Path. Activities that has Total Float Time but was used up to become zero or negative may also become Critical Activities. If further delays occur, they will impact the overall project completion time.

The Critical Path often changes during construction work. Monthly schedule updates help track changes in the Critical Path month by month.

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## Who owns the total float?

Total Float refers to the amount of time an activity can be delayed without impacting subsequent activities in the project plan and without affecting the overall project completion date. Activities with Total Float have flexibility in their scheduling and do not affect the overall project timeline.

Total Float is an expiring resource, meaning it expires if the activity is not delayed. Usually, the owner or the contractor can utilize this Total Float; it does not belong to anyone.

It is First come, First serve!

## What is Critical Delay?

In large construction projects, there can be a significant number of work orders from the project owner, and there may be numerous delay events, even up to hundreds of events. These delays may be caused by various parties involved in the project, including the project owner, owner's representatives, direct contractors, subcontractors, manufacturers, designers, third parties or government agencies. However, delay events are not always an impact to the overall project completion time. Only the delays on the Critical Path will impact the overall project duration. Analysis of delays with the Critical Path Method will identify the Critical Delays that cause the delay of the project completion date.

### Monthly Schedule Updates

Changes in construction projects are common and can be caused by various factors such as changing weather conditions, design, or material modifications from those specified in the contract or deviations of starting time from the originally planned sequence of work. Therefore, project plans need to be adjusted to reflect the actual conditions at a given time, which is referred to as schedule updates.

Monthly schedule update is a necessary process in construction projects which include the following activities:

- Updating the actual start and finish dates.
- Updating the percentage of completion of activities.
- Adjusting the remaining part of the plan, such as reducing the duration of activities or resequencing work.
- Incorporating delay fragnets into the plan, specifying the relationships or logic with existing activities as appropriate.
- Calculating new estimated completion dates and summarizing the Critical Path for each month.

### Use of Critical Path in Practice

The monthly schedule update would help project stakeholders understand as to whether the project is likely to experience delays or not. It identifies which activities or delay events on the Critical Path need an immediate remedial action. It also provides an insight as to whether the project is on the right track, allowing for pinpointing issues. This ensures that the project management can address the problems effectively and guide the project back to a suitable direction.

# 4 Delay Analysis with Critical Path

The author gathers from over 20 years experience in an Extension of Time (EOT) claim with more than 300 mega construction projects both in Thailand and International.

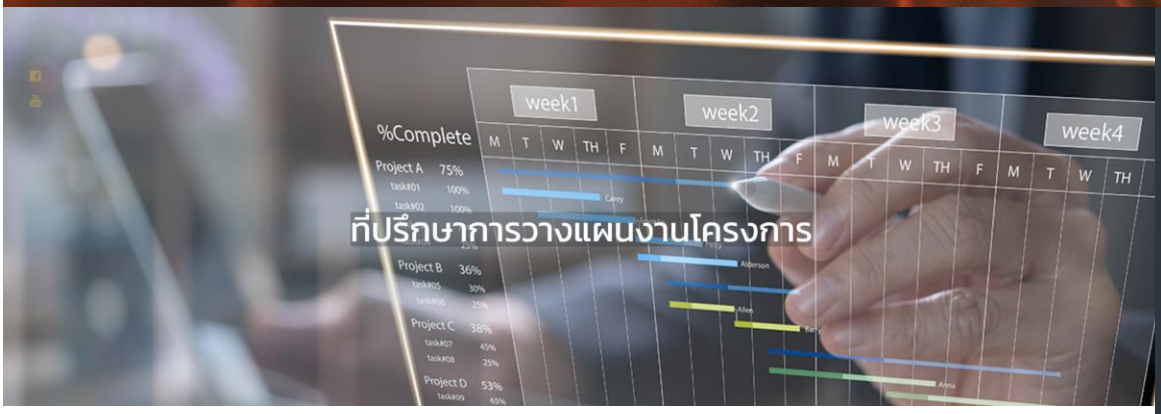
### Analysis of Delay with Critical Path

There are various methods for analyzing delays in construction projects. This article will focus on the analysis of delay with the Critical Path Method which evaluate which delay events impact the overall project completion time or which events become critical, either through prospective or retrospective analysis.

### Prospective Delay Analysis:

Prospective delay analysis involves incorporating a Delay Fragnet or a delayed activity segment into the project plan and calculating a new estimated project completion date.

- If the Delay Fragnet is added to the initial plan, it's known as Impacted as-planned analysis. This method does not consider actual activity completion dates, work acceleration, or plan adjustments during construction, making it more likely to have a significant impact on the overall project duration.
- If the Delay Fragnet is included in monthly schedule updates, it's known as Time Impact Analysis. This method assesses the monthly impact of delays, considers actual progress, involves plan adjustments to address issues, and maintains an appropriate Critical Path for each month.




