

22 PULL-DRIVEN ORDER FULFILLMENT IN DISTRIBUTION CENTERS



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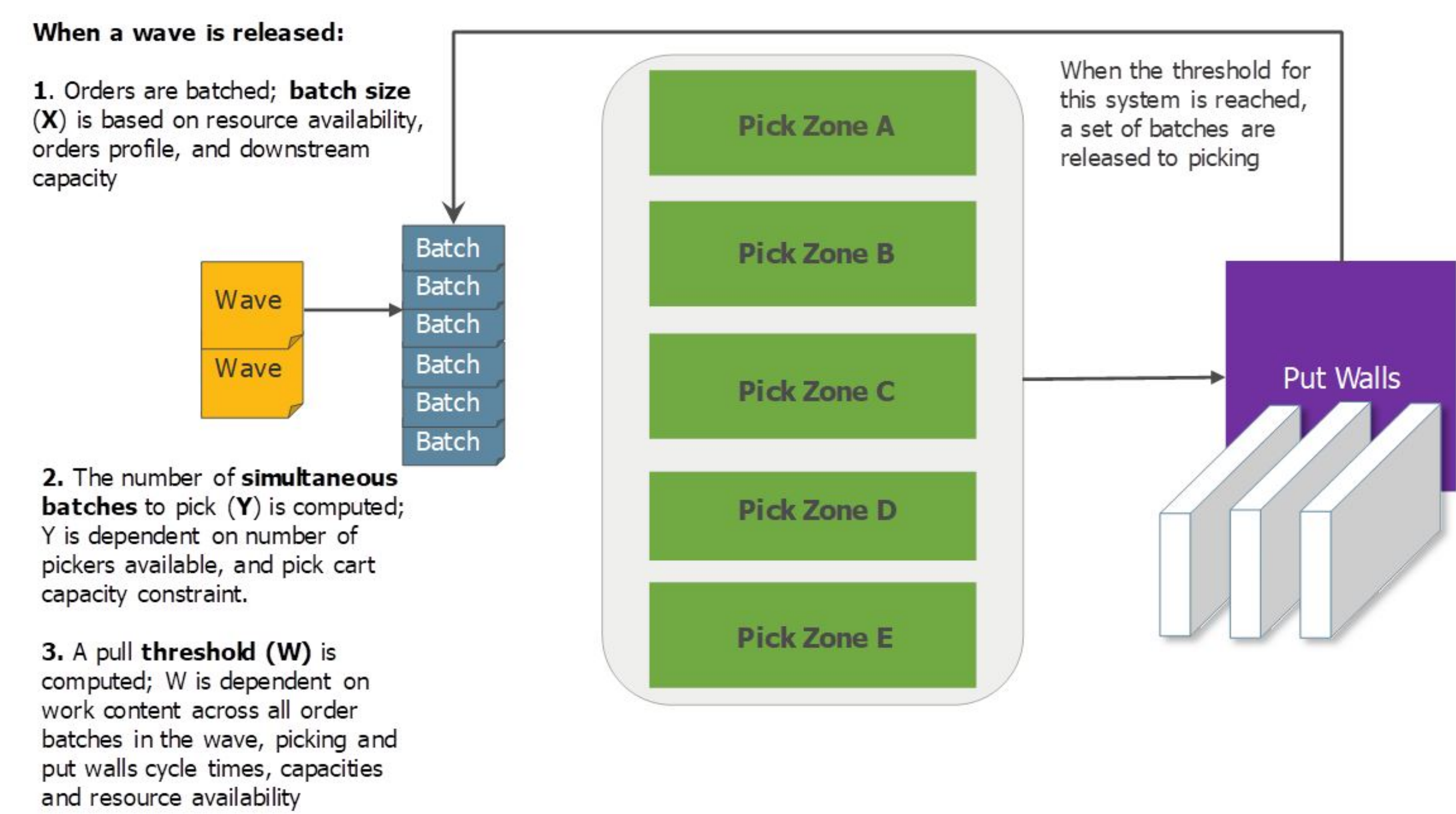
Motivation and Objective of Research

- E-commerce increases the need for innovative software solutions that can adapt swiftly to macro demand pattern changes as well as seasonal and daily volume peaks:
 - Proliferation of SKUs combined with high and fluctuating volume of orders that have few lines and few units
 - Customer expectations demanding high service levels in the form of shortened delivery times and free shipping
 - Desire to maintain high resource utilization and high workers productivity

Zone Picking to Put Walls



Pull Framework for Batch Picking to Put Walls



Results and Conclusions

System Parameters

- Duration = 20 hours
- Orders = 40,000
- Average Lines per Order = 4.2
- 12 Pick Zones
- 50 Put Walls

