A simulation approach for a periodic PCR buffer allocation strategy in organizational program management

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ABSTRACT

In a dynamically changing environment, the manager of a maintenance and remodeling (M/R) program is confronted with an increasing complexity of coordinating and cooperating multi-resource constrained multiple projects. Uncertainty and interdependence are sources of the complexity, and cause an internal disruption of an activity and chain reactions of disturbance propagation that deteriorate the stability and manageability of the program. This paper evaluates previous endeavors to apply production control and management techniques to the construction industry, and investigates the possibility of applying other production concepts and theories to organizational program management. In particular, this paper proposes a buffer allocation strategy by which periodic buffers are allocated in the flows of program constraint resources (PCRs) to stabilize a master construction schedule instead of protecting individual activities. Comparative experiments by Monte Carlo simulations illustrate better performance of the proposed strategy in terms of program goals: productivity, flexibility, and long-term stability.

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1. Introduction

Time and cost are two important performance measures of a maintenance and remodeling (M/R) program[1] in a large owner organization. To a great extent, the costs of M/R projects depend on project durations, and project delays are becoming a major management issue in the M/R program. When the program undertakes multiple projects under the capacity constraints of multiple trade shops, a project coordinator[2] is confronted with the following two objectives: (1) timely completion of current/future projects and (2) efficient and stable utilization of multi-trade technicians. The complexity of the coordination in the projects is increased by the uncertainties of a dynamic M/R environment. In contrast to external uncertainty (an unknown stream of project requests), the project coordinator needs to manage the impact of the internal uncertainty (unexpected delays of activities) across interdependent M/R projects.

An activity delay of one project causes negative ripple effects to subsequent activities of that project. To make matters worse, disruption of the activity and/or the projects tends to trigger chain reactions of disturbance propagation throughout the whole program.

From the internal perspective of program execution, a project is delayed due to unpredictable events such as incomplete or defective design followed by reworks, untimely supply of required material and components, and absence of shop technicians. To control project progress in the program, it is imperative for the project coordinator not only to accurately forecast the duration of each project, but also to manage any impacts of duration variance on the program's global progress. Currently, these impacts are considered only intuitively, and the effectiveness of uncertainty management depends upon the scheduling skill of the project coordinator [1,2]. Intuitive consideration of this dynamic uncertainty does not yield reliable estimates of project progress, resulting in difficulty in controlling multi-project processes. To overcome this limitation, there is a need to explicitly generate and incorporate estimates of activity durations along with uncertainties and interdependence of these estimates.

Among the research in construction academia, "pull-driven" lean construction aims at "selectively" pulling resources from queues without "unduly" waiting [4,5]. If the decentralized "last planner" approach [6,7] is not directed by global objectives when internal disturbance occurs in the highly linked/cooperated system, the program/project manager may not find the coordination mechanism between subcontractors and general contractor(s), and lose the direction of the entire construction process. In the non-repetitive

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[1] Hansa et al.[3] defines a program as "a family of related projects managed in a coordinated way" (p. 565).

[2] In the dual level management structure of the M/R program (a planning-level program manager and an operational-level projects coordinator), the project coordinator: (1) generates an operational scheduling, and (2) coordinates trade shops and schedules outside vendors to provide a smooth flow of each project during actual construction. When a request for information (RFI) or a change order arises, the project coordinator resolves it while trying to keep the project within the budget and the planned completion date.