## Retrospective delay analysis

Retrospective delay analysis examines the actual impact of delay events by comparing the baseline schedule with the as-built or actual schedule.

- Analyzing delays by comparing the Baseline Schedule with the As-Built Schedule at project completion is known as As-planned vs. as-built analysis. This method evaluates the initial plan against the actual plan when the project is finished.
- Analyzing delays by using the previous month's updated schedule as the new baseline compared to the subsequent month's updated schedule, assessing delays within specified time windows, is called Window Analysis. This method is similar to Time Impact Analysis but is performed after project completion, using the updated plan. The analysis can be conducted at regular intervals, such as every 3 months or 6 months, or during specific periods when delay events conclude.

Delay analysis reveals which delay events impact the overall project duration but does not specify who should be held responsible or explicitly indicate whether contractors should receive time extensions or compensation for time extensions.

Table 1: Summary of the methods for analyzing delays by using the Critical Path as mentioned above.

| Delay Analysis Methods | **Prospective delay analysis** | **Retrospective delay analysis** |
|---|---|---|
| Impacted as-planned | ✓ | |
| Time impact analysis | ✓ | |
| Window analysis | | ✓ |
| As-planned vs as-built | | ✓ |

## This Month's Q&A ConTime Tips

**Q: Who is responsible for the critical delay that causes construction delay?**

A: If it can be proven that the critical delay was caused by the owner, the owner's representative, or other contractors of the owner, the owner should extend the overall construction time and increase money for additional expenses during the time extension.

However, if the delay is caused by the contractor or subcontractors, the owner has the right to claim Liquidated Damages as specified in the construction contract.

In cases where delays are caused by force majeure or concurrent delays, the owner should also extend the overall construction time.

Provided that, the consideration and analysis of delays should be based on the conditions specified in the construction contract.

## Which delay analysis method does Dr. Mew use most?

From Dr. Mew's experience in analyzing delays in various construction projects in the United States, the most commonly used and contractually specified method is Time Impact Analysis.

Therefore, Dr. Mew uses this method because it is the most reliable way to analyze delays at a specific point in time, taking into account changes in the Critical Path.

If Dr. Mew is involved in time management and planning from the beginning of a project, she will update the schedule, add delay fragnets, and assess delays every month, even if it is not specified in the contract. Dr. Mew believes that this method is the most trustworthy and provides the best proof of delays.

However, if Dr. Mew needs to analyze delays after the project has ended or is close to completion, the choice of delay analysis method will depend on various factors, such as the construction contract, the process of handling claims, the availability of data, the schedule, and updates, the time frame for analysis, budget, and the amount of damages claimed.

Please specify the preferred delay analysis method in the construction contract.

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## Author's Brief Biography

Dr. Apirath Prateapusanond or Dr. Mew, a consultant for Extension of Time request for contruction project, a delay Analysis specialist, and Managing Director of Quantum PPP Consulting Co., Ltd., has more than 20 years of experience in delayed construction project analysis and international construction dispute consulting for over 300 large and medium-sized projects around the world, for example, Big Dig in Boston, USA, Hong Kong subway project, WAGP gas pipeline construction project in Africa, and Klong Dan sewage treatment plant project, Suvarnabhumi airport phase 1 construction project, and Mahanakorn building construction project in Thailand.

To prevent and resolve disputes from the beginning of the construction project, Dr. Apirath has introduced a modern construction document management system to the construction industry in Thailand. The system should be used by all parties in the construction project, such as project owners, project consultants, design consultants, contractors, and manufacturers in order to reduce costs, increase accuracy, avoid unnecessary delays, and to maintain a good relationship between all parties in the construction project with QConZol document management service (ConZol system provided by Quantum PPP).

Dr. Apirath holds a Ph.D. in Civil and Environmental Engineering. (Construction Management) from Virginia Polytechnic Institute, Blacksburg, Virginia, Master of Business Administration from University of Maryland University College, College Park, Maryland, Master of Operations Research from The George Washington University, Washington, DC, and Bachelor of Industrial Managementfrom Thammasat Business School, Thammasat University, Thailand.

**EXPERIENCE**

| | |
|---|---|
| Quantum PPP Consulting Limited | 2010 – present |
| PPP Consultants, Bangkok, Thailand | 2005 – 2010 |
| Hill International, Inc., Washington, DC | 1998 - 2005 |
| S.P. Electric Industry Co., Ltd., | 1992 – 1993 |

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