Research on Schedule Control Strategies in Construction Project Management

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Keywords: Construction Project; Full Life Cycle; Schedule Control Strategy; Dynamic Monitoring

Abstract: The construction industry is now going through two concurrent trends, larger projects delivered in complex formats and a rapid digitalisation. To address construction-oriented schedule/content-constituent and cost constituent problems in public construction philosophy led by client organizations, it becomes ubiquitous to extract systematic controlling strategies from full life-cycle perspective for constructing systems. In this article, we take the pain points of construction project schedule control as the entry point, discuss the core role of schedule control in achieving project objectives, focus on full life cycle main stages schedule management requirements, and propose scientific and feasible foundation with regular timetable design based on evidence. It is supposed to provide reference for the schedule management of construction unit and contractor, and supplement empirical basis to improve theoretical system in construction project management.

1. Introduction

As an important carrier of national economic development, a proper delivery implementation mode is not only directly related to the construction of urban functions and people's livelihood needs, but also contributes to livelihoods and social benefits. As one of the three major objectives in construction project management, schedule control is a key link to ensure on-time delivery of engineering projects, control costs and avoid default risks. If the schedule is out of control, it will not only lead to additional costs such as labor idle time and equipment underutilization but may also cause losses to multiple parties due to missing market windows or violating contract agreements.

2. The Core Role of Schedule Control in Achieving Project Objectives

Schedule control is a core supporting link in the process of achieving construction project objectives. The project management team functions as the executive body of this model, which is mainly reflected in the comprehensive guarantee of system implementation duration, cost, quality, delivery and resource coordination. It can be specifically organized in a coherent way from the following aspects:

2.1 Ensuring Project Completion on Time

First, the project management team develops a detailed schedule plan according to requirements and clarifies the completion time of each stage. Next, they simultaneously track on-site activities in real-time enabling them to identify schedule delays and promptly reset expectations, avoiding a delay of one link to turn into an overall schedule overrun. In this way, the project can finally made it to its final stage of completion and delivery within the time-frame set in place.

2.2 Ensuring Project Cost Control

A project that gets delayed in schedule tends to become costlier, therefore. An even longer duration increases labor idle costs (paying workers to stand on air), equipment rental for capacity not used, e.g., tower cranes are expensive even when not in service, and greater materials storage management if the material arrives before it can be used [1]. By controlling the schedule, the project management team prevents unnecessary costs and helps keep project costs within the budget by ensuring that all links proceed as planned.

  DOI: 10.25236/icacel.2025.148

2.3 Ensuring Overall Project Quality

In the specific early stage delays of a project, rushing work blind can lead to streamlined processes, missing quality checks and thus quality hidden dangers. By controlling the schedule scientifically, there is no shortage of time for each construction activity and for quality inspection in the project management team; thus sequential activities are carried out without sacrificing quality while expediently finishing the speed progression to ensure that the finally delivered project meets standards [2].

2.4 Ensuring Rational Resource Allocation

The project management team is trained in the schedule plan, and can also predict the stand-by demand of resources: how many steelworkers and carpenters are needed when the main work comes in peaks; how many tons of cement in a certain stage; several cubic meters of sand and gravel need to be transported; which month needs excavators and concrete mixer trucks (CMs). They are trained on the basis of this, and then coordinate and allocate resources so that they have them exactly when the need arises [3]. It eliminates waste from premature resource accumulation and prevents the cessation of work arising from resource ceilings to enable orderly progress through all phases of a project, contributing eventually to achieving overall objectives.

2.5 Ensuring the Realization of Project Objectives

For a construction project, the owner and the contractor specify duration firmly in contracts negotiated between the two parties or associated with each contract from contractor to suppliers. Liquidated damages are to be paid by the party breaking the duration and commercial reputation may suffer close to time limits. By rigorous schedule control, the project management team ensures that the progress of construction is carried out as per contract time nodes so that the project can be finally completed and delivered in time without any overdue risks to protect all parties' legitimate rights and interests and commercial reputation.

3. Pain Points in Current Construction Project Schedule Management

Problems in current construction project schedule management are generally focused on various links of the whole process, involving the general project team and other participants and management mechanisms.

