Risk management for rapid transit network capacity expansion planning

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A dynamic stochastic pure 0-1 model is presented for optimizing the rapid transit network design (RTND) problem under uncertainty in passenger demand, strategic and operational costs and network disruption. The uncertainty and decision variables in the model are represented in a multistage multi-level-scenario tree. Given the type of problem to deal with (a mixture of numerous strategic and operational decisions), the time horizon is partitioned in stages which are composed of consecutive periods. Two types of scenario trees are considered, namely, the strategic and the operational ones. So, we consider a so-named strategic scenario tree, such that at each node of the first period of any stage, the strategic decisions are made. For the operational scenario tree, an two-stage setting taken from [1] is considered, such that its first stage is included by each strategic node and its second stage represents the local uncertainty for the whole set of periods in the related strategic stage. This construction seems appropriate under the assumption that the uncertainty and passengers service of the available rapid transit network (RTN) is independent from one period to the next one in the same stage as, in fact, it happens in reality. The aim of the global model consists of maximizing the expected passenger demand, minimizing the expected service interruption and minimizing the PV of the expected total design and operational cost over the scenarios along the time horizon. Additionally, a measure for risk reduction of the negative impact of the solutions on non-wanted scenarios is considered, being this impact a shortage on transport demand, an excess on service interruption or an excess on strategic and operational costs. So, we propose to consider a set of multi-function risk reduction profiles in the risk averse measure of our choice, the so-called time stochastic dominance (TSD). The profiles include thresholds on the transport demand, non-interruption service levels and costs, bounds on the shortfall on reaching the thresholds for each scenario, and bounds on the expected shortfall on reaching them and on the fraction of scenarios with shortfall in the modeler-driven risk reduction period subset in the time horizon. The goodness of the proposal is verified by computational experience on well-known RTNs in the literature.

References

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