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Evaluating the Effectiveness of Activities to Enhance Construction Schedule Robustness Using Simulation Method

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Extended Abstract

Risk and uncertainty are an unavoidable aspect of project planning. The implementation of construction projects is exposed to risk factors and uncertainty more than other sectors of the economy. This is primarily due to the large number of participants in the investment and construction process and also long execution cycles, which increase the strength of the impact of external environment factors on the implementation of construction processes. The more complex the project is and the longer it is implemented, the greater the impact of risk factors, and the more difficult it is to assess the likelihood of their occurrence and predict their impact [1].

Traditional planning methods used in the construction industry, in which the durations of construction processes are random variables (PERT, CYCLONE, Petri networks, among others), focus primarily on determining the probability of meeting a directive deadline without considering random execution conditions. In addition, a common assumption in the aforementioned methods is that processes must start as soon as predecessors are completed, making it impossible to consider other strategies for starting processes [2-3].

When planning projects, one should strive to increase the reliability of meeting the directive deadlines set for the entire project, but also for its stages or individual processes.

Concepts that take into account changing execution conditions and process execution times are referred to as reactive and proactive scheduling [4-5]. The proactive approach involves designing schedules that are resilient to unforeseen disruptions that may occur during the course of a project. Proactive scheduling focuses on anticipating and planning for potential disruptions or uncertainties in the project schedule. For this purpose, robust optimization techniques are used, which focus on maintaining the acceptability of the solutions obtained for all realizations of the uncertain durations within an uncertainty set. A common way to increase schedule robustness in a proactive approach is to allocate time buffers. These buffers are in the nature of idle time and are located to protect the start dates of processes and counteract the propagation of schedule disruptions [6-8].

In reactive project scheduling, no base schedule is created. Subsequent activities are added to a predetermined partial schedule based on a so-called scheduling policy (or priority rule), which adds new activities at each decision point taking precedence and resource constraints into account [9-11]. Reactive scheduling involves rescheduling the project in response to unexpected events or disruptions to minimize their impact on project duration. It also provides flexibility to adapt to disruptions, ensuring timely completion of construction projects in stochastic environments [12].

The reactive approach assumes that when the schedule becomes outdated, corrective actions are taken, the scope of which is determined by information obtained during the course of the project [13]. Rescheduling can be done periodically or when an unexpected event occurs, causing a significant disruption to the course. Periodic rescheduling solves multi-period scheduling problem and implements only the first period schedule a due to the lack of a base schedule for the entire scheduling horizon, which makes resource management difficult, it is used more in industry in continuous batch production [14-16].

For most managers, complex optimization procedures are incomprehensible and therefore they prefer simple scheduling rules based on clear operating procedures. For this reason, the study proposes a method for selecting actions crashing the execution time of processes not yet implemented and determining the timing of their implementation in order to reduce delays in starting processes or project stages. For this purpose, network simulation experiments with non-deterministic times were conducted to evaluate the impact of process execution time variability on project duration.

The proposed method includes construction of a network model of the project, development of a baseline schedule, design of variants of activities that reduce process execution time and determination of their costs, simulation studies of the project execution model for various time reduction policies, and selection of the optimal time reduction modes. The established policy for responding to execution disruptions does not require complex optimization calculus and allows reducing the cost of increasing schedule robustness to disruptions. The established policy for responding to execution disruptions does not require complex optimization calculus and allows reducing the cost of increasing schedule robustness to disruptions.

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