Float Mapping: An Effective Tool to Optimize Project Planning, Scheduling, and Risk Assessment [1]

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Abstract

This paper presents a case study of a metro project in which float mapping was applied to a CPM-based schedule to improve planning, scheduling, and risk assessment. Due to the project's complexity and the contractual requirements—which included a preliminary Quantitative Schedule Risk Analysis (QSRA) and the identification of float opportunities—I developed and proposed a custom float mapping approach as the project controls consultant to the contractor consortium.

While QSRA provided a probabilistic assessment of schedule reliability, float mapping offered a clearer understanding of the execution plan and helped focus attention on risks impacting key milestones. Float mapping is an essential technique for effective float management—an increasingly relevant topic in modern project planning and controls.

By mapping float values across the CPM logic network, project teams gain visibility into the distribution of total and free float across critical and sub-critical paths. This information enables better decision-making, proactive risk mitigation, and resource prioritization during both planning and execution phases. Associating float values with key milestones and assigning levels of criticality allows for a structured, risk-informed approach to project delivery.

Introduction

The programme (project schedule) is not fixed on the rock and critical path is doomed to change, due to various causes. Managing longest, critical and sub-critical paths is a matter of risk management; technical speaking, it requires the so called "float management" (Total and Free Float, as minimum), which, in turn, depends upon many factors included contract specifications and terms, nature of project (which dictates the hard-logic sequence of works), project organization and procurement strategy adopted, number and roles of key Stakeholders, which are all elements that can constrain the sequence of works.

"Float management" becomes the way by which the project manager can focus on the evolution of longest, critical and sub-critical paths. Obviously, you need a robust CPM network which represents the project and a set of project planning and scheduling procedures to guarantee that

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schedule update is performed properly, apart the expertise of the project manager and project team members, who all need a good understanding of planning and scheduling as well as of its relationship with risk management.

Float represents both a margin and an opportunity within a project schedule. It is the total amount of time a task can be delayed without affecting the overall project completion date or any other contractual milestone. This flexibility makes float a valuable resource for mitigating delays, optimizing project delivery, and assessing risks and opportunities.

Importance of Float Management and Ownership

Float management is the systematic process of planning, monitoring, and controlling float throughout a project lifecycle. Effective float management involves:

- **Mapping Float Distribution**: Understanding how float is distributed across critical and sub-critical paths.
- **Monitoring Float Consumption**: Tracking how delays erode float margins to identify potential risks.
- **Adjusting Scheduling Strategies**: Using float information to make informed decisions on schedule adjustments.

Float Ownership

Float ownership determines which party—the contractor, the owner, or both—has the right to utilize available float within a project schedule. This concept is often debated in large projects, especially when delays arise. Explicit contractual terms outlining float ownership help prevent disputes, promote fair risk allocation, and foster collaborative scheduling practices.

Ownership of float determines who has the right to use the float in the schedule. There are three common ownership models:

1. **Contractor Owns the Float**: The contractor retains control over the float and can use it to manage their risks and delays.
2. **Owner Owns the Float**: The owner reserves the right to use float for changes or delays they introduce.
3. **Shared Float**: Float is treated as a project resource, available to either party as needed.

Explicitly defining float ownership in contracts is crucial to avoid disputes and ensure fair risk allocation. For example, float-sharing clauses may specify that the float is available to either party to prevent delays, whereas float-allocating clauses assign ownership explicitly to one party.

Regardless of the ownership model, understanding float distribution is a prerequisite for effective float management.

Float Mapping

Float mapping is a powerful tool for improving project planning and control by associating float values with key project milestones. It provides a comprehensive understanding of how float is distributed across critical and sub-critical paths, helping to identify associated risks. This enables project teams to focus on high-risk areas during both planning and execution.

Float distribution is calculated through a CPM logic network, which represents the project schedule. The robustness of the CPM logic network not only ensures accurate float calculations but also determines the reliability of the criticality framework in guiding project decisions. In this context, the software Primavera P6 was utilized to perform the calculations.

Shifts in criticality can be effectively monitored by defining thresholds, which are project-specific parameters designed to reflect the unique characteristics, risks, and operational needs of each project. For instance, a reduction in float for a specific milestone increases its level of criticality, requiring heightened attention and resource allocation. Conversely, an increase in float may result in the milestone being classified at a lower level of criticality, allowing for greater flexibility in its management.

These thresholds also play a critical role during the execution phase, where they assist in monitoring shifts in criticality and guiding real-time decision-making.