3.1 Unsolid Task Planning in the Planning Stage

Project teams frequently struggle with poor task planning. Most project schedules are established simply on industry norms or previous projects experiences. The charges are remains relatively approximate, with a limited detail of the sub-items in as far as explicit exercises and without truly looking at useful limit of asset supply and genuine site conditions [4]. Such as some projects do not confirm the supply cycle of sand and gravel suppliers when making pouring plans, resulting in a significant gap between the planned time and the actual resource availability time after commencement, which becomes a cause of delay at the very beginning. At the same time, plans often do not have very flexible buffers with or donot provide for contingencies, such as risk arising from climatic scenarios or policy shifts. As soon as the unexpected happens, your plan becomes easily passive.

3.2 Lag in Progress Tracking and Data Feedback

The majority of the project managers continue to use archaic means such as weekly reports and monthly inspections to monitor their progress, leading to delayed on-site data feedback. After the practical step of a construction team, it has to be signed and summed up by the project department in order for the progress to be upgraded. This process can take 2-3 days of lag. While a few projects employ digital tools, such as BIM—they are largely limited to visualization in the model rather than achieving the necessary real-time integration between schedule data and the model. With this, it is impossible to timely discover problems such as delayed rebar tying or out of place formwork

installations. Schedule deviations are often identified by managers after the optimal adjustment time has passed, causing to increases in the remedial cost up [5].

3.3 Poor Collaboration Among Multiple Participants and Information Barriers

The construction project subject consists of many main bodies such as the owner, contractor, design unit, supervision agency and suppliers. Among these agents have barriers to each other in the transfer of information. Notices of drawing changes from the design unit are circulationed by e-mail or on paper. In such a scenario, the contractor may not receive them in time and continue working with the previous drawings, resulting in rework and delay. Communication problems are also common between the contractor and suppliers of construction material. Supplier was unaware of material price increase and, did not inform it beforehand – delaying procurement process; contractor needed the feedback on the new sum in a timely manner without providing any information regarding schedule adjustment etc. In addition to this, the boundaries of responsibility between the parties involved is not always clear. In the presence of scheduling problems, there is typically a blame shifting effect without a clear collaboration mechanism.

3.4 Lack of Dynamic Resource Coordination Mechanisms

Standardized mechanisms are mostly used for the resource planning process of project teams and it has not been managed to create a dynamic adjustment mechanism. So, e.g., for a residential building project one could calculate a demand of 50 carpenters over all durations based on the total duration but then didn't account in the peak time during which the core structure is built. This led to a lack of carpenters working on some levels of the construction while other manpower was not working at various stages [6]. Material management has the same problems. To expedite progress, certain projects hoard quantities of steel bars in advance but because of limited spaces have to contend with rusting. Others, unable to anticipate the risk of sharp price increases in materials, find suppliers limiting supply during busy periods of construction.

3.5 Passivity in Risk Response

The risk-response passivity is especially pronounced. In the initial stage of risk identification, project teams neglect to identify many risks involving geology change, tight environmental regulations and supply chain disruptions. Such as the municipal construction, many projects made mistakes and did not investigate the distribution of underground pipelines in advance, resulting in damaging steel liquid gas pipes during construction, stopping work and rectifying. There were projects, which hadn ́t thought out contingency plans for a heavy rain and at some days needed to stop work due to insufficient drainage measures on that day, affecting the critical path. In the absence of effective response plans, project teams are forced to temporally coordinate resources in response to realized risks which inevitably leads to further delays in schedules.

4. Effective Schedule Control Strategies for the Full Life Cycle of Construction Projects

4.1 Preliminary Planning Stage

In the early planning stage of the full life-cycle schedule control in construction projects, it will be the key work for project management teams to develop a reasonable schedule plan scientifically matching with project objectives and implementable plans.

Subproject management team will begin with WBS, from large to small layer by layer decomposing down the overall project tasks: First clarifying indivdiual projects, further refining unit projects and further subdividing into sub-divisional works then further to sub-item works. The team will need to use Critical Path Method (CPM) after the decomposition, which helps establish logical relationships between sub-item tasks and sorts out core tasks that impact total duration versus flexible non-core tasks; it defines task priorities so future execution is not diverted by unclear focus.

