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# Estimating and Optimizing Congestion Delay in Picker-to-Part Systems

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## Abstract

In the context of warehouse operations, picker-to-part systems are operational setups in which operators, commonly called pickers, navigate around the warehouse collecting all the necessary products to prepare customer orders. In the Operations Research scope, a common assumption is to consider a complete independent operation scenario for each picker, neglecting potential interactions between pickers.

Nowadays, given the changes on the behavior of customers it is common to see a large number of pickers operating simultaneously. This frame can lead to undesirable situations in which congestion appears. Congestion occurs when two or more pickers compete for the use of a shared space, delaying operational times and impacting overall performance.

In this work, we propose a mathematical and computational approach to estimate the delay produced by congestion on the total operation times. We analyze the delay in terms of the main factors and different storage policies and evaluate the effect of approximating it by using a time discretization. Finally, we present a column generation based solving procedure to optimize order batching and picker routing decisions, explicitly considering the impact of congestion on the total completion times.

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\*Speaker