Levels of Criticality

Building upon the foundational understanding of float mapping, the cornerstone of this approach is the **concept of levels of criticality**. A structured framework is applied to assign levels of criticality to each milestone based on its float value, providing a practical approach to prioritize milestones and enabling the project team to effectively allocate resources and actions.

The levels of criticality determine the degree of attention and monitoring required for each milestone:

Criticality Level example	Description
Level 0 (Longest Path)	Zero or minimal float; requires immediate attention to avoid delays.
Level 1 (High-Criticality)	Limited float; needs close monitoring to maintain progress.
Level 2 (Medium-Criticality)	Moderate float; allows balanced monitoring and resource allocation.
Level 3 (Low-Critical Path)	Significant float; provides flexibility in resource management.

Levels of criticality allow a better understanding of float distribution, improving clarity on critical and sub-critical paths. This understanding enables better risk identification and assessment, enhancing decision-making by highlighting high-risk areas and guiding resource allocation.

In practice, the framework must be adapted to reflect the unique demands of each project. As demonstrated in the case study, defining float ranges tailored to the project's characteristics ensures the criticality levels are both accurate and practical, improving planning and control outcomes.

Monitoring Levels of Criticality During Execution

While this study focuses on the tender phase, the defined levels of criticality offer valuable insights that should be leveraged during project execution. Monitoring these levels provides crucial data for effective project management by:

- **Identifying Shifts in Criticality**: Changes in float values can signal emerging risks, such as delays that may impact key milestones.
- **Optimizing Resource Allocation**: Recognizing when sub-critical paths approach criticality allows the project team to proactively redistribute resources.
- **Preventing Schedule Slippage**: Continuous tracking of float consumption can help avoid negative float values, reducing the likelihood of significant project delays.

In the case study described below, thresholds were tailored for key milestones such as 'TBM base slab completion,' with a float range of 3 to 5 days, indicating a level of criticality requiring immediate action. By defining such thresholds, the framework ensures practical and actionable categorization, aligning criticality management with overall project goals and providing a robust tool for decision-making."

By continuously monitoring these thresholds, the project team can maintain alignment with project goals, minimize risks, and ensure a smoother execution process.

Case Study: Metro Line Project

In the Metro Line Project, thresholds for float values were explicitly defined based on milestone importance. For example, the milestone 'Base Level Slab FOR TBM OVERHAULING' had a defined float threshold of 3 to 5 days, ensuring prompt resource allocation and corrective actions when float approached the lower limit. Similarly, for 'PORTAL FRAME READY,' a float range of 4 to 35 days was established, balancing flexibility with close monitoring of critical components.

Project Overview

The project involves the construction of a new metro line valued at over six billion euros, spanning seven years, with a workforce peak of more than five thousand personnel. The scope includes:

- **Stations and Tunnels for Underground Sections**
- **Bridges and Viaducts for Elevated Sections**

Each section of the project features contractual key dates tied to penalties, making float management a crucial aspect of the planning and execution process. During the tender stage, specific float opportunities were identified to enhance project flexibility and mitigate risks. These opportunities included:

- **Underground Stations**: A float range of 50–60 days was planned for completing base level slabs. This buffer, linked to the milestone "**Base Level Slab FOR TBM OVERHAULING**," (fig. 2) ensured that delays in station construction would not disrupt TBM operations.
- **Elevated Sections**: Float between 35 and 4 days was allocated for bearing completion, tied to the milestone "PORTAL FRAME READY," enabling seamless deck erection in subsequent sections.
- **Design Phase Overlap**: By overlapping Detailed Design Stage 1 (DD1) and Stage 2 (DD2), delays from multiple review cycles were minimized, ensuring a smoother design process.
- **Procurement Buffers**: Sensible float was allocated for procurement items, except for critical-path components like TBMs and launch gantries, which required closer monitoring due to their impact on the schedule.

Milestones and Float Distribution

The float distribution framework categorized milestones into these levels of criticality, ensuring clarity and prioritization:

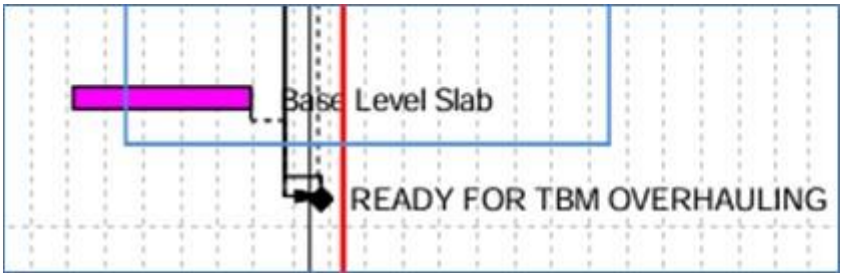


Figura 1 Float indicator and milestone

- **Level 0 (Longest Path)**: 0 to 5 days of float, requiring immediate intervention.
  - **Example**: Completion of Base Level Slabs for TBM Operations – Float Value: 3 days.
    - **Actions**: Immediate allocation of resources to mitigate risk of delays.
- **Level 1 (High-Criticality)**: 6 to 15 days of float, monitored closely for timely progress.
  - **Example**: Deck Erection for Elevated Sections – Float Value: 10 days.
    - **Actions**: Regular monitoring and contingency planning.
- **Level 2 (Medium-Criticality)**: 16 to 30 days of float, requiring moderate oversight.
  - **Example**: Electrical Systems Installation – Float Value: 20 days.
    - **Actions**: Moderate oversight, with flexible adjustments possible.
- **Level 3 (Low-Critical Path)**: More than 30 days of float, allowing greater flexibility.
  - **Example**: Finishing Works in Stations – Float Value: 35 days.
    - **Actions**: Minimal intervention required unless other delays arise.

Figura 2 TBM operations

Figura 3 Deck erections

Tools and Practices for Effective Monitoring

To maximize the utility of criticality levels, the following practices can be implemented during execution:

1. **Regular Schedule Updates**: Incorporate real-time progress data to verify whether critical and sub-critical paths align with initial projections.
2. **Float Consumption Analysis**: Utilize trend charts to visualize changes in float over time, aiding in early detection of issues.
3. **Integration with Performance Metrics**: Combine criticality levels with indices like CPI (Cost Performance Index) and SPI (Schedule Performance Index) for a comprehensive assessment of project health.

Insights for Project Leadership

Effective monitoring of criticality levels during execution provides:

- **Early Warnings**: Alerts for milestones at risk of being missed, enabling timely corrective actions.
- **Performance Trends**: Patterns in float consumption that reveal recurring challenges or systemic inefficiencies.
- **Data-Driven Decisions**: Accurate, actionable information to justify resource reallocation, prioritization adjustments, or stakeholder negotiations.

By integrating the framework developed during the tender phase into execution, project teams can maintain tighter control over schedule performance and achieve greater alignment with project objectives.

Float Consumption: An Indicator of Delay

Float consumption serves as a measurable indicator of delay events. By tracking float erosion, project teams can:

- **Detect Early Delays**: Monitor how delays on non-critical paths gradually consume float margins.
- **Evaluate Impact**: Assess when float values transition to negative, signaling schedule risks.
- **Support Corrective Actions**: Use float consumption trends to implement timely interventions.

During execution, float consumption trends can also highlight potential disruptions, such as increased resource overlapping or productivity loss. Visualizing this data in trend charts can improve comprehension.

Applications and Benefits

Float mapping has demonstrated its value in various phases of project planning and execution. By leveraging float mapping during the tender stage, project teams can gain a granular understanding of schedule flexibility, helping to mitigate risks and optimize resource allocation. This technique also provides a framework for identifying critical paths, enabling the project team to prioritize actions and interventions effectively.

Looking forward, the next section explores how these benefits translate into actionable insights during both the tender and execution phases, showcasing the tangible advantages of float mapping in real-world project management scenarios.

Tender Stage Advantages

- **Improved Schedule Transparency**: Float Mapping provides a clearer understanding of critical and sub-critical sequences.
- **Risk Simulation**: Integration with Quantitative Schedule Risk Analysis (QSRA) models supports probabilistic evaluations of schedule reliability.
- **Enhanced Cost Contingency Planning**: Float Mapping enables more detailed contingency allocation, improving cost planning accuracy.

Execution Phase Advantages

- **Delay Detection**: Monitoring float consumption identifies early signs of schedule disruption.

- **Productivity Analysis**: Evaluating float consumption against operations types can quantify disruption impacts, supporting claims for compensable delays.
- **Dynamic Adjustments**: Float redistribution strategies help mitigate risks and maintain project alignment.

Conclusions

The integration of thresholds into float mapping frameworks adds significant value by enhancing precision in identifying criticalities and risks. Project-specific thresholds ensure that float categorization remains practical and responsive, improving both planning and execution phases. This adaptability is crucial for achieving alignment between operational resilience and strategic project goals.

Float Mapping is an invaluable tool for managing complex projects, offering insights into float distribution, delay trends, and schedule optimization opportunities. By establishing a robust Float Management system during the tender stage, project teams can proactively address risks, ensure schedule reliability, and improve decision-making throughout the project lifecycle.