Secondly, the project management team will determine the activity durations as an outcome of a single proof-of-method by time series integrating multi-dimensional data for each action. On one

hand they cite industry quota baselines; on the other hand, they pull data from previous projects. To comprehend this they organize for technical experts and team leaders from construction sector corps for reviews to resolve variances in estimates [7]. At the same time, 10% to 15% of buffer time is reserved in estimated duration for unpredicted events such as stoppages from heavy rain or temporary material shortages so that a strict plan does not cause an overall delay.

Finally, the project management side will promote the deep matching of schedule planning with resource requirements to avoid disconnection between plan and actual execution. By analysing the sub-tasks and respective time estimates, it will determine demand lists for labour, materials and equipment per stage. Such as, top-level main structure built-up period demand for how many steelworkers and carpenters to arrive; a certain month need transport how many tons of cement, and sand gravel cubic meter quantity; in which phase need how much tower crane or concrete mixer truck. In the case of key resources such as special classes of materials and skilled labor teams, the project management team will notify suppliers and labor companies in advance, sign a letter of intent or cooperation agreement, specify the cycles and delivery times for resource supply, and ensure that resources are collocated before carrying out related tasks to prevent work stoppage caused by lack of resources.

4.2 Completion and Handover Stage

For construction project schedule control, the completion stage is an important step in which the project management team pushes for a final sprint and reviews experiences. They have to deliver the project quickly and smoothly while building an experience suitable for schedule management in later projects.

Firstly, the project management team will refine the completion and handover schedule plan, clarifying the responsible entities and completion times for each task. The team will break down the closing work into sub-tasks such as organizing completion data, special inspections (fire control, planning, environmental protection, etc.), final account settlement, and site cleaning. For instance, specifying that the data specialist needs to complete the compilation and archiving of construction logs, test reports, drawing changes, and other materials within 15 days; assigning the inspection coordinator to initiate fire control inspection with the construction department within 10 days after data completion. Meanwhile, the team will prioritize key inspection links, as these directly affect whether the project can be delivered legally. For example, if the planning inspection fails, the project cannot proceed with property registration. Therefore, the team will communicate requirements with the inspection department in advance, preparing materials such as survey reports and as-built drawings to avoid inspection delays due to missing documents.

Secondly, for issues remaining from the project implementation process, the project management team will establish a register and promote quick resolution.By carrying out joint site checking with construction teams and the supervision unit, the team will register all unopened items such as local wall repairs, poor sealing of doors and windows, undelivered ancillary facilities, etc. Prioritizing these along "urgency + delivery scope impact". Such as, for rectification of water and electricity pipelines which affects owner occupancy would rank higher in list and must be completed by the construction team within 3 days; meanwhile, perfecting landscape features which do not affect core use can wait [8]. While rectifying these violations, a team will designate special individuals who will have to monitor the status of each violation on a day to day basis coordinating with testing agencies for inspecting at the same time. That is, for each rectification item completed, apply for inspection as soon as possible to avoid wasting time due to the disconnection between rectification and inspection.

Thirdly, the project management team will organize a experience review of schedule control and summarize the success and failure of this project. The team will then compare the actual time taken against estimates, identifying areas where delays occurred. Other good practices will be also highlighted: if the real duration was shorter than expected, such as those linked to BIM visual monitoring for early detection and adjustment of schedule deviations or the "priority supply agreement" with suppliers that allowed to anticipate shortages of materials. If the actual duration

exceeded expectations, the project management team will explore root problems such as work stoppages due to unforeseen tightening of environmental policies in a certain stage, or rework arising out of delayed transmission of design change notifications during multi-party coordination. Then, the team will integrate these analysis results into case reports, recording reusable strategies and avoidable risk points, and writing them into an enterprise project management database, serving for reference in schedule plan formulation and schedule control of similar future projects.

5. Conclusion

In this paper, a set of schedule control strategies are systematically established based on the full life cycle and under the core view point of "full life cycle" with respect to each stage characteristics on construction projects. Including the focal point which is Say at preliminary stage on scientific disposition of planning and Later experience reuse and closing efficiency at completion stage. It gathers a number of usable & practical operation techniques for project management teams to apply, and guide more projects to achieve on-time delivery, cost control and quality compliance. At the same time, it also enriches the knowledge system for practice level theory of construction industry schedule management, thus guiding the competitiveness transition and refined sustainable management in this industry.

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