Pull vs. Push Parameters

- Batch Size = 108 for Push vs. 60 for Pull
- Batches/Pick Cycle = 10 for Push vs. 6 for Pull
- Push Release Policy: Release 1000 orders every 30 minutes
- Pull Release Policy: Release a batch when the number of batches in the system go below 48

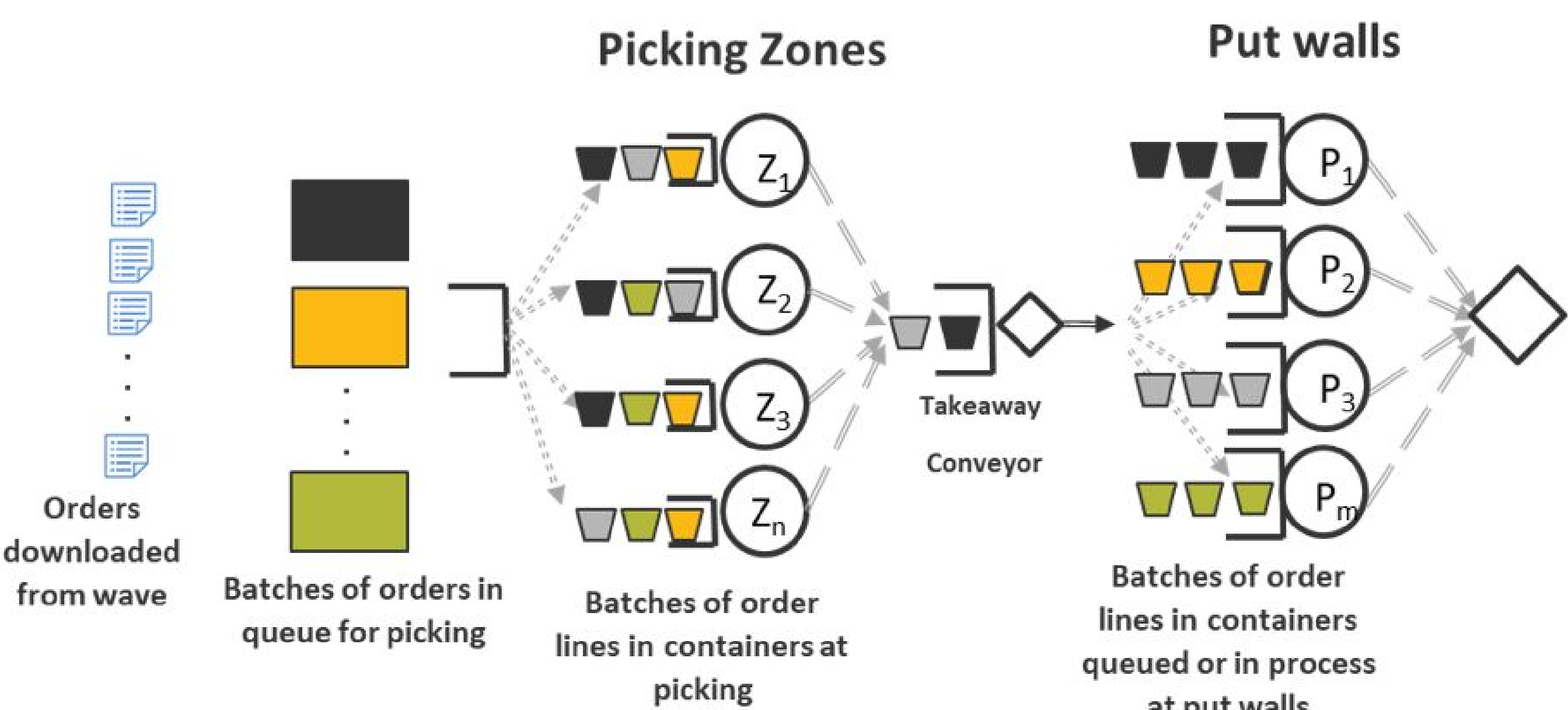
Put Wall Advantages

- Require lower capital investment compared to conveyor-based unit sorters
- Scalability and flexibility
- Easy to operate
- Productivity and accuracy can be enhanced substantially when coupled with an intelligent execution system

