Large-scale order batching in parallel-aisle picking systems

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Introduction

One of the critical issues in warehouses when retrieving small-sized, broken-case orders is a significant number of trips required for a picker to retrieve the batch resulting in high operational cost. Therefore, an efficient order batching algorithm can significantly impact operational costs in an order-picking environment that requires the retrieval of a large number of small orders.

This study deals with picking systems that process **500-2000 orders in a l-h time window** and considers both **short-while-pick and pick-then-sort strategies and both random and class-based storage policies**. The authors **approach the batching problem** by **selecting an appropriate route**, not by constructing route, and **derive a batching procedure** by first **assigning orders to routes and then constructing batches** within each route set.

Paper Contributions

(1) Demonstrating a large-scale, near-optimal order batching procedure for parallel-aisle picking systems.

(2) Introducing a new order batching formulation and relevant relaxation models utilizing a bin packing problem.

(3) Proposing batching algorithm that is comparable with the available heuristic algorithms in terms of both the travel distance and the total travel time.

Key Findings

This paper proposes **an order batching formulation and heuristic solution procedure** appropriate for a large-scale order picking situation in parallel-aisle picking system.

The procedure developed in this paper **contributes to efficient and effective DC design and operation**, where both space utilization and operational throughput are critical.

RBP is relatively robust to picker blocking, while Seed and CW II produce very poor results under heavy congestion. **The heuristic procedure constructed in this study, therefore, outperforms the existing methods**.

The proposed **RBP batching method could easily be added to a standard warehouse management software package**.

A variety of **direct extensions of RBP are possible**.

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Model Formulation

(1) Formulating the Route Selecting order Batching (RSB) model.

(2) Reformulating the Route-bin packing (RPP) by developing two relaxed models of RSB which are appropriate to serve as lower bounds.

(3) Constructing a heuristic route-packing based order batching (RBP) procedure.

Experimental Results

Computational time and the total travel distance

- RBP produces near-optimal solutions within about 2 min and outperforms the Seed and Clark and Wright II (CWII) algorithms.
- RBP demonstrates its significant advantages on large-sized problems and even more prominent results when the number of orders is small.

The average travel length per order

- RBP dominates the other heuristics in solution quality with very small gaps compared to both LB and IB.

Overall results

- The results confirms that RBS outperforms both the CWII and Seed algorithms but that CWII is more competitive.

Application in wide-aisle picking systems

- The paper covers the proposed extended framework with two-way wide-aisle pick areas. The result indicates that RBP benefits are even more pronounced for the two-way traversal rout