18

Optimization of a fast-pick area in a cosmetics distribution center

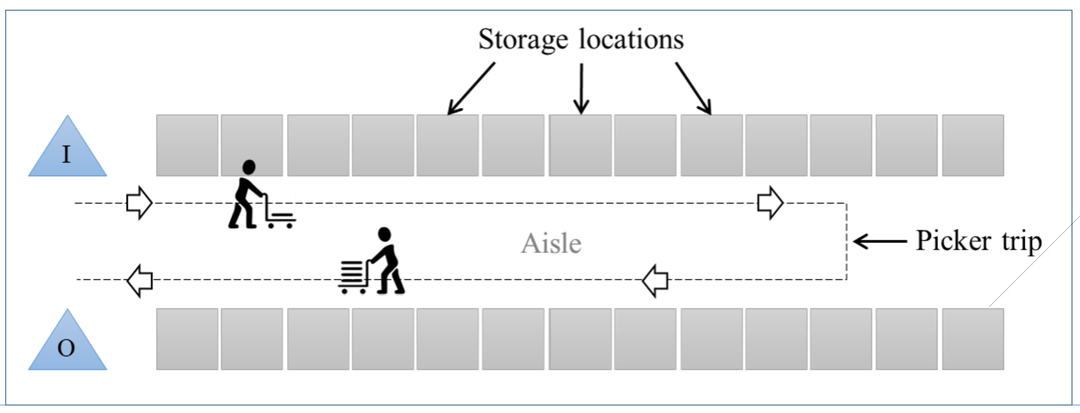
Mario C. Vélez-Gallego[1], Ph.D. and Alice E. Smith[2], Ph.D.

[1] Universidad EAFIT

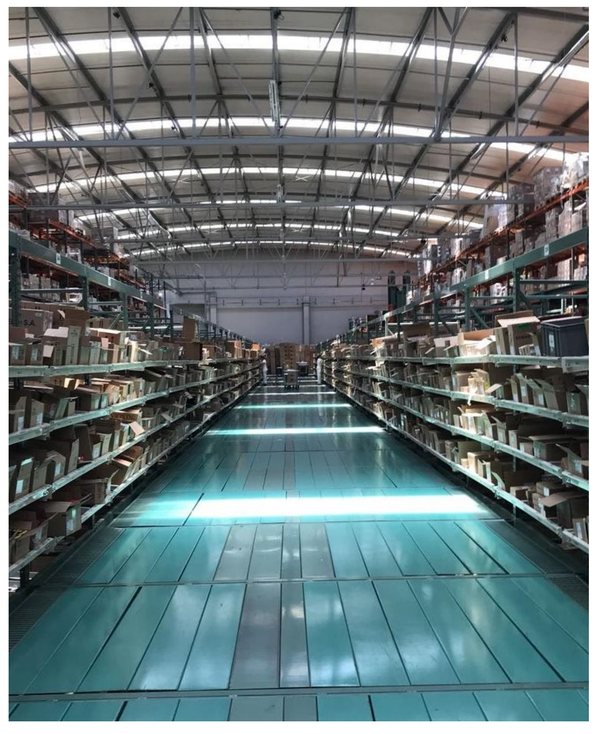
[2] Auburn University

Introduction

- This research was motivated by a manual picking operation of cosmetics and personal care products
- Each picker processes one customer order at a time
- To complete one customer order, the picker performs a U-shaped trip
- The depth of the trip is determined by the SKU stored furthest in the fast-pick area
- The problem is to decide on how many and which storage positions should be assigned to each SKU
- Related work in the literature assume that the travel time within the fast-pick area is negligible, not appropriate here



A storage location with 20 bins



Fast-pick area

Problem Description

Assign the SKUs to storage locations to **minimize** the labor cost represented by the **distance traveled** by the workers while performing both **picking and replenishment** activities.

Main assumptions:

1. A single SKU is restocked during a replenishment trip
2. At each replenishment trip all bins assigned to the SKU being restocked are filled to maximum capacity
3. All SKUs must be assigned to at least one storage bin

Solution Approach

A mixed integer linear programming formulation is proposed:

$$\textit{Minimize} \quad \underbrace{\sum_{k \in O} z_k}_{\text{Picking}} + \underbrace{\sum_{i \in L} \sum_{s \in S} \sum_{t=1}^{n_i} f_{ist} \cdot y_{ist}}_{\text{Replenishment}}$$

Travel distance

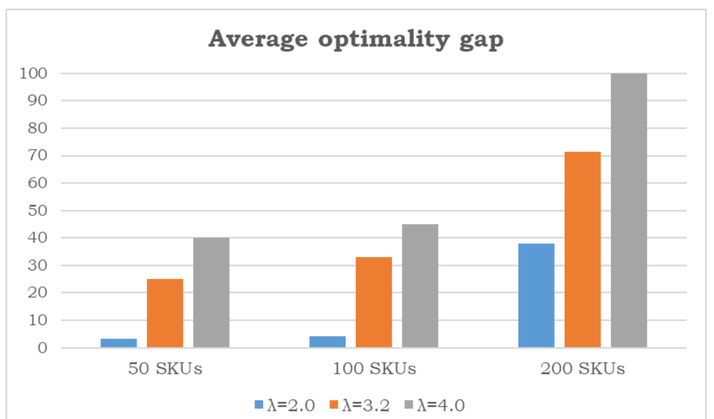
Computational Experience

A set of 45 random instances was used to test the performance of the formulation. The following parameters were used to generate the instances:

1. The number of SKUs
2. The size of the fast-pick area:
   a) Number of storage locations
   b) Number of bins per storage location
3. The ratio λ between the total number of bins and the number of SKUs

SKUs	λ	Storage locations	Bins per storage location
50	2.0	10	10
	3.2	16	10
	4.0	20	10
100	2.0	10	20
	3.2	16	20
	4.0	20	20
200	2.0	20	20
	3.2	32	20
	4.0	40	20

Test Instances



The solver (Gurobi 8.0®) was allowed to run for a maximum of three hours

Conclusions

- In this work we considered a relatively large fast-pick area where the distance traveled by the pickers should not be neglected.
- We addressed the problem of deciding where the SKUs should be placed, and the number of storage bins that should be assigned to each SKU.
- Our computational experience showed that the solving to optimality of realistic sized instances would be challenging.

Future Work

- Develop an approximation / heuristic solution approach to solve larger instances of the problem.
- This model addresses the problem that arises in a fast-pick area with a single aisle, where all the trips performed by the picker have a U-shaped pattern. A more general layout can be investigated.

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