

## An Analysis of Pick Travel Distances for Non-Traditional Unit Load Warehouses with Multiple P/D Points

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**Abstract :** Existing warehouse configurations use non-traditional aisle designs with a central P/D point in their models, which is mathematically simple but less practical. Many warehouses use multiple P/D points to avoid congestion for pickers, and different warehouses have different flow policies and infrastructure for using the P/D points. Many warehouses use multiple P/D points with non-traditional aisle designs in their analytical models. Standard warehouse models introduce one-sided multiple P/D points in a flying-V warehouse and minimize pick distance for a one-way travel between an active P/D point and a pick location with P/D points, assuming uniform flow rates. A simulation of the mathematical model generally uses four fixed configurations of P/D points which are on two different sides of the warehouse. It can be easily proved that if the source and destination P/D points are both chosen randomly, in a uniform way, then minimizing the one-way travel is the same as minimizing the two-way travel. Another warehouse configuration analytically models the warehouse for multiple one-sided P/D points while keeping the angle of the cross-aisles and picking aisles as a decision variable. The minimization of the one-way pick travel distance from the P/D point to the pick location by finding the optimal position/angle of the cross-aisle and picking aisle for warehouses having different numbers of multiple P/D points with variable flow rates is also one of the objectives. Most models of warehouses with multiple P/D points are one-way travel models and we extend these analytical models to minimize the two-way pick travel distance wherein the destination P/D is chosen optimally for the return route, which is not similar to minimizing the one-way travel. In most warehouse models, the return P/D is chosen randomly, but in our research, the return route P/D point is chosen optimally. Such warehouses are common in practice, where the flow rates at the P/D points are flexible and depend totally on the position of the picks. A good warehouse management system is efficient in consolidating orders over multiple P/D points in warehouses where the P/D is flexible in function. In the latter arrangement, pickers and shrink-wrap processes are not assigned to particular P/D points, which ultimately makes the P/D points more flexible and easy to use interchangeably for picking and deposits. The number of P/D points considered in this research uniformly increases from a single-central one to a maximum of each aisle symmetrically having a P/D point below it.

**Keywords :** non-traditional warehouse, V cross-aisle, multiple P/D point, pick travel distance

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