Let Customers Scatter the Inventory: Multi-Objective Storage Location Assignment in Warehouses

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The rapid growth of online retailing necessitates flexible warehouse management strategies to adapt to this evolving landscape [1]. One of the critical challenges in this area is to reduce the order-picking travel distance [2]. This travel distance is highly affected by the Storage Location Assignment (SLA) decision, which determines how products are allocated to locations in the warehouse [3].

Prevalent SLA strategies are: (a) Scattered storage assignment (SSA): increases the accessibility of each Stock Keeping Unit (SKU) by spreading its units through the storage locations [4]; (b) Correlated storage assignment (CSA): stores correlated SKUs close to each other [5]; (c) Turnover class-based (TCB): stores high-demand SKUs near the depot(s) [6].

This study proposes a mixed SLA approach that adopts each prevalent SLA strategy to some degree, tailored to the customer order pattern. To do so, three analytical measures are defined to assess the realization degree of each prevailing SLA strategy. In order to address the dynamic nature of business needs, a data-driven approach is introduced to weigh each criterion. Then, proceeding from a descriptive phase to a prescriptive one, a novel multi-objective mathematical model for SLA optimization is proposed. This model incorporates the mentioned weighted measures and the contextual constraints.

As the main goal of SLA optimization is to reduce the order-picking travel distance, the proposed model is tested in the collaborative human-robot configuration in a mixed-shelves layout. In this configuration, robots and pickers are paired and pick all items on a pick list; once all items are picked, the picker sends the robot to the depot and starts picking with another robot [7]. Finally, post hoc analyses are being performed to validate the reliability of the proposed approach.

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