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SIMULATION OF A COAL LADING PORT

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ABSTRACT

This case study considers the simulation of a coal lading port in order to determine which extensions are needed based on expected capacity demands. These investigations are executed in cooperation with the German company TAKRAF GmbH which planned and constructed the considered port. Processes at this port are influenced by uncertainties, like the provided coal mix from mines and transportation times from mines to the port or meteorological disturbances. The maximum capacity of the current state of the port was determined at a first step. Components which mainly limit the maximum outcome were identified. Based on these results, different extension scenarios were evaluated.

1 INTRODUCTION

The German company TAKRAF GmbH is specialized on planning and constructing facilities for the mining industry, including coal lading ports. A coal lading port is used to load coal, which is delivered from different mines, to ships in order to transport it to different customers. There are different types of coals handled by one port. The operating company of the considered coal lading port is expecting an increase of demand by 33%. Due to this forecast, they plan an extension of the port. Simulation is used in order to determine which extensions are necessary to reach the aimed throughput of the coal lading port.

In this paper, we describe the main steps of the simulation study. Firstly, the considered processes of the coal lading port are described. The simulation model is created using different modeling techniques. The main results are discussed at the end of this study.

2 PROCESS OVERVIEW

All processes of the coal lading port from delivery to shipping are considered. The coal is delivered by trains from different mines. Each wagon of a train can contain one type of coal. There are several rails at the port area where wagons can wait to be emptied. Trains are often late due to utilization and disturbances of the railway system.

Coal is loaded from wagons to conveyors by tipping stations. A tipping station can handle a train with 36 wagons. Two or three wagons can be emptied at once and loaded to the conveyors. These wagons must have loaded the same coal type. The coal is stored at heaps sorted by types. A stacker-reclaimer stacks the coal at the dedicated heap area.

Coal is delivered to customers by ships. One ship contains different hatches. Each hatch can contain one coal type. A ship must wait in the roadstead until a landing and all requested coal types are available. Loading starts when the ship has landed. The sequence of hatches is predefined. A stacker-reclaimer reclaims coal from the heap area and loads it to the conveyor system which transports coal to the ship. A ship loader loads the coal to the hatch. The ship can leave the port area when loading and toll documents are completed. A ship loading must be interrupted in case of meteorological disturbances like ice or storms. Ships must leave the port area in such a situation until weather conditions have improved.

3 SIMULATION MODEL

We created a simulation model using AnyLogic. This simulation tool provides a combination of different modeling techniques including several special libraries, i.e. for railway simulation.
Figure 1 shows the simulation model of the coal lading port. The Rail Library was used in order to model the railyard and tipping stations. Handling, especially sorting, of the trains at the railyard is not considered. Coal conveyors are modeled using elements of the Fluid Library. We used agent based modeling techniques especially for modeling stacker-reclaimers and ship loaders.

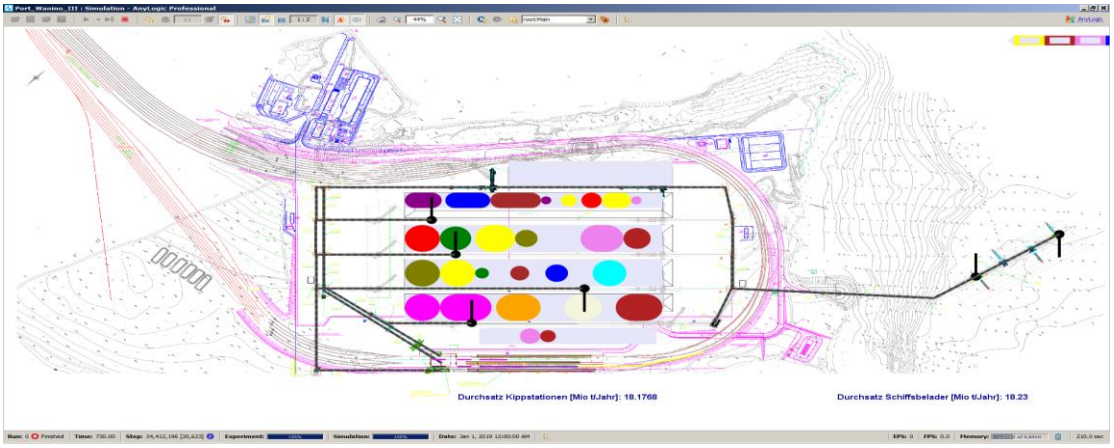

Figure 1: Simulation model of the coal lading port.

The main issue of this project was modeling of available heaps for storing coal.

Figure 1 shows a typical situation of storing coal at the port. The coal must be stored sorted by types, which is represented by different colors in the model. The amount of coal which can be stored at one place is determined by the width of the storage area, the available length of storage space, and the maximum heap height. A storage control is used in order to determine and allocate areas for storing coal. The main storing strategy is focused on creating as large heaps of one coal type as possible. This reduces loss of storing capacity. Additionally, the reclaiming capacity of stacker-reclaimers is reduced in case of small coal amounts at a storage place. The objects of the simulation model can be used as basic elements for creating new simulation models of coal lading ports with different layouts in an efficient way.

4 RESULTS

The first step of our investigations considers the current state of the coal lading port. It was expected, that the capacity of the coal lading port is not used completely currently. Hence, the maximum capacity of the port was determined. The capacity could be enhanced by these strategies:

- Coal types of high demand should be stored in a way that allows different stacker-reclaimers to access this coal type at the same time.
- Access of a storage place for loading coal to a ship should take into account, where coal from a tipping station should be stored next, in order to avoid waiting times at tipping stations.
- The possibility of tipping coal for a direct load to a ship can reduce the needed storage place. A detailed planning and presorting of wagons is needed for implementing this strategy.

The extension of the coal lading port includes a new tipping station and new storage areas for coal. There were two kind of tipping stations with different capacities which could be used. We proved that an extension with a tipping station of lower capacity and a new storage area is needed to reach the aimed throughput.