Incorporating float ownership into the broader framework of float management adds depth and clarity, enabling better alignment of contractual terms, project goals, and stakeholder expectations.

Operational Clarity

The association of float values with key milestones and the categorization into levels of criticality have made it possible to identify risk areas, enhancing the planning team's ability to anticipate problems and allocate resources effectively. This approach is essential for large projects, where a strategic overview is required to enable the project management leadership to take the best course of action.

Flexibility and Resilience

The strategic distribution of float has allowed for the identification of real maneuvering margins to address unforeseen events during critical phases of construction, such as the passage of the TBM or the erection of bridge segments.

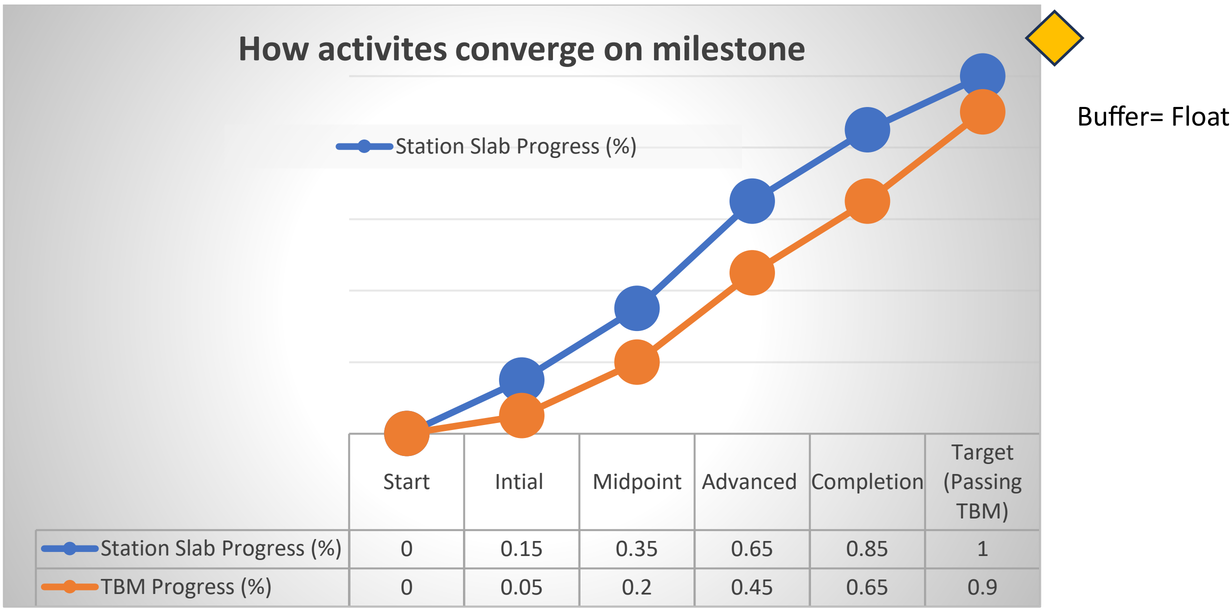
A Replicable Framework

The adopted approach can serve as a model that can be adapted and applied to other complex projects, ensuring greater control over the program: clarity of criticalities, identification of risks during planning, and strategic monitoring.

Future research and applications may explore the relationship between float consumption and disruption evaluation in greater depth, providing further tools for effective project management.

Float Mapping and QSRA

Finally, Float mapping, through the definition of criticality levels associated with key milestones, further facilitates the QSRA process. Once the key milestones are identified, it is possible to identify the risks that could impact them. This allows us to obtain a range of probabilistic values for the float associated with the milestones. In practice, we can determine the probability that a milestone will fall into one level of criticality rather than another. QSRA also increases the project team's confidence in the planning and provides fundamental input for identifying risk mitigation actions or, conversely, for exploiting opportunities.



About the Author

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Massimoluigi Casinelli, CCP is a senior consultant in project planning and controls with over 30 years of experience supporting international engineering and construction companies on complex infrastructure projects. His expertise covers highways, railways, civil and industrial buildings, air terminals, hospitals, and specific contributions in the energy sector. He specializes in setting up and implementing project management systems to measure costs, progress, and performance, mitigate delays, and support claims and risk mitigation. He is the author of international publications, including articles in the Cost Engineering Journal (on schedule delays and concurrent delay analysis) and in the PM World Journal (on EVM performance evaluation in complex projects).

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