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also the containers on the higher levels. To get to the next container, the mechanics have small cars such that they can drive longer distances alongside the blocks. Within the rows of a block,

partial schedule, that is, after previously added jobs. Recall, however, that only the first job can be executed from the calculated schedule because rescheduling is initiated when the first job is finished.

The time complexity of the dispatching approach is $O(nm)$, because a job can be added to each of the m mechanics' partial schedules, and at most n jobs are scheduled until the procedure terminates.

4.3 Insertion-Based Scheduling Approach

The second heuristic is a bit more advanced than the first one although still simple and sufficiently fast. It can be seen as a variant of the well-known insertion concept for the TSP, see Rosenkrantz

This leads to acceptable computation times for the simulation model and to sufficiently realistic slots. The probability distributions reflect the actual distribution of containers in the stack that results from the original slot calculation strategy. Note that the slot is only needed for determining the pick-up and drop-off positions in the stacking crane jobs as well as the plug and unplug positions in the reefer jobs. Given that the distributions are realistic, realistic jobs are created for the stacking cranes and the reefer mechanics. It should be added that, due to the simplified slot assignment, shuffle moves cannot be derived from the stack. Consequently, for each departing container, a distribution based on its attributes is applied to generate the number of associated shuffles and the related stacking crane and reefer mechanic jobs.

6 Simulation Results

6.1 Experimental Design

The workload of a container terminal changes over time. On the waterside, it is higher during days with more vessels at the quay. On the landside, it is higher during daytime and on weekdays. Throughout this study, however, a constant high terminal workload case has been used. This is because workload peaks are the most critical situations in which each subsystem of the terminal must work properly. If the system works well during peak times, other times with lower workload will typically not be a problem. Another point is that a simulation with changing workload might not produce appropriate statistics. Productivities, waiting times, delays etc. are often reported in terms of averages, but these averages are often only meaningful if the workload situation is kept constant over time. Otherwise, large delays during busy times could be evened out by very small delays during less busy times, and the result might be a moderate average delay. This way, critical issues might not be detected.

With this in mind, a large terminal workload has been defined as follows: The quay is fully occupied, and all quay cranes are active. On the landside, the rate of internal and external trucks