Computation of Temporal Uncertainties in Construction Project Management Using Imprecise Probability

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Abstract

In construction project management, scheduling plays a crucial role in a project's success. Construction scheduling and monitoring schemes are used to predict the project's total duration. For this prediction, the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) are widely used. These methods predict the overall project's completion time based on the duration of each task and the allowable float in each task's starting time thru a network of tasks.

However, there exist variations and uncertainties in the duration of each event. As such, deterministic construction scheduling schemes are incapable of quantifying and computing these uncertainties. Although precise probability approaches are utilized for the enumeration and analysis of uncertainties in construction scheduling, their accuracy highly depends on the availability of significant data. Due to limitations of the available data, those precise probability approaches may yield erroneous results.

In this work, a new forward-backward formulation for CPM and PERT is introduced through which, uncertainties are defined based on the concepts of imprecise probability. To represent the imprecise probability structures, a probability box (P-box) formulation is utilized. Thru the network, in the forward formulation, the uncertainty in the duration of each task is represented by a P-box, leading to a determination of the resulting P-box for the project's total time. Conversely, in the backward formulation, given the P-box for the project's total time, the float time P-box for each task is determined. The forward path calculation is performed using P-box arithmetic; whereas, the backward path calculation is achieved through solving an inverse problem. For illustrating the applicability of this method, an example problem is presented and compared with conventional CPM, PERT, and interval approaches.