Batch picking in narrow-aisle order picking systems with consideration for picker blocking

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Introduction

Congestion in the form of picker blocking has been a major issue in the order picking system (OPS) often causing significant performance loss. An OPS can be implemented by designing wide aisles to create less blocking or operating a zone picking with a single picker in each zone. Both solutions, nevertheless, can be intensively laboring and costly.

This study aims to **develop an order batching framework** to directly mitigate both travel distance and time blocked and **present a practical solution procedure** to solve the integrated batching and sequencing problem.

Model Formulation

(1) Constructing **batching framework considering a picking area with one-way aisles** and **adopting insights from flow-shop scheduling** problems to identify strategies to reduce picker blocking.

(2) Developing an **IBM framework** addressing in-the-aisle picker blocking, the sequencing of batches, the extension to multiple the same pick wave, and the effects of a picker retrieving multiple batches within the same pick wave.

Key Findings

This paper delves into **strategies controlling picker blocking delay of the batch picking in a narrow-aisle order picking system** by proposing an integrated batching and sequencing procedure called **the indexed batching model (IBM)** to minimize the total retrieval time.

This study develops **a mixed integer programming solution** for exact control and demonstrates a **simulated annealing heuristic procedure** to analyze realistic problem sizes.

The results indicate that the **IBM unveils significant effectiveness on narrow-aisle picking systems,** demonstrated by the mitigation of congestion in a class-based storage.

The **consideration of blocking in an integrated batching and sequencing** approach extrapolates substantial benefits.

The effective integration of batching, sequencing, and routing strategies can address issues around order picking systems.

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(3) Formulating a MIP to solve the IBM problem as a means of calculating an exact optimal solution to the joint routing, batching, and batch sequencing problem.

(4) Developing a simulated annealing heuristic algorithm.

Experimental Results

Experimental design and exact approach

- Designed to analyze the impact on walk time and delay time by comparing the proposed integrated batch creation and sequencing framework and alternative order batching and release approach.
- Considering three different batching (B) and release (R) scenarios, B-then-R, B-then-S, and IBM.

Simulated annealing (SA) approach for large-size applications

- Comparison of neighborhood rules in SA algorithm.
- Comparison to available algorithms across different pick-walk time ratios.
- Comparison across diverse storage policies.
- Comparison across the number of orders and sorting strategies.