Abstract

This thesis presents an approach based on process simulation to quantify the influence of disturbances on operational productivity in mechanized tunneling. The limitations of the conventional planning methods are discussed in the thesis. These deficiencies include low transparency of assumptions and generated results, difficulties in considering uncertainty, abstraction of complex process interactions, and lack of detailed investigation of disturbances.

It is generally agreed that simulation is a suitable tool to address such deficiencies. The developed approach is based on a formal model description with standardized and graphical modeling notation. Three patterns of operational disturbances are distinguished in the thesis and modeled with graphical modeling notation. These disturbance patterns are disturbances directly affecting production, disturbances related to the supply chain, and cascading disturbances. Cascading disturbances may arise if the duration of a disturbance exceeds a certain threshold. This is exemplified in this thesis by the disposal of backfill grout to avoid hardening in the system.

Based on the formal model, a modular simulation approach is developed in the general purpose simulation framework. The elements identified in the system analysis are implemented as distinct simulation components. This ensures reusability and flexibility and enables the extension of the presented approach with additional simulation components to account for further developments or new areas of application.

The operational data of a reference project is processed to suffice as input data of the simulation study. This is done by structuring the data and application of the distribution fitting method. Probability distribution functions are derived to express uncertainties in process durations, as well the occurrence and duration of operational disturbances. The data from the reference project is applied in a case study to demonstrate the influence of the three disturbance patterns. Each disturbance pattern is presented in a separate example of application.

The presented approach holistically addresses the interdependencies between production and logistic processes of mechanized tunneling influenced by uncertainties and disturbances. This allows the identification of logistic bottlenecks. The explicit consideration of uncertainties and detailed modeling of interdependencies provides robust results for project scheduling.

The modularized simulation approach reduces the effort needed for model development and allows transparent evaluation of the alternatives. Decision-making is thus supported by a transparent planning tool.