

Risk Mitigation Budget Allocation: A Simulation-Optimization Approach

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Abstract

Projects are exposed to numerous risks that may adversely affect their cost, schedule, and quality objectives. Since resources available for risk mitigation are usually limited, project managers must determine how to allocate a finite risk-response budget among competing risks. This study presents a simulation-based optimization framework for supporting risk mitigation budget allocation under uncertainty. The proposed approach combines Monte Carlo simulation and mathematical programming to evaluate and prioritize risk responses. First, project risks are identified and characterized in terms of occurrence probability, impact, mitigation cost, and mitigation effectiveness. Monte Carlo simulation is then used to estimate the expected impact and variance of each risk before and after mitigation. These outputs serve as inputs to a set of optimization models that allocate the available budget according to different decision criteria, including maximizing expected net savings, minimizing total variance, minimizing the probability of exceeding a predefined impact threshold, and minimizing regret. Since different criteria may lead to different mitigation strategies, a multi-criteria aggregation procedure is proposed to support the final decision. The methodology is demonstrated through a real-world infrastructure project involving thirteen identified risks and a limited mitigation budget. The results show that the proposed framework provides a practical and systematic decision-support tool for allocating risk-response budgets while explicitly accounting for uncertainty, expected benefits, and risk variability.

Keywords

Project Management, Simulation-Optimization Models, Risk Mitigation.