Put Wall Drawbacks

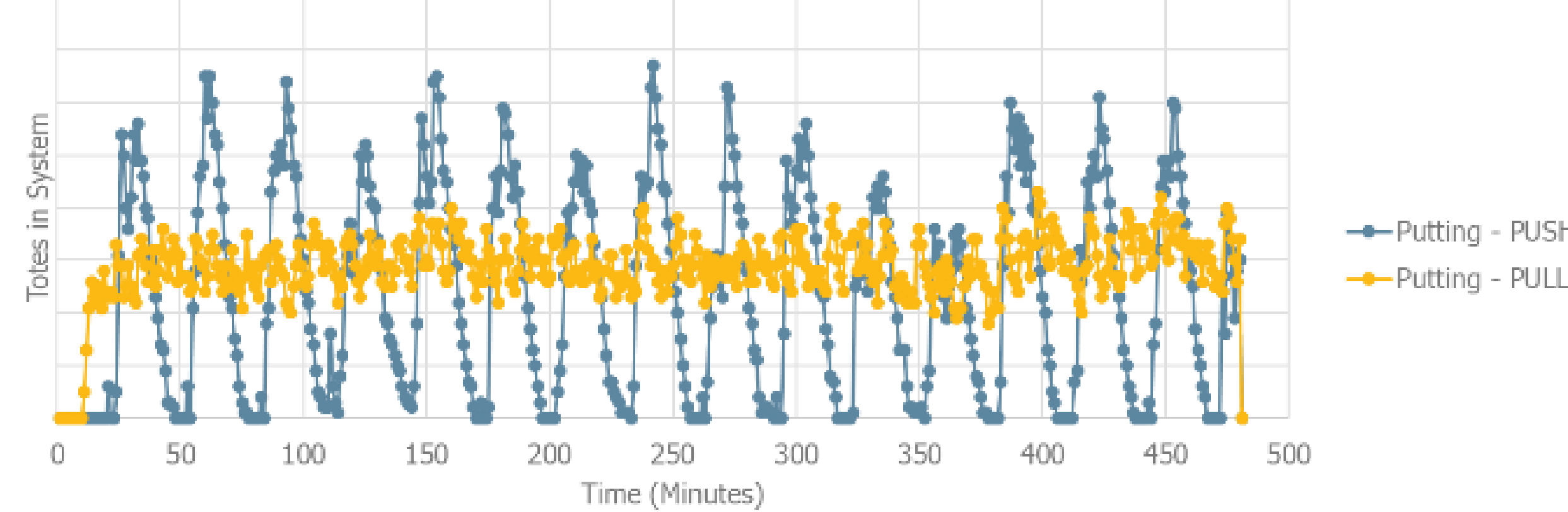
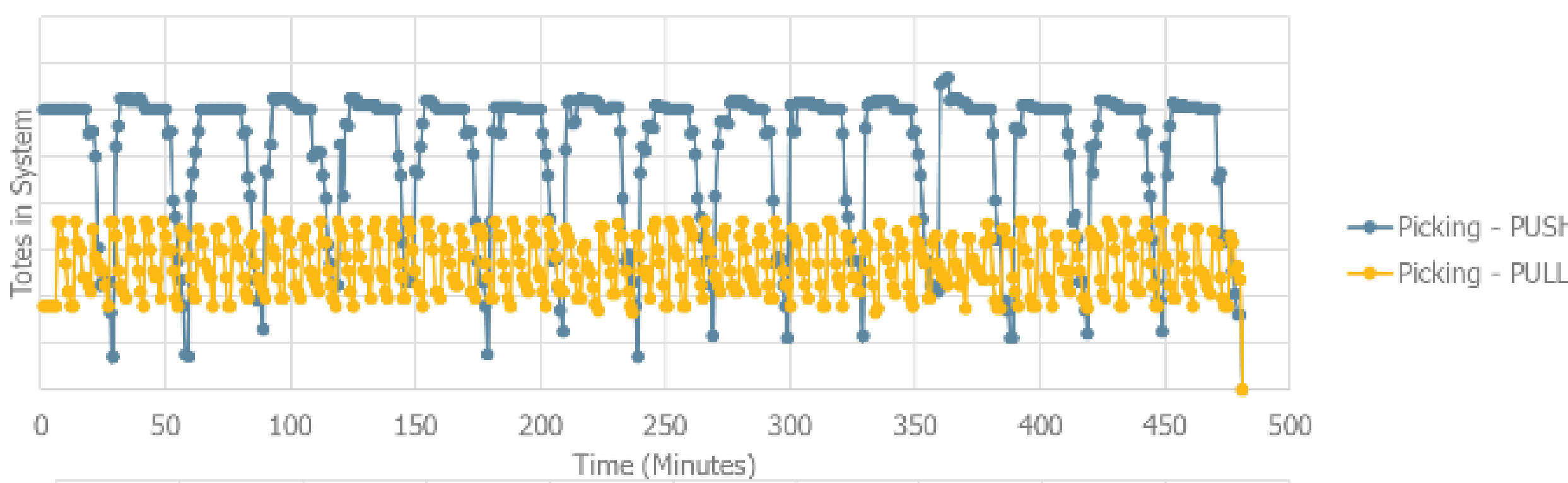
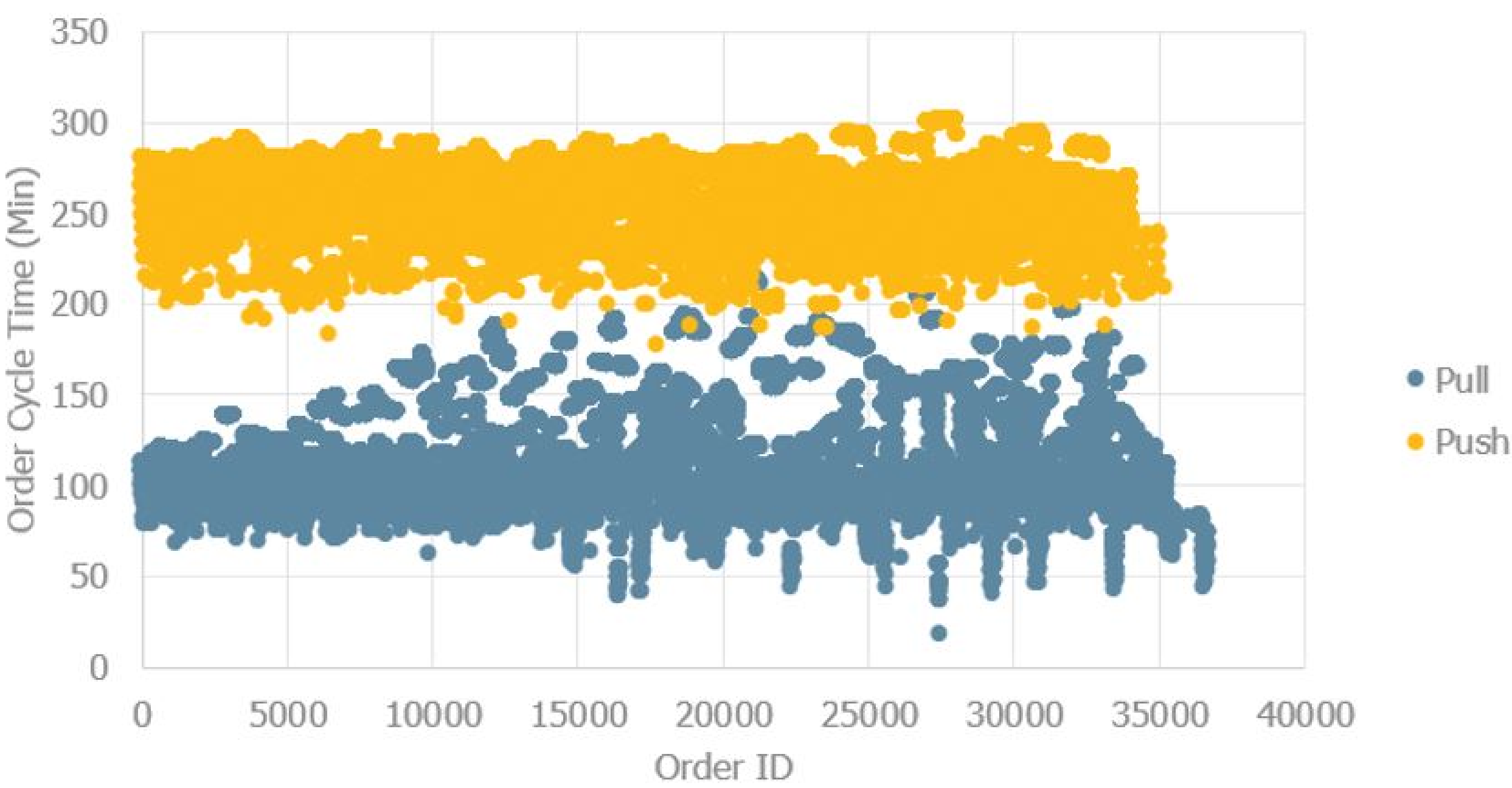
- Difficult to synchronize arrival of units that belong to the same order, and hence:
 - Long and highly variable dwell times of orders in put wall cubbies
 - Erratic resource utilization patterns
 - Long queues of containers at the put walls

Zone Picking to Put Walls Process Flow



Proposed Solution: Pull-Driven Order Release Control

- For a given setting characterized by:
 - Pool of orders
 - Picking and putting process parameters and capacities
- Determine minimum batch size (X) and cluster size (Y) that meet throughput within capacity constraints
- Determine the pull threshold (W) that maximizes system throughput



- A pull-based flow for fulfilling orders can vastly improve the operational performance including reducing the cycle time, meeting throughput requirements, and leveling resource utilization
- Interdependency between batch sizes, human resource availability, work content, and productivity need to be modeled and understood well prior to setting the pull parameters
- There are unintended consequences for smaller batches, such as the need for more people or more containers and more carts to keep the work flowing, or resource starvation